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# ASSESSMENT OF CORRELATION OF NEONATAL GESTATIONAL AGE AND BIRTH WEIGHT WITH MATERNAL HAEMOGLOBIN DURING PREGNANCY

**Paediatrics**

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## ABSTRACT

**Background:** Low birth weight and prematurity remain major contributors to neonatal morbidity and mortality, particularly in low- and middle-income countries. Maternal anemia is highly prevalent and may adversely influence fetal growth, birth weight, and gestational age, yet its local impact needs further clarification. **Objectives:** To evaluate maternal hemoglobin levels during pregnancy and examine their correlation with neonatal birth weight and gestational age, and to assess associations between maternal demographic factors and the presence and severity of anemia. **Methodology:** This single-centre, hospital-based retrospective study was conducted in a tertiary-care pediatric department in Central India from December 2023 to April 2025. One hundred term and preterm inborn neonates of either sex, delivered vaginally or by caesarean section, were included, excluding mothers with major systemic or obstetric comorbidities. Maternal demographics, hemoglobin levels, neonatal birth weight, and gestational age were recorded and analyzed using Chi-square tests and correlation statistics ($p < 0.05$ significant). **Results:** Most mothers were aged 21–30 years, and 60% of neonates were delivered vaginally. Overall, 55% of mothers were anemic (22% mild, 17% moderate, 16% severe), with mean hemoglobin 9.9±2 g/dL (range 5–12.4 g/dL). Forty-three percent of neonates weighed 1.5 to 2.5 kg and 41% weighed >2.5 kg, with a mean birth weight of 2.22±0.78 kg (0.8–3.5 kg). Sixty-two percent were term and 38% preterm, with mean gestational age 39±2.3 weeks (29 to 42 weeks). Maternal age and socioeconomic class showed significant associations with anemia ($p = 0.043$ and 0.037). Lower maternal hemoglobin was strongly associated with lower birth weight and reduced gestational age (both $p <0.0001$), and increasing anemia severity significantly increased the likelihood of preterm delivery and low birth weight ($p = 0.0001$ and 0.0009, respectively). **Conclusion:** Maternal anemia was highly prevalent and independently associated with lower neonatal birth weight and earlier gestational age, particularly at higher anemia severity. Optimizing maternal hemoglobin through targeted screening and timely nutritional and therapeutic interventions may reduce preterm birth and low birth weight in similar settings.

## KEYWORDS

Maternal anemia; Hemoglobin; Low birth weight; Gestational age; Neonate

## INTRODUCTION:

Low birth weight [(LBW)], defined by the World Health Organization [(WHO)] as a birth weight of less than 2,500 grams irrespective of gestational age, remains a major global public health concern [(1)]. Worldwide, nearly 15–20% of live births—amounting to over 20 million infants annually—are classified as LBW. The burden is disproportionately higher in developing countries such as India, where approximately 8 million infants are born with LBW each year, accounting for nearly 28% of total live births [(2)]. Recent WHO and UNICEF data compiled from 54 countries, including India, indicate that India's infant mortality rate remains high, with LBW contributing to nearly 57% of infant deaths [(3)].

Among the major determinants of LBW, maternal anemia continues to be a critical and preventable public health issue. Anemia, characterized by reduced oxygen-carrying capacity of blood due to decreased hemoglobin or red blood cell levels, affects pregnant women disproportionately across both developed and developing regions[(3)]. In India, nearly 50% of women of reproductive age are anemic, with prevalence rising slightly from 52.6% in 2016 to 53% in 2020 [(4)]. According to WHO, anemia in pregnancy is defined as hemoglobin levels below 11 g/dL. The Indian Council of Medical Research further classifies anemia during pregnancy into mild, moderate, severe, and very severe categories based on hemoglobin concentration [(5)]. Iron plays a vital role in fetal growth, particularly during the third trimester when placental iron transfer peaks. Inadequate maternal iron stores during this period can adversely affect pregnancy outcomes [(6)].

Maternal nutritional status during pregnancy significantly influences fetal growth and birth weight. Hemoglobin level serves as a practical indicator of maternal nutritional and iron status and is routinely assessed during antenatal care [(7)]. Although the relationship between maternal hemoglobin levels at different gestational stages and fetal growth is complex, evidence suggests that maternal anemia-particularly in early pregnancy-is associated with increased risks of LBW, preterm birth, and SGA infants [(8)]. The present study was conducted to assess correlation in gestational age of neonates and their birth weight with the maternal levels of haemoglobin levels during pregnancy.

## MATERIALS AND METHODS:

This study protocol was approved by the Institutional Ethics Committee (IEC). This was a single centre, hospital based retrospective group study, performed from December 2023 to April 2025 in the pediatric Department of a tertiary care hospital located in Central India. All neonates of either gender, both term and preterm neonates born vaginally or by caesarean section in our hospital were included. Deliveries with Obstetric complications like DM type 1 and 2 or GDM and mothers with major systemic disease with co-morbidities which might confound the study findings, were excluded.

Detailed demographic data of mothers with respect to name, age, detailed address, education, occupation, monthly income, marital status was noted. Data from case record forms were carefully entered into an Excel spreadsheet, ensuring accuracy throughout the process. The data was backed up weekly to prevent loss, and confidentiality was strictly maintained. Periodic data validation was performed by the study supervisor and subject matter experts. Before enrolment, written informed consent was obtained from each parent after thoroughly explaining the study details through an information sheet. Neonates born at our tertiary care teaching hospital were initially screened by clinicians. Those meeting the inclusion criteria were provided with detailed information about the study. All potential participants received the patient information sheet, and written consent was secured from those who agreed to participate.

Screening tests were conducted, and eligible newborns were enrolled. Mothers were informed about the study objectives and follow-up schedule. Face-to-face interviews were conducted in the local language using a structured questionnaire, collecting data on

sociodemographic factors, economic status, reproductive health history, infant feeding practices, and intended delivery location. Additional clinical data collected included gestational age, mode of delivery, birth weight, and any noted complications. Clinical examinations were performed, and blood samples were taken to assess anemia status.

Data were presented as percentages and means ± standard deviation, and statistical comparisons were made using paired or unpaired t-tests where appropriate. Data collection was performed using Microsoft Excel. The significance of differences in frequency distributions was assessed using the Chi-square test or Fisher's exact test. A p-value below 0.05 was considered statistically significant. All statistical analyses were conducted with SPSS software (IBM SPSS Statistics for Windows, Version 21.0, Armonk, NY: IBM Corp).

## RESULTS:

**Table 2. Demographic Profile Of The Mothers And Neonates:**

| Demographic Profile | | Number (n=100) | Percentage (100%) |
|---|---|---|---|
| Age groups (Years) | >30 years | 11 | 11 |
| | 26-30 years | 37 | 37 |
| | 21-25 years | 37 | 37 |
| | ≤ 20 years | 15 | 15 |
| Gender of Neonates | Male | 47 | 47 |
| | Female | 53 | 53 |
| Mode of Delivery | Vaginal | 60 | 60 |
| | LSCS | 40 | 40 |
| Education of the Head of the Family | Graduate | 20 | 18 |
| | Inter/ Diploma | 31 | 31 |
| | High School | 17 | 17 |
| | Middle School | 21 | 21 |
| | Primary school | 8 | 8 |
| | Illiterate | 3 | 3 |
| Socioeconomic class | Upper Middle | 4 | 4 |
| | Lower Middle | 16 | 16 |
| | Upper Lower | 76 | 76 |
| | Lower | 4 | 4 |
| BMI of Mother | Normal 18.5-24.9 | 45 | 45 |
| | Overweight 25-29.9 | 26 | 26 |
| | Underweight <18.5 | 29 | 29 |

Most mothers were within the age groups of 21-25 years and 26- 30 years, each comprising 37% of the sample, followed by those aged 20 years or younger at 15%. The average age of the mothers was 25.4±3.9 years. The youngest mother was 19 years old, while the oldest was 34 years. Nearly half of the neonates who were recruited into the study were males (47%). More than half of the neonates who were recruited into the study delivered vaginally. Two-fifth of the neonates were delivered by LSCS.

Education of the Head of the Family. 31% belonged to families with the Head of the Family having Inter/Diploma as their education followed by Middle school certificate (21%) and graduates (18%). The socioeconomic status of the neonates' families was determined based on the occupation and education of the head of the household, as well as the monthly income. Approximately three-quarters of the neonates belonged to the Upper Lower class, followed by 16% from the Lower Middle class. A majority of them (45%) had normal BMI, followed by underweight (29%).

**Table 2. Clinical Parameters Of The Neonates:**

| Clinical parameters | | Number (n=100) | Percentage (100%) |
|---|---|---|---|
| Birth Weight (Kgs) | < 1kg | 3 | 3 |
| | 1-1.5 kg | 13 | 13 |
| | 1.5 – 2.5 kg | 43 | 43 |
| | >2.5kg | 41 | 41 |
| Gestational Age (weeks) | ≤ 33 weeks | 14 | 14 |
| | 34-36 weeks | 24 | 24 |
| | 37-42 weeks | 62 | 62 |
| Maternal Hemoglobin (gm%) | <7 | 16 | 16 |
| | 7-9.9 | 17 | 17 |
| | 10-10.9 | 22 | 22 |
| | >11 | 45 | 45 |

43% of the neonates had their birthweights between 1.5 and 2.5 kg, followed by 41% of them with more than 2.5 kg. 62 % of the neonates were term babies and rest 38% were preterm babies. 45% of the mothers had normal Hemoglobin. 55% of the mothers had anemia. 22% had mild anemia, 17% had moderate anemia and 16% had severe anemia. The neonates' birth weight averaged 2.22±0.78 kg, ranging from 0.8 to 3.5 kg. The average gestational age was 39±2.3 weeks, with a minimum of 29 weeks and a maximum of 42 weeks. Maternal hemoglobin levels had a mean of 9.9±2 g/dL, with values ranging between 5 and 12.4 g/dL.

**Table 3. Association Between Demographic Factors And Presence Of Anemia:**

| Demographic factors | | Maternal Anemia | | P value |
|---|---|---|---|---|
| | | Present n=55 | Absent n=45 | |
| Age group of Mothers (Years) | >30 years | 3 | 8 | 0.043, Significant |
| | 26-30 years | 18 | 19 | |
| | 21-25 years | 22 | 15 | |
| | ≤ 20 years | 12 | 3 | |
| Socioeconomic class | Lower | 3 | 1 | 0.037, Significant |
| | Upper Lower | 46 | 30 | |
| | Lower Middle | 6 | 10 | |
| | Upper Middle | 0 | 4 | |
| Birth weight | < 1kg | 3 | 0 | <0.0001, HS |
| | 1-1.5 kg | 13 | 0 | |
| | 1.5 – 2.5 kg | 35 | 8 | |
| | >2.5kg | 4 | 37 | |
| Gestational age | < 33 weeks | 14 | 0 | <0.0001, HS |
| | 34-36 weeks | 20 | 4 | |
| | >36 weeks | 21 | 41 | |

There is significant correlation between maternal age and anemia, with a p-value of 0.043. This indicates that younger mothers at the time of delivery are more likely to experience anemia. Lower the socioeconomic class of the family, the presence of anemia is more (p value 0.037). There is low birthweight of the neonate, if the hemoglobin level of the mother is low (p value <0.0001). Lower maternal hemoglobin levels are linked to reduced gestational age in newborns (p value <0.0001).

**Table 4. Association Between Birth Weight And Gestational Age With Severity Of Anemia:**

| Birth Weight And Gestational Age | | Severity Of Anemia | | | P value |
|---|---|---|---|---|---|
| | | Severe | Moderate | Mild | |
| Birth weight | < 1kg | 3 | 0 | 0 | 0.0001, HS |
| | 1-1.5 kg | 8 | 1 | 4 | |
| | 1.5 – 2.5 kg | 5 | 12 | 18 | |
| | >2.5kg | 0 | 4 | 0 | |
| Gestational Age | Preterm | 16 | 8 | 10 | 0.0009, HS |
| | Term | 0 | 9 | 12 | |

Association between Birth weight and gestational age of the Neonate with the severity of Maternal Anemia were highly significant (both p values <0.001). It showed that increase in severity of anemia increases the chances of Preterm delivery and lower birth weights.

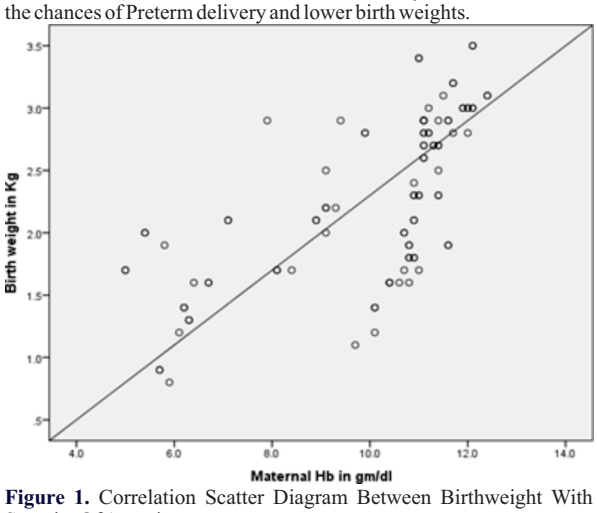


**Figure 1.** Correlation Scatter Diagram Between Birthweight With Severity Of Anemia:

Pearson correlation coefficient demonstrates that there is significant correlation (p value <0.001), shows higher the anemia, lower is the birthweight of the neonate.

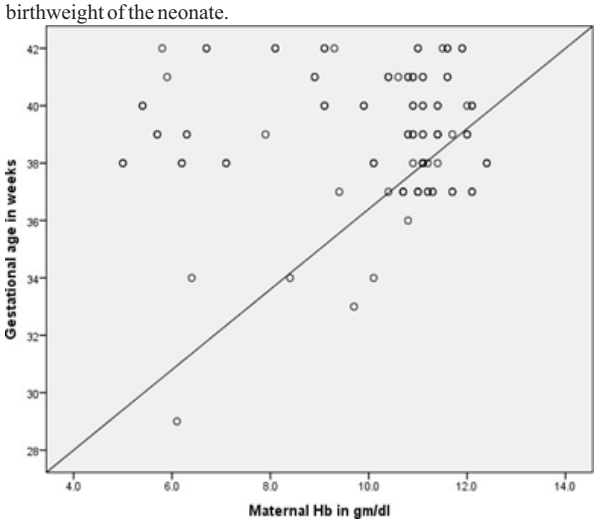


**Figure 2.** Correlation Scatter Diagram Between Birthweight With Severity Of Anemia:

Pearson correlation coefficient demonstrates that there is significant correlation (p value <0.001), shows higher the anemia, lower is the birthweight of the neonate.

In the study, 60% of the mothers of the neonates were found to have some degree of anemia-mild, moderate, or severe. Maternal anemia was associated with an increased likelihood of preterm delivery and low birth weight infants. A negative correlation was observed between maternal hemoglobin levels and both birth weight and gestational age, indicating that lower maternal hemoglobin increases the risk of delivering preterm and low birth weight babies.

## DISCUSSION

### Age Of Mother:

Maternal high-risk factors such as early or late maternal age, closely spaced pregnancies, and high parity are important bio-demographic determinants that can negatively impact women's health. Early childbearing remains common, with over one-third (34%) of women aged 20 to 49 having given birth by age 18, and 11% of adolescent girls aged 15 to 19 already mothers or pregnant with their first child. About 20% of births occur within 24 months of the previous delivery, contributing to a higher risk of anemia among adolescent girls[9]. In India, giving birth before age 18 is associated with increased anemia risk among adolescents, while in the United States, pregnant women aged 35 and older face greater medical complications, including anemia, compared to younger women[10].

In the present study, most mothers belonged to the 21–25 and 26–30-year age groups (each 37%), with 15% younger than 20 years and 11% older than 30 years. The mean age was 25.4±3.9 years, ranging from 19 to 34 years. Similarly, Maka et al. [11] reported the most common maternal age group as 19–24 years (47%), followed by 25–29 years (34%). Sah et al.[12] found a mean maternal age of 26.5±4.3 years, with over one-third (37.9%) of mothers aged 21–25 and 26–30 years respectively, aligning closely with our data.

### Education Of The Head Of The Family:

In the present study, 31% of heads of families had Inter/Diploma-level education, followed by middle school (21%), graduates (18%), and high school certificate holders (17%). A smaller proportion had primary school education (8%), and only 3% were illiterate. Liu et al. [13] reported contrasting results, with most participants having junior high school education or below (54.4%), while only 14.1% attained college-level education. Similarly, Sah et al. [12] found that 38.1% of mothers had higher education, and 37.2% had intermediate education levels, aligning partially with our results.

### Socioeconomic Class Of The Family

Anemia is the most common hematologic disorder during pregnancy, primarily caused by iron deficiency, and it is strongly influenced by socioeconomic and educational factors.(97,98) In the present study, 76% of neonates belonged to the upper-lower socioeconomic class, and 16% to the lower middle class; only 4% were from upper middle and lower classes each. Similar findings were reported by Maka et al. [11], who noted 84% of participants in lower socioeconomic groups. Rangnekar et al. [14] also found that 67% of women were from low socioeconomic backgrounds.

### Gender Of Neonates:

In our study, female neonates slightly predominated (53%) compared to males (47%). Carpenter et al. [15] reported a male predominance of 50.7%, differing from our findings, while Pande et al. [6] observed nearly equal distribution of male (n=142) and female (n=133) neonates, supporting our observation of balanced gender distribution.

### Mode Of Delivery:

We found that 60% of neonates were delivered vaginally, while 40% were delivered by LSCS. Tarek et al. [16] reported similar rates, with 48.5% vaginal and 51.5% cesarean deliveries. Carpenter et al.[15] noted a slightly higher cesarean rate (55.1%), while Peng et al. [17] reported comparable numbers-54.2% cesarean and 40.4% vaginal deliveries.

### Maternal Hemoglobin:

Anemia during pregnancy, largely due to iron or folate deficiency, increases the risk of maternal and neonatal complications[18]. In the present study, 55% of women were anemic-22% mild, 17% moderate, and 16% severe-with a mean hemoglobin of 9.9±2 g/dL. Sah et al.[12] reported a mean of 11.8±1.3 g/dL, and Khezri et al. [19] found 11.49±1.08 g/dL. Pande et al. observed 51.1% within the normal range (11–13.5 g/dL), while 38.6% exhibited varying anemia severity. Peng et al.[17] further highlighted that hemoglobin decreases gradually across trimesters before stabilizing in the third.

### BMI Of Mother:

In the present study, most mothers (45%) had a BMI between 18.5–24.9 kg/m², followed by 26% who were overweight (25–29.9 kg/m²) and 29% who were underweight (<18.5 kg/m²). Liu et al.[13] similarly found higher proportions of women with normal BMI (71.0%), followed by overweight (14.8%) and underweight (10.9%). Sah et al. [12] reported an average BMI of 23.6±3.6 kg/m², with 3.7% underweight and 30% overweight or obese participants, comparable to our findings. Sekhavat et al. [20] also observed a mean BMI of 23.6±1.8 kg/m².

### Birth Weight Of The Neonate:

Birth weight is a key determinant of neonatal health and survival, closely linked to maternal nutrition and prenatal care[10,13,21]. In our study, 43% of newborns weighed 1.5–2.5 kg, 41% weighed above 2.5 kg, 13% ranged between 1–1.5 kg, and 3% weighed below 1 kg. The mean birth weight was 2.22±0.78 kg, ranging from 0.8 kg to 3.5 kg. Sah et al. [12] noted an average birth weight of 3.1±0.4 kg, while Rupnar et al. [22] reported a mean of 2.3±0.28 kg with 45% classified as low birth weight (LBW).(92) A similar LBW incidence (46%) was reported by Maka et al[11].

Globally, the UNDP and UNICEF report LBW rates of 31% in South Asia, 19% in developed regions, and roughly 15% in Africa and North America; LBW neonates face nearly 20 times higher mortality than those above 2.5 kg[23]. In this study, 62% of neonates were delivered at term (37–42 weeks) and 38% preterm. Among the preterm group, 24% were born between 34–36 weeks and 14% before 33 weeks. The mean gestational age was 39±2.3 weeks, consistent with Sah et al.'s[12] findings (39.2±1.1 weeks).

### Correlation Of Demographic Profile Of Mother With Maternal Hemoglobin:

In the present study, we evaluated the association between maternal characteristics and anemia and found a statistically significant relationship between maternal age and anemia, as well as between socioeconomic class and anemia (P = 0.043 and 0.037, respectively). This indicates that younger maternal age at delivery and lower socioeconomic status were associated with a higher prevalence of anemia in our study population. Maternal anemia is a well-recognized risk factor for delivering low birth weight (LBW) neonates, consistent with prior evidence that reduced hemoglobin impairs placental angiogenesis and fetal growth.

### Correlation Of Birthweight And Gestational Age Of The Neonate With Maternal Anaemia And Its Severity:

We observed a highly significant association between neonatal birth weight and maternal anemia (P < 0.001), with lower maternal hemoglobin linked to lower birth weight. Birth weight also showed a highly significant association with anemia severity (P = 0.0001), demonstrating that increasing severity of maternal anemia corresponded to progressively lower neonatal birth weight, whereas higher maternal hemoglobin was associated with higher birth weight, indicating a positive correlation. Gestational age showed a similarly strong association with maternal anemia (P < 0.0001) and with anemia severity (P = 0.0009), with lower hemoglobin and more severe anemia associated with increased likelihood of preterm delivery and higher hemoglobin linked to term delivery. These findings align with earlier studies reporting higher risks of preterm birth and LBW among anemic mothers, with the risk rising as anemia becomes more severe[10,12,15].

Both low and excessively high maternal hemoglobin levels have been associated with adverse birth outcomes. Concentrations below about 11 g/dL increase the risk of LBW, while very high levels (for example, ≥130 g/L in late pregnancy) have also been linked to reduced birth weight and higher rates of LBW and small-for-gestational-age infants, likely due to increased blood viscosity and reduced placental perfusion. Inadequate plasma volume expansion in such cases may further compromise uteroplacental blood flow and fetal oxygenation, contributing to poor growth and unfavorable perinatal outcomes. These observations underscore the importance of monitoring and optimizing maternal hemoglobin levels throughout pregnancy to minimize the risk of LBW and preterm birth.

## CONCLUSION:

In conclusion, anemia continues to be commonest medical condition impacting pregnant women, especially in low- and middle-income nations, where it significantly adds to maternal illness and mortality. The incidence of LBW in these settings is alarmingly high-up to 43%-with maternal anemia being a key factor. Anemia also worsens indirect causes of maternal mortality such as postpartum hemorrhage, infections, and cardiac issues. Negative fetal outcomes including miscarriage, preterm birth, intrauterine growth restriction, and low birth weight are frequently linked to anemia during pregnancy.

Nutritional deficiencies, particularly iron deficiency, are responsible for nearly 90% of anemia cases in pregnant women, underscoring the urgent need for effective preventive and treatment strategies. It is noteworthy that women from higher socio-economic and educational backgrounds often have elevated hemoglobin levels during pregnancy. However, high Hb levels have also been linked with adverse fetal outcomes, indicating the importance of careful monitoring for all demographic groups.

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