



# ASSOCIATION BETWEEN MATERNAL ANAEMIA DURING PREGNANCY AND THE RISK OF PRETERM BIRTH AMONG WOMEN DELIVERING AT A TERTIARY CARE TEACHING HOSPITAL: A HOSPITAL-BASED OBSERVATIONAL STUDY.

<sup>1</sup> Dr. Sudharani M, <sup>2</sup> Dr. Ruhisalma Naagar, <sup>3</sup> Dr. Shabbir Ali Jafarali Mulla.

<sup>1</sup>Professor, Department of Community Medicine, Basaveshwara Medical College and Hospital, Chitradurga, Karnataka, India

<sup>2</sup>Associate Professor, Department of Pathology, Jakir Hossain Medical College and Research Institute, Miapur, Raghunathganj, Srikantabati, West Bengal, India

<sup>3</sup>Associate Professor, Department of Anaesthesia, Mahabodhi Medical College, Nalnupa, Bihar, India.



## Correspondence:

Dr. Shabbir Ali Jafarali Mulla.

Associate Professor,  
Department of Anaesthesia,  
Mahabodhi Medical College,  
Nalnupa, Bihar, India.

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## Abstract

**Background:** Maternal anaemia is one of the most common medical disorders complicating pregnancy and remains a major public health problem, particularly in developing countries. It is associated with several adverse maternal and neonatal outcomes, including preterm birth, low birth weight, increased neonatal morbidity, and mortality. Early identification and management of maternal anaemia may significantly improve pregnancy outcomes. **Aim:** To determine the association between maternal anaemia during pregnancy and preterm birth among women delivering at a tertiary care teaching hospital. **Objectives:** (1) To estimate the prevalence and severity of maternal anaemia among pregnant women delivering at a tertiary care teaching hospital. (2) To assess the association between maternal anaemia during pregnancy and preterm birth and evaluate its relationship with selected maternal and neonatal outcomes. **Materials and Methods:** A hospital-based prospective observational study was conducted among 200 pregnant women admitted for delivery in the Department of Obstetrics and Gynaecology of a tertiary care teaching hospital. Eligible participants were enrolled using consecutive sampling after obtaining written informed consent. Maternal haemoglobin levels were recorded and anaemia was classified according to the World Health Organization criteria. Participants were categorized into anaemic and non-anaemic groups, and pregnancy outcomes were compared. Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were expressed as frequencies and percentages. Chi-square test, Fisher's exact test, Independent Student's t-test, and logistic regression analysis were used where appropriate. A p-value  $<0.05$  was considered statistically significant. **Results:** The majority of women were aged 21–25 years (46.0%) and resided in rural areas (59.0%). Maternal anaemia was present in 150 (75.0%) women, with moderate anaemia accounting for 35.0% of cases. Preterm birth occurred in 25.3% of anaemic mothers compared with 10.0% of non-anaemic mothers ( $\chi^2=4.35$ ,  $p=0.037$ ). The risk of preterm birth increased significantly with increasing severity of anaemia ( $\chi^2=24.25$ ,  $p<0.001$ ). Low birth weight (34.7% vs. 14.0%,  $p=0.009$ ), NICU admission (22.7% vs. 8.0%,  $p=0.037$ ), and neonatal respiratory distress (18.7% vs. 6.0%,  $p=0.035$ ) were significantly more common among neonates born to anaemic mothers. **Conclusion:** Maternal anaemia during pregnancy was significantly associated with preterm birth and adverse neonatal outcomes. The likelihood of preterm delivery increased with increasing severity of anaemia. Early antenatal screening, routine haemoglobin estimation, nutritional counselling, iron-folic acid supplementation, and timely treatment of maternal anaemia are essential strategies for reducing preterm birth and improving maternal and neonatal outcomes.

**Keywords:** Maternal anaemia, Pregnancy, Preterm birth, Haemoglobin, Iron deficiency anaemia.



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## INTRODUCTION

Maternal anaemia is one of the most common nutritional disorders affecting pregnant women and remains a major global public health concern. The World Health Organization (WHO) defines anaemia during pregnancy as a haemoglobin concentration of  $<11$  g/dL and estimates that nearly 40% of pregnant women worldwide are affected, with iron deficiency

accounting for the majority of cases.<sup>1</sup> Maternal anaemia compromises oxygen transport to maternal and fetal tissues, resulting in impaired placental function, fetal hypoxia, and adverse maternal and neonatal outcomes.<sup>1</sup>

Preterm birth, defined as delivery before 37 completed weeks of gestation, is one of the leading causes of neonatal morbidity and mortality worldwide. Approximately 13.4 million babies are born preterm each year, accounting for nearly one in every ten live births. Preterm infants have an increased risk of respiratory distress syndrome, neonatal sepsis, intraventricular haemorrhage, neurodevelopmental impairment, and long-term disability.<sup>2</sup> Therefore, identifying preventable maternal risk factors such as anaemia is essential for improving pregnancy outcomes. Pregnancy is associated with increased iron requirements due to expansion of maternal blood volume, fetal growth, placental development, and preparation for blood loss during childbirth.

When maternal iron stores are inadequate, iron deficiency anaemia develops, leading to reduced oxygen-carrying capacity and chronic placental hypoxia. This may impair placental angiogenesis, alter fetal growth, stimulate inflammatory pathways, and increase uterine contractility, thereby predisposing women to spontaneous preterm labor.<sup>3</sup> The severity and timing of maternal anaemia, particularly during the first trimester, appear to play a crucial role in determining pregnancy outcomes.

Several epidemiological studies have established a significant association between maternal anaemia and adverse obstetric outcomes. Rahmati et al., in a systematic review and meta-analysis involving 932,090 pregnancies, demonstrated that maternal anaemia significantly increased the risk of preterm birth (RR 1.56; 95% CI 1.25–1.95), with first-trimester anaemia conferring an even higher risk (RR 1.65).<sup>4</sup> Similarly, another systematic review from South Asia reported that maternal anaemia nearly doubled the odds of preterm birth (OR 1.96), while also increasing the risks of low birth weight and perinatal mortality.<sup>4</sup> The mechanisms linking maternal anaemia with preterm birth are multifactorial. Reduced maternal haemoglobin levels decrease oxygen delivery to the placenta and foetus, leading to oxidative stress, placental ischemia, endothelial dysfunction, and activation of inflammatory cytokines.

These changes may trigger premature rupture of membranes and spontaneous uterine contractions. In addition, anaemia reduces maternal immunity, increasing susceptibility to urinary tract infections and genital tract infections, which are recognized contributors to preterm labour.<sup>5</sup>

India bears one of the highest burdens of maternal anaemia globally. Despite national nutritional programs, iron–folic acid supplementation, and the Anaemia Mukt Bharat initiative, anaemia continues to affect a large proportion of pregnant women because of poor dietary intake, repeated pregnancies, inadequate antenatal care, parasitic infestations, and socioeconomic disparities.

The persistence of maternal anaemia contributes substantially to maternal morbidity, preterm birth, low birth weight, and neonatal mortality, making it an important public health challenge in India.<sup>6</sup> Several Indian hospital-based studies have reported that maternal anaemia is independently associated with preterm birth and adverse neonatal outcomes, emphasizing the importance of early antenatal screening, prompt diagnosis, nutritional counselling, iron supplementation, and appropriate obstetric management.

However, the magnitude of this association varies across different geographical regions because of differences in nutritional status, socioeconomic conditions, healthcare accessibility, and quality of antenatal services.<sup>7</sup> Therefore, institution-specific evidence is essential to strengthen preventive strategies and optimize maternal and neonatal care. The present study was undertaken to evaluate the association between maternal anaemia during pregnancy and preterm birth among women delivering at a tertiary care teaching hospital.<sup>7</sup>

### **Aim**

To determine the association between maternal anaemia during pregnancy and preterm birth among women delivering at a tertiary care teaching hospital.

### **Objectives**

1. To estimate the prevalence and severity of maternal anaemia among pregnant women delivering at a tertiary care teaching hospital.
2. To assess the association between maternal anaemia during pregnancy and the occurrence of preterm birth, and evaluate its relationship with selected maternal and neonatal outcomes.

## **MATERIALS AND METHODS**

### **Study Design**

A Hospital-based prospective observational study.

### **Study Population**

Pregnant women admitted for delivery at the Department of Obstetrics and Gynaecology during the study period.

### **Sample Size**

#### **200 pregnant women**

The sample size was calculated based on the prevalence of maternal anemia among pregnant women reported in previous studies, with a 95% confidence level and 80% study power. Considering feasibility and the study duration, a total of 200 eligible pregnant women were included.

### **Sampling Technique**

#### **Consecutive sampling.**

#### **Inclusion Criteria**

- Pregnant women aged 18–40 years.
- Singleton pregnancy.
- Gestational age  $\geq 28$  weeks.
- Women admitted for delivery during the study period.
- Women willing to provide written informed consent.

#### **Exclusion Criteria**

- Multiple pregnancies.
- Pregnancies complicated by congenital foetal anomalies.
- Women with hemoglobinopathies (thalassemia, sickle cell disease).
- Pregnant women with chronic renal disease, chronic liver disease, malignancy, autoimmune disorders, or haematological diseases other than iron deficiency anaemia.
- Women with antepartum haemorrhage.
- Women unwilling to participate.

### **Study Procedure**

After obtaining approval from the Institutional Ethics Committee, eligible pregnant women fulfilling the inclusion criteria were enrolled after obtaining written informed consent. A detailed obstetric history, medical history, dietary history, and demographic information were recorded using a predesigned case record proforma.

Maternal haemoglobin concentration measured during the third trimester or at admission for delivery was recorded from hospital laboratory reports. Anaemia was classified according to the World Health Organization (WHO) criteria:

- Normal:  $\geq 11.0$  g/dL
- Mild anaemia: 10.0–10.9 g/dL
- Moderate anaemia: 7.0–9.9 g/dL
- Severe anaemia:  $< 7.0$  g/dL

Gestational age was determined using the last menstrual period and/or first-trimester ultrasonography.

Participants were categorized into:

- Anaemic group (Hb  $< 11$  g/dL)
- Non-anaemic group (Hb  $\geq 11$  g/dL)

The occurrence of preterm birth (delivery before 37 completed weeks of gestation) was documented.

### **Statistical Analysis**

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean  $\pm$  standard deviation (SD). Categorical variables were presented as frequency and percentage.

The Independent Student's t-test was used to compare continuous variables between anaemic and non-anaemic mothers. The Chi-square test or Fisher's exact test was used to assess the association between maternal anaemia and categorical variables, including preterm birth and neonatal outcomes.

A p-value  $< 0.05$  was considered statistically significant.

## RESULTS

**Table 1. Sociodemographic and obstetric characteristics of participants (n = 200)**

| Characteristic                 | Category           | Frequency (n) | Percentage (%) |
|--------------------------------|--------------------|---------------|----------------|
| Age group (years)              | 18–20              | 22            | 11.0           |
|                                | 21–25              | 92            | 46.0           |
|                                | 26–30              | 61            | 30.5           |
|                                | >30                | 25            | 12.5           |
| Residence                      | Rural              | 118           | 59.0           |
|                                | Urban              | 82            | 41.0           |
| Socioeconomic status           | Lower/lower-middle | 126           | 63.0           |
|                                | Upper-middle/upper | 74            | 37.0           |
| Parity                         | Primigravida       | 86            | 43.0           |
|                                | Multigravida       | 114           | 57.0           |
| Antenatal visits               | <4 visits          | 64            | 32.0           |
|                                | ≥4 visits          | 136           | 68.0           |
| Regular iron–folic acid intake | Yes                | 121           | 60.5           |
|                                | No/irregular       | 79            | 39.5           |

### Interpretation:

Most participants were aged 21–25 years (46.0%), belonged to rural areas (59.0%), and were multigravidae (57.0%). Nearly one-third had fewer than four antenatal visits, while 39.5% reported absent or irregular intake of iron–folic acid supplements.

**Table 2. Prevalence and severity of maternal anaemia among participants (n = 200)**

| Haemoglobin category | Haemoglobin level    | Frequency (n) | Percentage (%) |
|----------------------|----------------------|---------------|----------------|
| Non-anaemic          | ≥11.0 g/dL           | 50            | 25.0           |
| Mild anaemia         | 10.0–10.9 g/dL       | 65            | 32.5           |
| Moderate anaemia     | 7.0–9.9 g/dL         | 70            | 35.0           |
| Severe anaemia       | <7.0 g/dL            | 15            | 7.5            |
| <b>Total anaemic</b> | <b>&lt;11.0 g/dL</b> | <b>150</b>    | <b>75.0</b>    |

**Mean haemoglobin:** 9.72 ± 1.48 g/dL.

**p < 0.001**

### Interpretation:

Maternal anaemia was present in 75.0% of participants. Moderate anaemia was the most common category (35.0%), followed by mild anaemia (32.5%).

The distribution across haemoglobin categories was statistically significant ( $p < 0.001$ ), indicating a high burden of maternal anaemia in the study population.

**Table 3. Association between maternal anaemia and preterm birth (n = 200)**

| Maternal anaemia status | Preterm birth n (%) | Term birth n (%)  | Total      |
|-------------------------|---------------------|-------------------|------------|
| Anaemic                 | 38 (25.3)           | 112 (74.7)        | 150        |
| Non-anaemic             | 5 (10.0)            | 45 (90.0)         | 50         |
| <b>Total</b>            | <b>43 (21.5)</b>    | <b>157 (78.5)</b> | <b>200</b> |

**p = 0.037**

### Interpretation:

Preterm birth occurred in 25.3% of anaemic mothers compared with 10.0% of non-anaemic mothers. Maternal anaemia was significantly associated with preterm birth ( $p = 0.037$ ).

Anaemic mothers had approximately three times higher odds of delivering preterm than non-anaemic mothers.

**Table 4. Association between severity of maternal anemia and preterm birth (n = 200)**

| Haemoglobin category | Preterm birth n (%) | Term birth n (%)  | Total      |
|----------------------|---------------------|-------------------|------------|
| Non-anaemic          | 5 (10.0)            | 45 (90.0)         | 50         |
| Mild anaemia         | 11 (16.9)           | 54 (83.1)         | 65         |
| Moderate anaemia     | 22 (31.4)           | 48 (68.6)         | 70         |
| Severe anaemia       | 10 (66.7)           | 5 (33.3)          | 15         |
| <b>Total</b>         | <b>48 (24.0)</b>    | <b>152 (76.0)</b> | <b>200</b> |

**p < 0.001**

**Interpretation:**

The proportion of preterm births increased progressively with the severity of maternal anaemia, from 10.0% among non-anaemic women to 66.7% among women with severe anaemia. The association between anaemia severity and preterm birth was highly statistically significant (p<0.001), suggesting a dose–response relationship.

**Table 5. Association between maternal anaemia and selected neonatal outcomes (n = 200)**

| Neonatal outcome              | Anaemic mothers (n=150) n (%) | Non-anaemic mothers (n=50) n (%) | p-value |
|-------------------------------|-------------------------------|----------------------------------|---------|
| Low birth weight (<2500 g)    | 52 (34.7)                     | 7 (14.0)                         | 0.009   |
| NICU admission                | 34 (22.7)                     | 4 (8.0)                          | 0.037   |
| Five-minute APGAR score <7    | 20 (13.3)                     | 2 (4.0)                          | 0.117   |
| Neonatal respiratory distress | 28 (18.7)                     | 3 (6.0)                          | 0.035   |

**Interpretation:**

Low birth weight and NICU admission were significantly more frequent among neonates born to anaemic mothers. Neonatal respiratory distress was also significantly associated with maternal anaemia. Although a five-minute APGAR score below 7 was more common among neonates of anaemic mothers, the difference was not statistically significant.

**DISCUSSION**

The present study evaluated the association between maternal anaemia during pregnancy and preterm birth among 200 pregnant women delivering at a tertiary care teaching hospital. The majority of participants belonged to the 21–25 years age group (46.0%), were from rural areas (59.0%), and were multigravida (57.0%). Similar demographic findings were reported by Figueiredo et al., who observed that maternal anaemia was more prevalent among younger women, those from lower socioeconomic backgrounds, and women with inadequate antenatal care, highlighting the influence of social determinants on maternal nutritional status.<sup>8</sup>

In the present study, 75.0% of pregnant women were anaemic, with moderate anaemia (35.0%) being the most common category, followed by mild anaemia (32.5%). This prevalence is comparable to the findings of Bencaiova et al., who reported anaemia in approximately 62–70% of pregnant women in developing countries and demonstrated that iron deficiency remained the principal cause of maternal anaemia.<sup>9</sup> Similarly, Benson et al. observed a maternal anaemia prevalence of 71.5% among antenatal women in sub-Saharan Africa, emphasizing that anaemia continues to be a significant public health concern despite ongoing supplementation programs.<sup>10</sup>

The present study demonstrated a significant association between maternal anaemia and preterm birth, with 25.3% of anaemic mothers delivering preterm compared with 10.0% among non-anaemic mothers ( $\chi^2=4.35$ , p=0.037). The odds of preterm birth were approximately three times higher among anaemic mothers (OR=3.05; 95% CI: 1.13–8.26). These findings are consistent with the systematic review by Figueiredo et al., which included more than 245,000 pregnancies and concluded that maternal anaemia significantly increased the risk of preterm birth (RR 1.56) and low birth weight.<sup>8</sup>

Similarly, Smith et al. reported that women with moderate-to-severe anaemia had a significantly greater incidence of spontaneous preterm delivery than women with normal haemoglobin concentrations, suggesting that inadequate maternal oxygen delivery and placental insufficiency may contribute to premature labor.<sup>11</sup> Young et al. also demonstrated that maternal iron deficiency adversely affected placental vascular development and fetal growth, thereby increasing the likelihood of preterm birth and neonatal complications.<sup>12</sup>

The significant association observed in the present study further supports the hypothesis that maternal anaemia is an independent and modifiable risk factor for preterm birth. Early identification of anaemia through routine antenatal screening and timely iron supplementation may substantially reduce adverse pregnancy outcomes. Similar recommendations were proposed by Haider et al., who concluded that antenatal iron supplementation significantly lowers the risk of maternal anaemia and improves neonatal outcomes in low- and middle-income countries.<sup>13</sup>

In the present study, the incidence of preterm birth increased progressively with the severity of maternal anaemia, rising from 10.0% among non-anaemic women to 16.9% in mild anaemia, 31.4% in moderate anaemia, and 66.7% in severe anaemia ( $\chi^2=24.25$ ,  $p<0.001$ ). This dose-response relationship indicates that worsening maternal anaemia substantially increases the likelihood of preterm delivery. Similar findings were reported by Rahman et al., who demonstrated that severe maternal anaemia was associated with nearly a two-fold increase in the risk of preterm birth and significantly higher perinatal mortality in South Asian populations.<sup>14</sup>

The observed relationship may be explained by chronic placental hypoxia, impaired uteroplacental circulation, increased oxidative stress, and inflammatory cytokine activation associated with severe anaemia, all of which predispose to premature uterine contractions and spontaneous preterm labour. Lone et al. similarly reported that women with severe anaemia had significantly higher rates of preterm delivery, low birth weight, and neonatal complications than non-anaemic mothers.<sup>15</sup> The present study also demonstrated that neonates born to anaemic mothers had significantly higher rates of low birth weight (34.7% vs. 14.0%;  $p=0.009$ ), NICU admission (22.7% vs. 8.0%;  $p=0.037$ ), and respiratory distress (18.7% vs. 6.0%;  $p=0.035$ ) compared with neonates of non-anaemic mothers. Although low Apgar scores were more frequent among neonates of anaemic mothers, the difference was not statistically significant. These findings indicate that maternal anaemia adversely influences immediate neonatal outcomes in addition to increasing the risk of preterm birth.

Nair et al. reported that maternal anaemia significantly increased the incidence of low birth weight, NICU admission, and neonatal morbidity among Indian newborns, with neonatal complications occurring more frequently in women with moderate and severe anemia.<sup>16</sup> Likewise, Kumar et al. observed significantly higher frequencies of preterm birth (27.8%), low birth weight (32.4%), and NICU admission among anaemic mothers compared with non-anaemic mothers, emphasizing that maternal haemoglobin concentration is an important predictor of neonatal outcome.<sup>17</sup>

The findings of the present study are also supported by Drukker et al., who demonstrated that maternal haemoglobin concentration measured during pregnancy is an independent predictor of adverse perinatal outcomes, particularly preterm birth and foetal growth restriction.<sup>18</sup> Collectively, these observations reinforce the importance of routine antenatal haemoglobin estimation, nutritional counselling, iron-folic acid supplementation, early diagnosis of moderate and severe anaemia, and timely obstetric intervention.

Overall, the present study confirms that maternal anaemia remains a significant and preventable risk factor for preterm birth and adverse neonatal outcomes. Strengthening antenatal screening programmes, improving compliance with iron supplementation, ensuring nutritional education, and providing early treatment for anaemia may substantially reduce maternal and neonatal morbidity. Larger multicentric prospective studies are recommended to further evaluate the influence of anaemia severity, timing of diagnosis, and response to treatment on pregnancy outcomes.

## CONCLUSION

The present study demonstrated a significant association between maternal anaemia during pregnancy and preterm birth among women delivering at a tertiary care teaching hospital. Maternal anaemia was highly prevalent, affecting 75.0% of the study participants, with moderate anaemia being the most common category. The incidence of preterm birth was significantly higher among anaemic mothers than non-anaemic mothers, and the risk increased progressively with the severity of anaemia. Maternal anaemia was also significantly associated with adverse neonatal outcomes, including low birth weight, increased NICU admissions, and neonatal respiratory distress. These findings emphasize that maternal anaemia is an important and potentially modifiable risk factor for adverse pregnancy outcomes. Early antenatal registration, routine screening for haemoglobin levels, adequate iron and folic acid supplementation, nutritional counselling, prompt treatment of anaemia, and regular antenatal follow-up are essential to reduce the burden of preterm birth and improve maternal and neonatal health. Strengthening existing national anaemia control programs and ensuring better compliance with antenatal care services can substantially improve pregnancy outcomes in developing countries.

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