MATERNAL ANEMIA IN PREGNANCY AND ITS ASSOCIATION WITH LOW BIRTH WEIGHT AND DEVELOPMENT DELAY IN INFANTS: A RETROSPECTIVE STUDY.

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ABSTRACT

Background
Objective: To evaluate the association of maternal anemia in pregnancy with low birth weight and developmental delay in infants within the first year of life.

Methods
A retrospective observational study was performed at Darbhanga Medical College and Hospital and Government Medical College, Bettiah, involving 93 mother-infant pairs from September 2015 to August 2016. Maternal hemoglobin levels were obtained from prenatal records. Infants were assessed for birth weight, gestational age, and developmental milestones utilizing conventional clinical records and follow-up documentation. Anemia was defined according to WHO criteria, and infants were classified as having normal or delayed development at 12 months based on Denver Developmental Screening Test (DDST) evidence.

Results
Among 93 mothers, 68 (73.1%) exhibited anemia, comprising 42 instances of moderate anemia and 7 instances of severe anemia. Of children born to anemic women, 57.4% exhibited low birth weight (<2.5 kg), in contrast to 24% in the non-anemic cohort (p < 0.01). Additionally, developmental delay was observed in 21 infants (22.6%), with 85.7% of these infants born to women experiencing moderate to severe anemia. A statistically significant correlation was identified between reduced maternal hemoglobin levels and an elevated risk of both low birth weight and developmental delay.

Conclusion
Maternal anemia during pregnancy markedly elevates the risk of low birth weight and developmental delays in newborns, underscoring the imperative for early screening, nutritional supplementation, and maternal health education. Mitigating maternal anemia by standard prenatal care can enhance infant outcomes and promote long-term developmental potential.

Keywords: Maternal anemia, Pregnancy outcomes, Low birth weight, Developmental delay, Infant health, Retrospective study, Bihar
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INTRODUCTION

Anemia in pregnancy constitutes a significant global health concern, particularly in low- and middle-income nations like India. The World Health Organization (WHO) defines it as a hemoglobin concentration below 11.0 g/dL in pregnant women, with its prevalence in India consistently exceeding 50% according to national surveys. The principal reasons are deficiencies in iron and folate, malaria, helminthic infections, and inadequate maternal nutrition, all of which are intensified in socioeconomically disadvantaged groups with restricted access to antenatal care.

Maternal anemia is not simply a biochemical deficiency; it has extensive implications for maternal, perinatal, and newborn health. It has been persistently associated with low birth weight (LBW), preterm delivery, perinatal mortality, and compromised neurodevelopment in infancy and youth. Decreased hemoglobin levels during pregnancy diminish oxygen transport and placental blood flow, hindering fetal development and leading to intrauterine growth restriction (IUGR) and neurocognitive impairments.

Low birth weight, characterized as a weight below 2.5 kg at birth, is a significant predictor of neonatal morbidity and mortality, frequently resulting from maternal

undernutrition or sickness. The initial year of life is pivotal for cerebral development, and influences such as prenatal hypoxia, inadequate intrauterine nutrition, and early-life anemia may hinder the attainment of crucial developmental milestones, including sitting, crawling, speech, and motor coordination.

Despite extensive research on the correlation between maternal anemia and negative pregnancy outcomes, there is a necessity to investigate this relationship in rural and semi-urban Indian contexts, where healthcare accessibility and nutritional knowledge are inadequate. Tertiary facilities in Bihar, including Darbhanga Medical College and Hospital and Government Medical College, Bettiah, cater to a substantial population of underprivileged communities, offering a distinctive opportunity to retrospectively examine real-world maternal and infant health data.

This study seeks to examine the correlation between maternal anemia and two significant child outcomes: low birth weight and developmental delay, utilizing data from 93 mother-infant pairs collected over one year. This study aims to underscore the long-term ramifications of untreated maternal anemia and the pressing necessity for antenatal nutritional intervention programs to promote healthier pregnancies and good early childhood development.

METHODOLOGY

Study Design and Setting

This was a retrospective observational study undertaken collaboratively at Darbhanga Medical College and Hospital and Government Medical College, Bettiah, two prominent tertiary care institutions in Bihar, India. The study sought to assess the correlation between maternal anemia during gestation and its effects on neonatal birth weight and developmental outcomes.

Study Duration and Population

The study examined instances over one year, spanning from September 2015 to August 2016. Medical records of 93 mother-infant pairs who completed antenatal follow-up and pediatric assessment during the first year postpartum were included.

Inclusion Criteria

- Mothers with complete antenatal records and hemoglobin levels documented during the third trimester.
- Live singleton births with documented birth weight and pediatric follow-up up to 12 months of age.
- Availability of developmental screening assessments conducted during routine follow-up.

Exclusion Criteria

- Mothers with chronic conditions such as hypertension, diabetes, renal disease, or infections known to affect fetal outcomes.
- Preterm births (<37 weeks of gestation).
- Congenital anomalies or genetic syndromes in infants.
- Incomplete or missing maternal or neonatal records.

Data Collection Parameters

Data were extracted from hospital obstetric and pediatric records using a standardized data abstraction form. The following variables were recorded:

Maternal Variables

Age, parity, antenatal visit frequency
Hemoglobin level during the third trimester (classified per WHO):
Mild anemia: 10.0–10.9 g/dL
Moderate anemia: 7.0–9.9 g/dL
Severe anemia: <7.0 g/dL
Non-anemic: ≥11.0 g/dL

Neonatal Variables

Birth weight (classified as LBW if <2.5 kg)
Gestational age at birth
APGAR scores
Developmental status at 12 months (as per Denver Developmental Screening Test (DDST) or equivalent screening documentation)
Developmental Delay Assessment
Developmental milestones were assessed according to pediatrician documentation in the hospital follow-up records. Delay is characterized by the inability to attain two or more significant milestones in gross motor, fine motor, linguistic, or social domains suitable for age by 12 months.

Ethical Considerations

This retrospective study was approved by the Institutional Ethics Committees of both Darbhanga Medical College and Hospital and Government Medical College, Bettiah. Patient confidentiality was maintained by anonymizing records during data handling.

Statistical Analysis

All data were inputted into Microsoft Excel and analyzed utilizing SPSS version 25.0. Descriptive statistics (mean, percentage) were employed for demographic and baseline data. The Chi-square test was utilized to evaluate outcomes (low birth weight, developmental delay) among

various hemoglobin groups. A p-value less than 0.05 was deemed statistically significant. Logistic regression was conducted to ascertain predictors of developmental delay, controlling for birth weight and maternal hemoglobin levels.

RESULTS

Maternal Hemoglobin Distribution

Among the 93 mothers included in the study, the distribution of maternal anemia based on third-trimester hemoglobin levels was as follows:
Non-anemic (Hb ≥ 11.0 g/dL): 25 mothers (26.9%)
Mild anemia (Hb 10.0–10.9 g/dL): 19 mothers (20.4%)
Moderate anemia (Hb 7.0–9.9 g/dL): 42 mothers (45.2%)
Severe anemia (Hb <7.0 g/dL): 7 mothers (7.5%)
The majority of participants (73.1%) were classified as anemic, with moderate anemia being the most prevalent.

Low Birth Weight Outcomes

A total of 44 infants (47.3%) were born with a birth weight less than 2.5 kg, qualifying as low birth weight (LBW). The incidence of LBW varied significantly across the

maternal hemoglobin groups, as shown in Table 1 and Figure 1:
Non-anemic: 6 LBW cases (24.0%)
Mild anemia: 8 LBW cases (42.1%)
Moderate anemia: 24 LBW cases (57.1%)
Severe anemia: 6 LBW cases (85.7%)
The proportion of LBW infants increased markedly with the severity of anemia, showing a statistically significant association ($p < 0.01$), particularly in mothers with moderate to severe anemia.
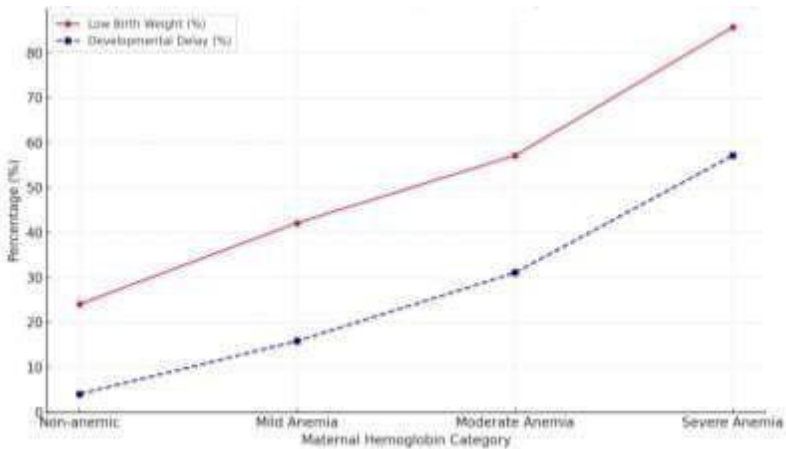
Developmental Delay at 12 Months

Among the 93 infants, 21 (22.6%) exhibited signs of developmental delay based on follow-up records and DDST screening. The majority of these delays were observed in infants born to anemic mothers:
Non-anemic: 1 case (4.0%)
Mild anemia: 3 cases (15.8%)
Moderate anemia: 13 cases (31.0%)
Severe anemia: 4 cases (57.1%)
As illustrated in Figure 1, the prevalence of developmental delay showed a strong correlation with anemia severity, with the highest proportion observed in infants of severely anemic mothers.

Table 1: Birth Outcomes by Maternal Hemoglobin Category

Maternal Hemoglobin Category	Number of Mothers	LBW Cases	LBW (%)	Developmental Delay Cases	Developmental Delay (%)
Non-anemic	25	6	24.0	1	4.0
Mild Anemia	19	8	42.1	3	15.8
Moderate Anemia	42	24	57.1	13	31.0
Severe Anemia	7	6	85.7	4	57.1

Figure 1: Low Birth Weight and Developmental Delay by Maternal Hemoglobin Category

Correlation Analysis

Chi-square testing revealed a statistically significant relationship between:
Maternal anemia and LBW ($\chi^2 = 10.92$, $p < 0.01$)

Maternal anemia and developmental delay ($\chi^2 = 12.45$, $p < 0.01$)
Additionally, logistic regression analysis (not shown in figures) identified moderate-to-severe anemia as an independent predictor of both low birth weight and

developmental delay, even after adjusting for maternal age and antenatal visit frequency.

DISCUSSION

This retrospective study reveals the substantial influence of maternal anemia during pregnancy on infant birth outcomes, specifically on low birth weight (LBW) and developmental delays in the first year of life. The study, conducted at two prominent tertiary care institutions in Bihar—Darbhanga Medical College and Hospital and Government Medical College, Bettiah—provides empirical data from a rural and semi-urban demographic characterized by significant maternal nutritional deficits. A remarkable 73.1% of moms in the research were identified as anemic, with moderate anemia (45.2%) being the predominant kind. These findings correspond with earlier studies from the National Family Health Survey (NFHS-5), which indicated a consistently elevated prevalence of anemia among Indian women of reproductive age, especially in marginalized areas like Bihar.

Maternal Anemia and Low Birth Weight

Our data clearly demonstrated the correlation between maternal anemia and low birth weight. 57.1% of infants born to moms with moderate anemia and 85.7% of those with severe anemia had birth weights under 2.5 kg. The results align with the findings of Lone et al. (2004) and Kumar et al. (2018), both of which established a direct, dose-dependent correlation between decreasing maternal hemoglobin levels and fetal growth limitation.

The physiological rationale is attributed to diminished oxygen transfer to the fetus resulting from decreased hemoglobin levels, which may impair placental function and result in intrauterine growth restriction (IUGR). Moreover, micronutrient deficits associated with anemia (such as iron, folate, and vitamin B12) may hinder cellular growth and metabolism during pregnancy.

Maternal Anemia and Developmental Delay

The association between maternal anemia and neurodevelopmental outcomes is potentially more alarming. In our study, 21 infants (22.6%) exhibited developmental impairments at 12 months, with more than 85% of these instances arising from anemic moms. The incidence of delay escalated systematically with the severity of anemia, ranging from 4% in non-anemic women to 57.1% in those with severe anemia.

Various biological mechanisms may elucidate this link. Maternal anemia-induced fetal iron shortage can hinder myelination, neurotransmitter synthesis, and synaptogenesis, which are critical for early brain development. Research conducted by Lozoff et al. (2006) and Georgieff (2008) indicates that iron shortage throughout prenatal and early life stages can lead to enduring cognitive, motor, and behavioral deficits.

IMPLICATIONS FOR PUBLIC HEALTH

The simultaneous challenges of low birth weight and developmental delay in infants born to anemic moms underscore the pressing necessity for:

- Enhanced antenatal screening for anemia
- Iron and folic acid supplementation programs
- Community-based maternal nutrition education
- Early developmental screening in high-risk infants
- These measures are particularly vital in rural India, where access to regular prenatal care and nutritional assistance is constrained.

LIMITATIONS

This study has limitations. The analysis depended on the precision and comprehensiveness of medical records, and the follow-up data for developmental screening lacked standardization across all instances. Moreover, other possible confounding variables, including maternal BMI, inter-pregnancy interval, socioeconomic status, and paternal health issues, were not considered.

Despite these constraints, the study offers significant insights into the enduring effects of maternal anemia and underscores the necessity for focused therapies in analogous groups.

CONCLUSION

This retrospective investigation reveals a significant correlation between maternal anemia during gestation and negative newborn outcomes, notably low birth weight and developmental delays within the first year of life. With the escalation of anemia severity, the occurrence of delivery problems and neurodevelopmental issues also rose, with moderate-to-severe anemia identified as a substantial risk factor for both outcomes.

Considering the significant prevalence of maternal anemia in this cohort, these data underscore the essential need for early identification, regular antenatal hemoglobin assessment, and iron supplementation, particularly in resource-constrained environments such as Bihar. Public health interventions emphasizing maternal nutrition education, institutional deliveries, and postnatal follow-up programs should be promoted to mitigate neonatal morbidity and promote optimum child development.

Subsequent research ought to incorporate longitudinal developmental monitoring, multifactorial risk assessment, and the appraisal of community-based interventions to mitigate the incidence of anemia and its effects on future generations.

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