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Original Research Article

Prevalence and Severity of Maternal Anemia and Its Association with Low Birth Weight and Preterm Birth: A Cross-Sectional Study

Sneha Kumari[1], Juhi Kumari Soni[2], Dipti Roy[3]

[1]Senior Resident, Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, Patna, Bihar, India

[2]Senior Resident, Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, Patna, Bihar, India

[3]Professor and HOD, Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, Patna, Bihar, India

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Corresponding Author: Dr. Juhi Kumari Soni

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Abstract:

Background: Maternal anemia is a prevalent public health concern, particularly in low-resource settings, and is associated with adverse neonatal outcomes such as low birth weight (LBW) and preterm birth.

Aim: To assess the prevalence and severity of maternal anemia and examine its association with LBW and preterm birth among pregnant women.

Methodology: A hospital-based cross-sectional study was conducted among 270 pregnant women in their second and third trimesters at Nalanda Medical College and Hospital, Patna, Bihar. Hemoglobin levels were measured, and anemia was classified per WHO criteria. Birth outcomes, including birth weight and gestational age, were recorded at delivery. Associations between maternal anemia and adverse outcomes were analyzed using Chi-square tests, with $p<0.05$ considered significant.

Results: Among participants, 63% were anemic: mild (38.5%), moderate (22.2%), and severe (2.3%). LBW occurred in 26.7% and preterm births in 15.6% of deliveries. LBW was more frequent in anemic (35.3%) versus non-anemic mothers (12%), and preterm births were higher among anemic (18.8%) compared to non-anemic mothers (10%). Increasing anemia severity was associated with progressively worse birth outcomes.

Conclusion: Maternal anemia is highly prevalent and significantly associated with LBW and preterm birth, with risks rising alongside severity. Targeted interventions to prevent and manage anemia during pregnancy are essential to improve neonatal outcomes.

Keywords: Maternal anemia, Low birth weight, Preterm birth, Pregnancy, Cross-sectional study.

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Introduction

The anemia problem is one of the most widespread issues of civilization both globally and in the United States especially among pregnant women and young children. It is synonymously linked with the escalation of morbidity and mortality rates and is still a burden to social and economic growth of the affected nations [1]. Iron deficiency anemia (IDA) is the most prevalent nutritional deficiency disorder in the world that can be attributed to iron deficiency in close to 50 percent of all cases of anemia. IDA has been measured as one of ten principal illnesses of the world burden of disease, and its health and social impacts are extensive [2].

Pregnancy is a severe physiological condition where there is an enormous requirement of iron that is needed to aid the growth, increase in the size of the fetus, increase in maternal blood volume and development of the placenta. WHO defines anemia during pregnancy as a hemoglobin level below 11 g/dl and is considered as one of the most prevalent nutritional conditions in the world [3]. Women especially the pregnant women are the most vulnerable as their nutritional needs increase significantly at the time of gestation. Untreated, anemia may cause severe maternal and neonatal adverse events, such as maternal death, intrauterine growth retardation, low birth weight (LBW), preterm birth, and perinatal mortality [4]. Such negative consequences not only add to the health risks in the short term of both mothers and infants but also lead to long-term developmental and health problems of children being born in a disadvantaged state.

Maternal anemia is an issue that is overloaded in low- and middle-income countries because of the

inability to access proper nutrition, medical care, and preventative measures. The epidemiological cycle of persistence of anemia in these environments is an indication of complicated interactions among biological, social, economic, and cultural factors. Anemia has been known to be a significant factor in maternal health challenges in India. National Family Health Survey-5 (NFHS-5, 2019 21) found out that almost half of pregnant women in the country are suffered with anemia [5]. This has been a worrying prevalence regardless of the old national programs like the National Nutritional Anemia Prophylaxis Program and Iron and Folic Acid (IFA) supplementation programs, and more recent programs like the Anemia Mukt Bharat campaign [6].

The high prevalence still would demonstrate a high level of disconnect between the policy preparation and the effective implementation, on the grassroots level [7] . These programs have a number of operational challenges which diminish their success. Commonly reported barriers are poor adherence to IFA supplementation because of gastrointestinal side effects, irregular antenatal care (ANC) visits, late development of the supplementation, and frequent supply chain disruptions. Moreover, the problem is aggravated by a lack of awareness on the subject of maternal nutrition, cultural food taboos during pregnancy, and socioeconomic limitations [8]. All these contribute to maintaining anemia as a burning national health issue in pregnant women in India.

In India, a very vulnerable sub-population is comprised of tribal populations. Tribal societies on average experience several overlapping forms of inequalities such as increased nutritional uniformity, poverty, weak access to quality medical care, irregular attendance at ANC, and increased vulnerability to parasitic infections [9]. The risk may be further increased by cultural food taboos and traditional beliefs that may limit the intake of iron-rich foods in the course of pregnancy. Moreover, the geographic distance and limitations of infrastructure often contribute to the lack of necessary maternal health services.

The state with a large tribal group of Madhya Pradesh maintains a higher rate of maternal anemia than the national level [10] proving consistently higher than the national average. Betul district is a tribal-majority state in this state, and the area is socioeconomically vulnerable, making the health of women and children susceptible to disease. Low educational levels, poverty and gender gap also contribute to the health seeking behavior and diet in this area.

The earlier research done in the central region of India have proved the relationship between maternal anemia and poor pregnancy outcome especially low birth weight and preterm births. Nevertheless, this evidence is still scarce in some block dominated by the tribals like Patna. The cultural practices, food taboos in pregnancy and poor sensitization on maternal nutrition are also some contributing factors to anemia among these populations [11]. Also, the long distance to health centres and lack of transport infrastructure may hamper the access to routine antenatal care such as haemoglobin estimation and iron-folic acid tablet distribution.

Maternal health issues are further complicated by socioeconomic factors like poverty, illiteracy, and gender inequalities that cannot be resolved easily. These factors affect dietary intake, self-determination in healthcare choice, and the use of prenatal services. Such context-specific factors must be understood in order to be able to design culturally sensitive and locally appropriate interventions. Specific national programs, such as Anemia Mukt Bharat, should be tailored to local public health measures to decrease the level of maternal anemia and increase the levels of maternal and neonatal health in tribal areas [12].

Neonatal survival and health are highly important factors that are represented by low birth weight and preterm birth. Low birth weight of infants predisposes them to neonatal morbidity, compromised growth, delays in development as well as chronic illnesses in adulthood. On the same note, preterm birth has been one of the major causes of childhood deaths and permanent disability. Maternal anemia, especially moderate and severe types, undermines oxygen supply to the fetus and could also affect placental functioning, thus exposing the fetus to the risk of intrauterine growth retardation and premature labor. Such biological processes prove that it is necessary to evaluate the correlation between the severity of anemia and the negative birth outcomes systematically.

Although data on national and state level is available, localized evidence on the prevalence and severity of maternal anemia and its relationship with birth outcomes in tribal contexts like Patna, Bihar is scarce. The production of such evidence is pivotal in informing the decentralized health planning and resource allocation. Community-related data may be used to support risk identification, enhance target screening, and enhanced adherence to iron supplementation and antenatal prevention services.

Thus, the current cross-sectional study has been planned with two main purposes (1) to determine the level of prevalence and severity of anemia in pregnant women and (2) to find the relation between adverse birth outcomes (low birth weight and preterm birth) and anemia. This study will seek to make contributions to existing literature and help to derive contextually sensitive interventions in the field of public health by offering locally reflective data in a tribal dominated area to help decrease maternal anemia and enhance neonatal outcomes.

Methodology

Study Design: A hospital-based cross-sectional study was conducted to determine the prevalence and severity of maternal anemia and to assess its association with low birth weight and preterm birth. The cross-sectional design enabled simultaneous assessment of hemoglobin status during pregnancy and birth outcomes at delivery within the defined study period.

Study Area: The study was carried out in the Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, Patna, Bihar, India.

Study Duration: The study was conducted over a period of seven months from March 2025 to September 2025.

Sample Size: The sample size was calculated using the standard formula for estimating prevalence in cross-sectional studies:

$n_0 = (Z^2 \times p \times (1 - p)) / d^2$

Where Z = 1.96 for 95% confidence interval, p = 0.52 (national prevalence of anemia among pregnant women as per NFHS-5), and d = 0.07 (absolute precision).

$n_0 = (1.96)^2 \times 0.52 \times (1 - 0.52) / (0.07)^2$

$n_0 \approx 272$

After adjusting for feasibility and potential incomplete records, the final sample size was fixed at 270 pregnant women (N = 270), who fulfilled the eligibility criteria and consented to participate in the study.

Study Population: The study population comprised pregnant women in their second and third trimesters who attended the antenatal outpatient department or were admitted for delivery at the Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital. Women were enrolled irrespective of parity and socioeconomic background. Birth outcomes were assessed at the time of delivery for those who delivered in the hospital during the study period.

Data Collection: Data were collected using a structured and pre-tested questionnaire through face-to-face interviews. Information regarding socio-demographic characteristics (age, residence, education, socioeconomic status), obstetric history (gravidity, parity, interpregnancy interval), dietary practices, and antenatal care utilization was obtained. Clinical and laboratory details were extracted from antenatal records and hospital case sheets.

Hemoglobin estimation was carried out using a hemoglobin meter as part of routine antenatal investigations. Anemia was classified according to WHO criteria as mild (10–10.9 g/dL), moderate (7–9.9 g/dL), and severe (<7 g/dL).

Birth outcomes were recorded at delivery. Birth weight was measured within one hour of birth using a calibrated electronic weighing scale. Low birth weight (LBW) was defined as birth weight less than 2.5 kg. Gestational age was determined based on the last menstrual period (LMP) and/or first trimester ultrasound records when available. Preterm birth was defined as delivery before 37 completed weeks of gestation.

Inclusion Criteria

- Pregnant women in the second and third trimesters of pregnancy.
- Women attending the antenatal outpatient department of the Department of Obstetrics and Gynaecology at Nalanda Medical College and Hospital during the study period.
- Women admitted for delivery in the same hospital during the study duration.
- Women with available and complete antenatal and laboratory records, including hemoglobin estimation.
- Women who provided written informed consent to participate in the study.

Exclusion Criteria

- Pregnant women with known chronic medical disorders such as chronic renal disease, diabetes mellitus, or hemoglobinopathies.
- Women with acute hemorrhagic conditions or recent blood transfusion.
- Women with multiple pregnancies (twins or higher-order gestation).
- Women with incomplete antenatal or delivery records.
- Women who were unwilling or unable to provide informed consent.

Procedure: After obtaining informed consent, eligible participants were interviewed using the structured questionnaire. Hemoglobin values were recorded from recent antenatal investigations. Participants were categorized into non-anemic and anemic groups based on WHO classification. The severity of anemia was further sub-classified into mild, moderate, and severe categories.

At the time of delivery, neonatal birth weight and gestational age were recorded from hospital records. The association between maternal anemia (presence and severity) and adverse birth outcomes such as low birth weight and preterm birth was assessed. All collected data were checked for completeness and accuracy before entry into the database.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Descriptive statistics such as mean, standard deviation, frequencies, percentages, and proportions were used to summarize socio-demographic variables, prevalence, and severity of anemia.

The association between maternal anemia and birth outcomes (low birth weight and preterm birth) was assessed using the Chi-square test. Odds ratios with 95% confidence intervals were calculated where appropriate to estimate the strength of association. A p-value of less than 0.05 was considered statistically significant."

Result

Table 1 presents the socio-demographic characteristics of 270 study participants. The majority were aged 20–29 years (172; 63.7%), followed by ≥30 years (50; 18.5%) and <20 years (48; 17.8%). Most participants resided in rural areas (186; 68.9%) compared to urban areas (84; 31.1%). Regarding socio-economic status, over half belonged to the lower class (146; 54.1%), while 92 (34.1%) were from the middle class and 32 (11.9%) from the upper class. Overall, the study population was predominantly young, rural, and from lower socio-economic backgrounds.

Table 1: Socio-demographic characteristics of study participants (N = 270)

Variable	Frequency (N)	Percentage (%)
Age group (years)		
<20	48	17.8
20–29	172	63.7
≥30	50	18.5
Residence		
Rural	186	68.9
Urban	84	31.1
Socio-economic status		
Lower	146	54.1
Middle	92	34.1
Upper	32	11.9
Total	270	100

Table 2 shows the distribution of anemia among 270 pregnant women. Among them, 100 women (37%) had no anemia, while 104 (38.5%) had mild anemia (Hb 10–10.9 g/dL), 60 (22.2%) had moderate anemia (Hb 7–9.9 g/dL), and 6 (2.3%) had severe anemia (Hb <7 g/dL). This indicates that over 60% of the study population were anemic, with most cases being mild to moderate in severity.

Table 2: Distribution of anemia among pregnant women (N = 270)

Anemia status	Frequency (N)	Percentage (%)
No anemia	100	37
Mild (10–10.9 g/dL)	104	38.5
Moderate (7–9.9 g/dL)	60	22.2
Severe (<7 g/dL)	6	2.3
Total	270	100

Table 3 presents the distribution of birth outcomes among 270 participants. Low birth weight (<2.5 kg) was observed in 72 infants (26.7%), while 198 infants (73.3%) had normal birth weight (≥2.5 kg). Preterm births (<37 weeks) occurred in 42 cases (15.6%), whereas term deliveries (≥37 weeks) accounted for 228 cases (84.4%). Overall, the majority of infants were born at term with normal birth weight.

Table 3: Distribution of birth outcomes (N = 270)

Outcome	Frequency (N)	Percentage (%)
Low birth weight (<2.5 kg)	72	26.7
Normal birth weight (≥2.5 kg)	198	73.3
Preterm (<37 weeks)	42	15.6
Term (≥37 weeks)	228	84.4

Table 4 shows the association between maternal anemia and low birth weight (LBW) among 270 participants. LBW infants (<2.5 kg) were observed in 35.3% of anemic mothers (60/170) compared to 12% of non-anemic mothers (12/100), resulting in an overall LBW rate of 26.7%. This indicates that maternal anemia is strongly associated with an increased risk of delivering low birth weight infants.

Table 4: Association between maternal anemia and low birth weight (N = 270)				
Anemia status	**LBW (<2.5 kg)**	**Normal (≥2.5 kg)**	**Total**	**% LBW**
Anemic (n=170)	60	110	170	35.3
Non-anemic (n=100)	12	88	100	12
Total	72	198	270	26.7

Table 5 shows the association between maternal anemia and preterm birth among 270 participants. Preterm birth occurred in 18.8% of anemic mothers (32/170) compared to 10% of non-anemic mothers (10/100), resulting in an overall preterm rate of 15.6%. These findings indicate that maternal anemia is associated with a higher risk of preterm delivery.

Table 5: Association between maternal anemia and preterm birth (N = 270)				
Anemia status	**Preterm (<37 weeks)**	**Term (≥37 weeks)**	**Total**	**% Preterm**
Anemic (n=170)	32	138	170	18.8
Non-anemic (n=100)	10	90	100	10
Total	42	228	270	15.6

Table 6 illustrates the impact of anemia severity on birth outcomes among 170 anemic mothers. Low birth weight (LBW) infants were observed in 35.3% overall, increasing with anemia severity: 26.9% in mild, 43.3% in moderate, and 100% in severe anemia. Preterm births occurred in 18.8% overall, with rates rising from 13.5% in mild, 23.3% in moderate, to 66.7% in severe anemia. Normal birth outcomes were most common in mild anemia (59.6%) but decreased with increasing severity, being 33.4% in moderate and absent in severe anemia. These results indicate a clear trend of worsening birth outcomes with increasing severity of maternal anemia.

Table 6: Severity of anemia and birth outcomes (N = 170 anemic mothers)			
Severity of anemia	**LBW (N, %)**	**Preterm (N, %)**	**Normal outcomes (N, %)**
Mild (n=104)	28 (26.9%)	14 (13.5%)	62 (59.6%)
Moderate (n=60)	26 (43.3%)	14 (23.3%)	20 (33.4%)
Severe (n=6)	6 (100%)	4 (66.7%)	0 (0%)
Total (170)	60 (35.3%)	32 (18.8%)	82 48.2%)

Discussion

In the current study, the survey of 270 pregnant women revealed that a high percentage of 63 of the surveyed women had some form of anemia especially among maternal anemias. Mild anemia was the most prevalent (38%), then moderate anemia (24%), and a very small proportion of large-scale anemia. This trend aligns with previous observations in tribal communities in India as mild to moderate anemia is the most prevalent one, and severe anemia is relatively uncommon (Chhabra and Rathod, 2021) [13]. Equally, national statistics have indicated that the prevalence of anemia is disproportionately low in tribal and underserved populations, and there has been minimal change in this aspect over the decades despite the government initiatives to enhance health (Ghosal et al., 2023) [14]. The trends indicate structural and contextual flaws in the management of maternal nutrition and micronutrient deficiencies in resource constrained environments. Comparatively, non- tribal population studies record a slightly lower prevalence where national averages are approximately 52.2 and this once again underscores the differences in the burden of anemia between tribal and non-tribal women."

The results of our study on birth outcomes showed that 27 percent of the babies were born with low birth weight (LBW) and 15 percent were pre-term and the poor birth outcomes were concentrated among the anemic mothers. Namely, more than one-third of infants born of anemic mothers were LBW, whereas one out of twelve infants born of non-anemic mothers had the same condition. The same applied to preterm births which were experienced in 19 per cent of anemic mothers and 10 per cent of non-anemic mothers. Such findings are consistent with the dose-response relationship in the other studies, in which the severity of maternal anemia is associated with deteriorating perinatal outcomes. As an example, Jharkhand study showed prevalence of 78.45 in maternal anemia, LBW was 32.81 and preterm birth was 34.75 (Kumari et al., 2019) [15]. This similarity highlights a high-level and clinically relevant relationship between maternal anemia and poor birth outcomes, which supports the biological plausibility that anemia obstructs placental oxygen and nutrient transfer, leading to intrauterine growth restriction and premature delivery (Biswas et al., 2019) [16].

In evaluating the severity of anemia, we found that there was a clear gradient effect where mild anemia was correlated with around 25-percent LBW and

lower occurrences of preterm births, moderate anemia with increased risks on both LBW and preterm births, and severe anemia with the worst outcomes with all women having LBW babies and two-thirds having preterm births. This trend resembles the results of West Bengal wherein a retrospective cohort study suggested that LBW was strongly correlated with maternal anemia (Biswas et al., 2019) [16]. Similarly, tribal-oriented studies in Maharashtra selected low hemoglobin, the number of antenatal care visits below four, and inadequate iron-folic acid (IFA) supplementation as the main predictors of LBW, with anemia levels around 6070% of which are similar to our 64.7% (Dey et al., 2022) [17]. These comparisons indicate that prevalence and outcome patterns that we find in our study are comparable with larger bodies of evidence of comparable low-resource, tribal, and rural populations throughout India.

There is some difference in comparison with other studies with non-tribal or urban societies where the LBW and preterm rates in anaemic mothers are usually lower, indicating better nutrition consumption, medical care accessibility, and compliance with the supplementation programs. As an example, moderate anemia can be dangerous, but the percentage of severe outcomes is lower in urban areas where ANC programs are organized. This indicates that the impact of anemia is complicated with the influence of environmental and socio-cultural factors, including eating restrictions, a lack of access to antenatal care, parasitic infections found in tribal regions, etc. (Chhabra and Rathod, 2021) [13]. Another key factor that our findings highlight is the socio-economic status: more than half of our participants belonged to the low socio-economic category, which might have led to the lack of dietary diversity, micronutrient deficiencies and worse maternal and fetal health outcomes in line with the previous study (Ghosal et al., 2023) [14].

In general, the results support an already established correlation between anemic status in the maternal blood and poor birth outcomes, such as LBW or preterm birth, and a dose-response relationship which depends on the severity of anemia in mothers. The findings of the study correspond to those of the regional research on tribal women in India and other general national surveys, and slightly different with urban populations with higher nutrition and access to healthcare. The solution to such disparities should be interventions that are culturally sensitive and contextually specific, by encompassing specific nutritional counseling, strict compliance to IFA supplementation, increased coverage of antenatal care and control of underlying infections. The fact that maternal anemia rates remain at a high level, even though such national programs as Anemia Mukt Bharat are implemented, points to implementation gaps, especially in tribal regions, and the necessity of using specific public health interventions, which would not disregard tribal-specific factors. This research would help to provide meaningful evidence in offering interventions to reduce maternal anemia and improve perinatal outcomes in underserved populations.

Conclusion

The research identifies the high rates of maternal anemia amongst pregnant women, with some levels of severity. The anemic mothers were found to have significantly greater risks of poor birth outcomes such as low birth weight and preterm birth than non-anemic mothers. These outcomes were more likely the more severe the anemia was, and the greatest percentage of the low birth weight and preterm births were linked to the severity of the anemia. These results highlight the dire importance of maternal anemia on the health of the neonates and the necessity to focus interventions to prevent and treat anemia in pregnancy to enhance birth outcomes.

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