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IMPACT OF MATERNAL HEMOGLOBIN AND SERUM FERRITIN ON BIRTH WEIGHT AND APGAR SCORES IN A TERTIARY CARE HOSPITAL

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ABSTRACT:

Background: Maternal anemia remains a major public health problem in developing countries and is associated with adverse neonatal outcomes. Hemoglobin reflects functional iron status, while serum ferritin represents iron stores. Their combined effect on neonatal birth weight and Apgar scores has not been adequately studied in Indian populations.

Objectives: To assess maternal hemoglobin and serum ferritin levels and determine their effect on neonatal birth weight and Apgar scores at 1 and 5 minutes, and to evaluate the association between maternal hemoglobin and selected demographic variables.

Materials and Methods: This prospective observational study was conducted in the Department of Obstetrics and Gynecology, Subbaiah Institute of Medical Sciences and Research centre, Shivamogga, from October 2024 to September 2025. A total of 100 term pregnant women (37–41 weeks gestation) aged 18–30 years with singleton pregnancies were included using convenience sampling. Maternal hemoglobin was estimated by Sahli's acid hematin method and serum ferritin by chemiluminescence immunoassay (CLIA). Neonatal birth weight was recorded using a digital scale, and Apgar scores were assessed at 1 and 5 minutes. Statistical analysis was performed using EPI INFO version 7, with $p < 0.05$ considered statistically significant.

Results: Maternal anemia was present in 71% of the study population, with moderate anemia being the most common (44%). Mean birth weight was significantly lower in neonates born to anemic mothers (2.77 ± 0.36 kg) compared to non-anemic mothers (3.26 ± 0.30 kg) ($p = 0.000001$). Apgar scores at both 1 minute (7.28 vs 9.51) and 5 minutes (8.35 vs 9.96) were significantly lower in neonates born to anemic mothers ($p = 0.000001$). Although 17% of mothers had low serum ferritin levels (<12 ng/ml), serum ferritin did not show a statistically significant association with neonatal birth weight or Apgar scores. Cesarean section rates were significantly higher among anemic mothers ($p = 0.03$).

Conclusion: Maternal hemoglobin levels have a significant impact on neonatal birth weight and Apgar scores, whereas serum ferritin levels did not show a direct association with immediate neonatal outcomes in this study. Early detection and correction of maternal anemia through effective antenatal care and iron supplementation are essential to improve neonatal outcomes.

Keywords: Maternal anemia; Hemoglobin; Serum ferritin; Birth weight; Apgar score; Neonatal outcomes

INTRODUCTION:

Maternal nutrition is a critical determinant of pregnancy outcome and neonatal well-being. Among nutritional deficiencies, iron deficiency anemia remains the most prevalent worldwide, particularly in developing countries, and disproportionately affects pregnant women due to increased physiological demands[1]. The World Health Organization defines anemia in pregnancy as hemoglobin (Hb) levels <11 g/dL and estimates that nearly 40% of pregnant women globally are anemic, with higher prevalence in South Asia[2]. Maternal anemia has been consistently associated with adverse obstetric and neonatal outcomes, making it a significant public health concern.

Hemoglobin is an essential indicator of the oxygen-carrying capacity of blood. During pregnancy, plasma volume expansion often exceeds the increase in red cell mass, resulting in physiological anemia. However, pathological anemia, particularly iron deficiency anemia, compromises maternal oxygen delivery to the placenta and fetus[3]. Reduced oxygen availability can impair placental development and function, leading to fetal hypoxia and growth restriction. Several studies have demonstrated that low maternal hemoglobin levels are associated with low birth weight (LBW), preterm birth, intrauterine growth restriction (IUGR), and increased perinatal morbidity and mortality[4–6].

Neonatal birth weight is a key indicator of intrauterine growth and an important predictor of neonatal survival and long-term health outcomes. Low birth weight infants are at increased risk of hypothermia, infections, neurodevelopmental delay, and chronic diseases later in life[7]. Maternal anemia, especially when moderate to severe, has been identified as an independent risk factor for LBW. Studies from both hospital-based and community-based settings have shown a significant inverse relationship between maternal hemoglobin concentration and neonatal birth weight[8],[9]. Furthermore, the severity of anemia has been shown to correlate with progressively poorer neonatal outcomes[10].

The Apgar score, assessed at 1 and 5 minutes after birth, is a widely used clinical tool to evaluate the immediate physiological condition of the newborn. It reflects neonatal adaptation to extrauterine life and helps identify infants requiring resuscitation or intensive care. Maternal anemia has been linked to lower Apgar scores, possibly due to chronic intrauterine hypoxia and compromised fetal reserves[11]. Neonates born to anemic mothers have been reported to have significantly lower Apgar scores at both 1 and 5 minutes compared to those born to non-anemic mothers[12],[13].

While hemoglobin reflects functional iron status, it may not accurately represent iron stores, especially in early stages of deficiency. Serum ferritin is considered the most reliable biochemical marker of body iron stores and is particularly useful in detecting subclinical iron deficiency[14]. During pregnancy, serum ferritin levels progressively decline due to increased iron requirements for fetal growth, placental development, and expanded maternal erythropoiesis[15]. Low maternal ferritin levels indicate depleted iron reserves and are often present even before hemoglobin levels fall below diagnostic thresholds.

Recent studies have emphasized the importance of maternal ferritin levels in determining fetal growth and neonatal outcomes. Low maternal serum ferritin has been associated with reduced placental iron transfer, impaired fetal iron endowment, and lower neonatal birth weight[16],[17]. Several observational studies have reported a positive correlation between maternal ferritin levels and neonatal birth weight, suggesting that adequate maternal iron stores are crucial for optimal fetal growth[18]. Neonates born to mothers with depleted iron stores are also more likely to have low cord blood hemoglobin and ferritin levels, predisposing them to early-onset iron deficiency[19].

However, the relationship between maternal serum ferritin and neonatal outcomes is complex. Ferritin is an acute-phase reactant, and elevated levels may reflect inflammation or infection rather than iron sufficiency. Some studies have paradoxically associated high maternal ferritin levels with adverse outcomes such as low birth weight and preterm delivery, possibly due to underlying inflammatory states[20]. These findings highlight the need for careful interpretation of ferritin values in pregnancy and consideration of confounding factors.

The combined assessment of maternal hemoglobin and serum ferritin provides a more comprehensive evaluation of iron status than either parameter alone. Despite numerous studies examining maternal anemia, limited data are available that simultaneously evaluate both hemoglobin and ferritin levels in relation to neonatal birth weight and Apgar scores, particularly in Indian populations. Variations in dietary habits, socioeconomic status, antenatal care practices, and prevalence of anemia necessitate region-specific research.

Given the high burden of maternal anemia in India and its potential impact on neonatal outcomes, there is a need for focused studies that evaluate the influence of maternal iron status on early neonatal health indicators. Understanding this relationship can aid in early identification of high-risk pregnancies, optimization of antenatal iron supplementation strategies, and improvement of perinatal outcomes

The present study aims to assess the effect of maternal hemoglobin and serum ferritin levels on neonatal birth weight and Apgar scores in 100 cases, thereby contributing valuable evidence toward improving maternal and neonatal health care practices.

OBJECTIVES:

1. To assess the Hemoglobin and Ferritin levels among mothers.
2. To determine the effect of maternal Hemoglobin and Ferritin levels on neonatal birth weight and Apgar scores.
3. To find the association between maternal hemoglobin and birth weight with selected demographic variables.

MATERIAL & METHODS:

Study Design: A prospective observational study.
Study area: Department of Obstetrics and Gynecology, Subbaiah Institute of Medical Sciences and Research Center, Shivamogga.
Study Period: October 2024 to September 2025.
Sample size: The study consisted of a total of 100 subjects.
Sampling method: convenience sampling method.

Inclusion criteria:

 Primi and Multiparous women
 Singleton pregnancy.
 Preganant mothers aged from18 yrs to 30 yrs.
 Gestational Age 37 wks to 41 wks.

Exclusion criteria:

 Multiple pregnancy
 Hemoglobinopathies to mother
 Maternal febrile illness prior to delivery
 Maternal Hypertension, pre-eclampsia, eclampsia.
 Medical disorders complicating pregnancy
 HIV infection
 TORCH group of Infections
 Major Congenital malformations in new born.

Ethical consideration: Institutional Ethical committee permission was taken before the commencement of the study.

Data collection procedure:

In total, 100 subjects were selected from the hospital. Required information was taken from interview and antenatal records.

Investigations:
 CBP (Complete Blood Picture)
 Serum Ferritin
 BGT (Blood Grouping and Typing)
 HIV (Human Immuno Defeciency Virus)
 HBS Ag (Hepatitis B Surface Antigen)
 VDRL (Venereal Disease Research Labratory)
 RBS (Random Blood Sugar)
 TSH (Thyroid Stimulating Hormone)
 Obstetric Scan at Term gestation

Intervention:
 The measurement of Hb was done by Sahli's Acid Hematin method.
 The measurement of serum Ferritin was done using Chemi Luminescence Immuno Assay(CLIA) method.
 Birth weight was recorded in kilo grams using a digital scale.
 Apgar score was caluculated at 1 and 5 minutes after the birth.

Gestational age was caluculated based on a reliable self-reported estimate of LMP by Naegle's formula, or in the case of unknown LMP, an ultra sound performed early in pregnancy. When both data available, with less than 14 days difference, LMP was used to estimate Gestational age. Where the difference in two estimates, exceeded 14 days, ultra sound was considered to estimate gestational age. Routine antenatal investigations were done, apart from them, CBP and serum Ferritin at term gestation were done. 4ml of venous blood sample taken from each patient, under aseptic precautions, of which 2ml was used for CBP(Hb), and 2ml for Ferritin. The container to collect blood sample for CBP was added prior with 0.2% of EDTA and the blood for Ferritin values were collected in plain bottle. Anemia was defined using the WHO criteria for anemia during pregnancy. Based on these criteria, Hb cut off value used to define anemia was 11mg/dl. The normal range of Ferritin levels 12 to 200 ng/ml, were considered.

STATISTICAL ANALYSIS: Data entry was done by Micrsoft Excel 2010 version and analysis using EPI INFO version 7. Data was summerised in percentage and proportions. Numerical data was expressed asthe mean +SD (standard devation) comparasion between 2 means was performed by using the student t test. A comparision between means containing more than two groups was performed by analysis of variance (ANOVA). Association between categorical variable was done using chisquare test. A, p value less than 0.05 was considered statistically significant.

OBSERVATIONS & RESULTS:

Table 1: Demographic Profile of the Study Population

Variable	Category	Number (n=100)	Percentage (%)
Age Group	20–25 Years	60	60%
	26–30 Years	36	36%
Residence	Rural	58	58%
	Urban	42	42%
Parity	Primigravida	43	43%

Variable	Category	Number (n=100)	Percentage (%)
	Multigravida (G2 to G4)	57	57%

The majority of the participants were between 20–25 years of age (60%). The study saw a higher representation of rural residents (58%) and primigravida mothers (43%).

Table 2: Maternal Hemoglobin (Hb) Status

Hb Level (gm%)	Classification	Number (n=100)	Percentage (%)
>11	Normal	29	29%
10.0–10.9	Mild Anemia	16	16%
7.0–9.9	Moderate Anemia	44	44%
<7.0	Severe Anemia	11	11%

There was a high incidence of anemia (71%) in the study population. Moderate anemia was the most common category, affecting 44% of the participants.

Table 3: Maternal Serum Ferritin Levels

Serum Ferritin (ng/ml)	Number (n=100)	Percentage (%)
Low (<12ng/ml)	17	17%
Normal (12–200 ng/ml)	83	83%
Total	**100**	**100%**

While most mothers (83%) had ferritin levels within the normal range, 17% were found to have depleted iron stores (<12 ng/ml).

Table 4: Correlation Between Maternal Hb and Birth Weight

Maternal Hb Level	Mean Birth Weight (kg)	Standard Deviation	p-value
<11 gm% (Anemic)	2.77	0.36	0.000001 (Significant)
>11 gm% (Normal)	3.26	0.30	

There is a strong, statistically significant association between maternal hemoglobin and birth weight. Anemic mothers delivered babies with a significantly lower mean birth weight compared to non-anemic mothers.

Table 5: Correlation Between Maternal Hb and APGAR Scores

Outcome Variable	Mean Score (Hb ≤11)	Mean Score (Hb >11)	p-value
APGAR at 1 Min	7.28	9.51	0.000001

Outcome Variable	Mean Score (Hb ≤11)	Mean Score (Hb >11)	p-value
APGAR at 5 Min	8.35	9.96	0.000001

Maternal anemia is significantly associated with lower APGAR scores at both 1 and 5 minutes. Babies born to mothers with normal hemoglobin levels showed better immediate neonatal vitality.

Table 6: Impact of Serum Ferritin on Neonatal Outcomes

Outcome Variable	Low Ferritin (<12)	Normal Ferritin (≥12)	p-value
Mean Birth Weight (kg)	2.93	2.90	0.1
Mean APGAR (1 min)	7.76	7.96	0.07
Mean APGAR (5 min)	8.64	8.85	0.8

Unlike hemoglobin, serum ferritin levels did not show a statistically significant association with birth weight or APGAR scores in this study.

Table 7: Relationship Between Gestational Age and APGAR Scores

Gestational Age	No Depression (7–10)	Mild Depression (4–6)	p-value
37–38 Weeks	31 (77.5%)	09 (22.5%)	0.00001 (Significant)
39–40 Weeks	11 (22.9%)	37 (77.1%)	

There was a significant correlation between gestational age and APGAR scores, suggesting that maturity at birth influences the newborn's immediate physical condition.

Table 8: Mode of Delivery and Maternal Anemia

Mode of Delivery	Number	Percentage (%)
Normal Vaginal (NVD)	69	69%
LSCS (Elective/Emerg)	31	31%

While most deliveries were vaginal, the study found that cesarean sections (LSCS) were significantly more frequent among anemic clients ($p=0.03$), often due to complications like fetal distress.

DISCUSSION:

Maternal Demographics and Study Population

The present study, conducted at Government Maternity Hospital, analyzed 100 cases to evaluate the impact of maternal hematological status on neonatal outcomes. The maternal age ranged from 19 to 31 years, with a mean age of 24.87±3.36 years. This age distribution aligns with several Indian studies, such as those by Alka Batar et al.[21] and Malhotra M et al.[22], which reflect the peak reproductive age group in the region.

Regarding parity, 43% of the participants were primigravida, and 32% were second gravida. Interestingly, the study noted that while parity and maternal age are often discussed in obstetric literature, they did not show a statistically significant association with birth weight in this specific cohort (p=0.3 and p=0.6, respectively). This suggests that the physiological impact of anemia may override basic demographic factors in determining fetal growth.

The Prevalence of Maternal Anemia

A significant finding in this study was the high incidence of maternal anemia, which stood at 71%. Among these, 16% had mild anemia, 44% had moderate anemia, and 11% were severely anemic. This prevalence is considerably higher than reports from developed regions but remains consistent with studies from other tertiary care centers in India, such as Ekta Dalal et al.[23], who reported a prevalence of 64.05%9. The high rate of moderate anemia (44%) highlights a critical public health concern, likely stemming from nutritional deficiencies, poor dietary habits, and inadequate iron supplementation.

Correlation Between Hemoglobin and Birth Weight

The most profound correlation observed was between maternal hemoglobin (Hb) levels and neonatal birth weight. The study revealed a strong positive correlation (p=0.000001), with anemic mothers (<11 gm%) delivering babies with a mean weight of 2.77 kg, compared to 3.26 kg for non-anemic mothers. This finding is supported by the physiological role of hemoglobin in oxygen transport. Chronic maternal anemia leads to a state of placental hypoxia, which can trigger intrauterine growth restriction (IUGR) or lower birth weights. These results are consistent with the findings of Levy A et al.[24] and Ahmad MD et al.[25], both of whom identified maternal anemia as an independent risk factor for low birth weight.

APGAR Scores and Neonatal Vitality

The study also demonstrated that maternal anemia significantly affects the immediate physical condition of the newborn, as measured by APGAR scores at 1 and 5 minutes.**1-Minute APGAR:** Mothers with Hb <11 gm% had a mean neonatal APGAR of 7.28, while those with normal Hb had a mean of 9.51 (p=0.000001). **5-Minute APGAR:** A similar significant difference was noted at the 5-minute mark (8.35 vs. 9.96, p=0.000001). These results suggest that infants born to anemic mothers are at a higher risk of birth asphyxia and may require more immediate medical attention. While some studies, like Soumyamol Francis et al.[26], found no significant relation between Hb and APGAR scores, our findings align with Elise M. Laflamme et al.[27], who observed that maternal anemia was associated with lower scores specifically due to reduced fetal oxygen reserves during labor.

The Role of Serum Ferritin Interestingly, while hemoglobin showed a strong correlation with outcomes, serum ferritin levels—a marker of stored iron—did not show a statistically significant association with birth weight (p=0.1) or APGAR scores (p=0.07 at 1 min). 83% of the cases had normal ferritin levels (12–200 ng/ml), while only 17% had low levels (<12$ng/ml). This discrepancy might be explained by the fact that anemia often develops only after iron stores are completely depleted. The study concludes that while ferritin is a useful diagnostic tool for early iron deficiency, hemoglobin remains the primary predictor for immediate neonatal outcomes in clinical settings.

Obstetric Outcomes and Mode of Delivery

The study noted a significant relationship between anemia and the mode of delivery (p=0.03). Cesarean sections were more frequent in anemic patients (31% of the total study population). This is often due to the increased incidence of fetal distress in babies of anemic mothers, who lack the oxygen reserves to tolerate the stress of labor. These observations echo the work of Malhotra M et al.[22], who found a 4.8-fold higher risk for operative deliveries in severely anemic women.

CONCLUSION:

This study of 100 cases concludes that maternal hemoglobin levels are a critical determinant of neonatal health, with a staggering 71% prevalence of anemia identified among the participants. A

strong, statistically significant correlation exists between maternal hemoglobin and newborn outcomes; mothers with normal hemoglobin levels (>11 gm%) delivered infants with significantly higher mean birth weights and superior APGAR scores at both 1 and 5 minutes compared to anemic mothers (p=0.000001). Furthermore, maternal anemia was linked to increased obstetric complications, resulting in a higher incidence of Cesarean sections (p=0.03). While serum ferritin is a key marker of iron stores, it did not demonstrate a significant direct association with birth weight or APGAR scores in this specific cohort. Ultimately, the research underscores the necessity of routine iron supplementation, nutritional education, and robust antenatal care to prevent maternal anemia and ensure favorable fetal outcomes.

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