

The effect of maternal anemia on the anthropometric measurements in full term neonates

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ABSTRACT

Background: Maternal anemia during pregnancy, prevalent in developing countries like India, is associated with adverse neonatal outcomes, including impaired anthropometric measurements. This study aimed to evaluate the effect of maternal anemia on the anthropometric measurements of full-term neonates.

Method: The study included 200 pregnant women (singleton pregnancies, aged 18-40 years, 37-41 weeks of gestation) presenting for antenatal care or labor. Data on hemoglobin levels, BMI, IFA supplementation, dietary intake, and pregnancy spacing were collected. Neonatal anthropometric measurements were analyzed based on the severity of maternal anemia.

Results: During the study period, a total of 3640 pregnant women were attended to our hospital, out of them 200 pregnant women had anemia. Thus, the prevalence of anemia in the present study was 5.49%. Among the anemic mothers, 171 (85.5%) women had mild, 24 (12%) had moderate, and 5 (2.5%) had severe anemia. Severe anemia was associated with lower mean neonatal weight (3.27 ± 0.61 kg), length (48.69 ± 1.31 cm), head circumference (34.04 ± 1.45 cm), and chest circumference (32.43 ± 1.63 cm) compared to mild and moderate anemia. Significant associations were observed between maternal hemoglobin levels and neonatal length, head circumference, and chest circumference ($p < 0.05$). The percentile distribution of weight-for-age, length-for-age, and weight-for-length were significantly affected ($p < 0.0001$), but head circumference-for-age was not. Maternal BMI, IFA supplementation, calorie intake, and pregnancy spacing positively influenced neonatal anthropometry. **Conclusion:** Maternal anemia adversely affects neonatal anthropometric measurements, particularly in severe cases. Improving maternal hemoglobin levels through prenatal interventions and addressing nutritional deficiencies is essential to optimize fetal growth and neonatal well-being.

Key-words: Maternal anemia, Neonatal anthropometry, Birth weight, Neonatal length, Head circumference, Chest circumference, Full-term neonates, Hemoglobin levels.

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INTRODUCTION

Anemia, characterized by reduced oxygen-carrying capacity due to low RBC count or hemoglobin levels, is a significant global health issue, especially among pregnant women and children. Worldwide, 58.27 million pregnant women are anemic, with 95.7% in developing countries.¹ In India, anemia prevalence is 65–75%, compared to 14% in developed nations.² Iron deficiency, the primary cause, results from poor dietary intake and increased pregnancy demands, with 80% of fetal iron transfer occurring in the third trimester.³ Maternal anemia negatively impacts pregnancy outcomes, leading to preterm births, SGA, IUGR, IUD, low birth weight, and increased perinatal mortality. It also heightens risks of postpartum hemorrhage and infections, major causes of maternal mortality in developing nations. Neonates of anemic mothers face poor growth, low iron stores, and increased infection risk.^{4,5} However, maternal anemia affects fetal growth, with anthropometric measurements offering insights into health and nutrition. Studies on the effect of maternal anemia on fetal birth weight have yielded conflicting results.^{6–8} There are few studies about the effects of maternal anemia and its severity on the anthropometric measurements in full-term neonates, hence the present study was planned to understand the effect of maternal anemia and its severity on anthropometric measurement of full-term neonates.

Materials and Methods

This cross-sectional study, conducted in the Department of Pediatrics at a tertiary care center in Western India from January to November 2023, included 200 pregnant women with singleton pregnancies, aged 18–40 years, and gestational ages of 37–41 weeks. Ethical approval and written informed consent were obtained. Women with smoking history, infections, multiple gestations, pregnancy

complications, chronic diseases, or fetal anomalies were excluded, along with preterm, postdate, or critically ill neonates. A complete obstetric history was recorded, including gravidity, parity, history of abortion, past medical conditions, antenatal care during pregnancy, occupation, educational level, and place of residence. Women with anemia were classified based on hemoglobin concentration into three groups: mild anemia (10.9–9.0 g/dl), moderate anemia (8.9–7.0 g/dl), and severe anemia (<7.0 g/dl). Anthropometric measurements of the newborns, including birth weight, length, head circumference, and chest circumference, were documented.

Statistical Analysis

Results were expressed as frequency and percentage as well as mean values $\pm$ standard deviation (SD) or median value if appropriate. Categorical data was compared using chi-square analysis, and for continuous data, t-test analysis was used. All the collected data were analysed by using Statistical Package of Social Sciences (SPSS Software Version 21). Results were considered significant if $P < 0.05$.

Observations and Results

The study included 200 pregnant women, with the majority aged 21–25 years (43.0%) and 26–30 years (36.5%), with a mean age of 24.78 ± 3.15 years. Most participants (64.5%) had a gestational age of 37–38 weeks, with a mean of 38.68 ± 1.41 weeks. Primiparas constituted 66.0%, and 34.0% were multiparas. Gravida 1 was most common (66.0%), followed by gravida 2 (28.0%). A majority (77.0%) had a BMI of 18.5–22.9 kg/m². Iron-folic acid supplementation was taken by 59.5% of participants. Among multiparous women, 58.5% had a spacing of 2–3 years, with a mean spacing of 2.43 ± 0.91 years, (Table 1).

Table 1: Demographic and obstetrics characteristics of patients

Characteristics		Frequency	Percentage
Age groups (years)	<20	19	9.5
	21 to 25	86	43.0
	26 to 30	73	36.5
	>30	22	11.00
Gestational age (Weeks)	37 to 38	129	64.5
	39 to 41	71	35.5
Parity	Primipara	132	66.00
	Multipara	68	34.00
Gravida	1	132	66.00
	2	56	28.00
	≥3	12	6.00
Maternal BMI	<18.5	12	6.0
	18.5-22.9	154	77.0
	23.0-24.9	32	16.0
	25.0-29.9	02	1.0
IFA supplementation	Not taken	81	40.5
	Taken	119	59.5
Spacing from previous pregnancy (Years)	1 to 2	79	39.5
	2 to 3	117	58.5
	>3	04	2.0

During the study, 3640 pregnant women were attended at the hospital, with 200 diagnosed with anemia, giving a prevalence of 5.49%. The mean hemoglobin among anemic women was 10.05 ± 2.88 g/dl (range: 6.89–10.80 g/dl). Of these, 85.5% had mild anemia, 12% moderate, and 2.5% severe anemia. The mean hemoglobin levels were 10.48 ± 3.29 g/dl in the mild group, 8.96 ± 2.85 g/dl in the moderate group, and 6.44 ± 0.67 g/dl in the severe group, with a statistically significant difference ($p=0.031$). Mean of birth weight, length, head circumference, and chest circumference were 3.27 ± 0.61 kg, 48.69 ± 1.31 cm, 34.04 ± 1.45 cm and 32.43 ± 1.63 cm respectively. The study showed

the less weight, length, head circumference and chest circumference of neonates in anemic group. Table 2 shows that full-term neonates of mothers with severe anemia had lower mean weight, length, head circumference, and chest circumference compared to those with mild or moderate anemia. While the relationship between weight and hemoglobin was not statistically significant between the moderate and severe anemia groups ($p=0.662$), significant associations were observed for length, head circumference, and chest circumference with the severity of maternal anemia ($p<0.05$).

Table 2: Effect of severity of maternal anemia on anthropometric measurement of full-term neonates

Parameters	Mild	Moderate	Severe	P value
Weight (Kg)	2.82 ± 1.53	2.49 ± 1.46	1.86±1.23	0.662
Length (cm)	49.05±1.77	48.06±1.29	45.6±0.98	0.001
Head circumference (cm)	34.20±1.11	33.55±1.15	32.59±0.89	0.013
Chest circumference (cm)	31.95±1.24	31.48±1.36	29.93±1.04	0.012

A positive association was observed between maternal hemoglobin and neonatal length, head circumference, and chest circumference, with better maternal hemoglobin significantly improving neonatal anthropometry ($p < 0.05$). However, no significant association was found between maternal hemoglobin and neonatal weight ($p = 0.662$). Gravida did not show a significant effect on neonatal birth weight,

length, or circumferences ($p > 0.05$). Underweight mothers had a significantly negative impact on neonatal weight and length compared to mothers with normal BMI ($p < 0.05$), though head and chest circumference were not significantly affected ($p > 0.05$). Compliance with IFA supplementation significantly improved neonatal anthropometric measures ($p < 0.001$), (Table 3).

Table 3: Comparison of maternal hemoglobin, gravida, BMI, Iron folic supplementation with neonatal birth weight, length, head and chest circumference.

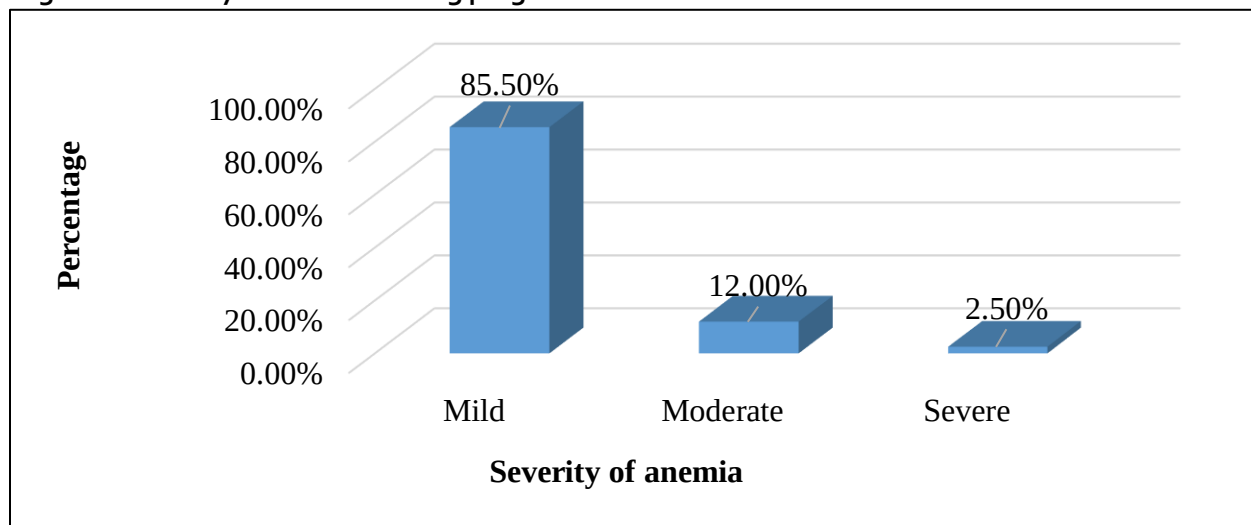
Parameters	No. (%) of mothers	Mean birth weight in kg	Mean baby length in cm	Mean baby head circumference in cm	Mean Chest circumference in cm
Hb (gm/dL)	Mild 171 (85.5%)	2.82±1.53	49.05±1.77	34.20±1.11	31.95±1.24
	Moderate 24 (12%)	2.49±1.46	48.06±1.29	33.55±1.15	31.48±1.36
	Severe anemia 5 (2.5%)	2.26±1.23	45.6±0.98	32.59±0.89	29.93±1.04
	P value	0.662	0.001*	0.013*	0.012*
Gravida	Primigravida 132 (66%)	2527.25±346.55	46.9±2.57	33.45±1.25	31.24±1.34
	Multigravida 68 (34%)	2493.16±367.15	46.8±2.80	33.65±1.33	30.89±1.27
	P value	0.519	0.801	0.296	0.076
BMI (kg/m²)	Underweight 12 (6.0%)	2122.20±343.82	44.57±3.14	34.15±1.39	30.88±1.30
	Normal 186 (93%)	2480.77±330.1	47.60±3.81	34.43±1.21	31.18±1.33

IFA supple mentat ion	Overweight 2 (1.0%)	9 2651.17±291.2	48.55±2.54	34.70±1.32	31.15±1.41
	P value	5 0.001*	0.026*	0.704	0.751
	Not taken 81 (40.5%)	2279.35±319.31	46.11±2.40	34.14±1.33	30.72±1.40
	Taken 119 (59.5%)	2683.20±270.8	49.21±1.54	34.81±1.52	31.29±1.33
	P value	8 0.001*	0.001*	0.002*	0.004*

The mean maternal daily calorie intake was 2061 kcal. There was a strong positive correlation between maternal daily calorie intake with birth weight and length and were found statistically significant ($p \leq 0.001$). There was a weak positive correlation with head and chest circumference, but this was also

significant ($p \leq 0.005$). There was a moderate positive correlation between spacing from previous pregnancy and birth weight ($p < 0.001$), while a weak positive correlation was found between spacing and length ($p < 0.001$), head and circumference ($p < 0.001$), which were all statistically significant.

Figure 1: Severity of anemia among pregnant women



DISCUSSION

In this study, most pregnant women were aged 21–25 years (43.0%), followed by 26–30 years (36.5%), with a mean age of 24.78 ± 3.15 years, aligning with findings by Behal M. et al.⁹ and Sento M. et al.¹⁰ The majority (64.5%) had a gestational age of 37–38 weeks (mean: 38.68 ± 1.41 weeks), were primipara (66.0%), and gravida 1 (66.0%). A large proportion had a BMI of 18.5–22.9 kg/m² (77.0%), and 59.5% had taken IFA supplementation. Among multiparous women, 58.5% had a spacing of 2–3 years (mean: 2.43 ± 0.91 years), consistent with findings by Dhole D. et al.¹¹

The prevalence of anemia in this study was 5.49%, with 85.5% having mild anemia, 12% moderate, and 2.5% severe anemia, consistent with general prevalence rates reported in other studies.^{12,13} The severe anemia group had a mean hemoglobin level of 6.44 ± 0.67 g/dl, similar to findings by Malhotra et al.¹⁴ The average maternal age was 24.78 years, and none of the severely anemic mothers received iron supplementation. The mean hemoglobin levels across anemia groups were significantly different ($p = 0.031$), aligning with Behal M. et al.'s findings.⁹ The study found that neonates

born to anemic mothers had a mean length of 48.69 cm, birth weight of 3.27 kg, head circumference of 34.04 cm, and chest circumference of 32.43 cm. Neonates of severely anemic mothers had significantly lower length (45.6 cm), birth weight (2.26 kg), head circumference (32.59 cm), and chest circumference (29.93 cm) compared to those of mildly anemic mothers. The differences in head and chest circumferences were statistically significant ($p = 0.013$ and $p = 0.012$, respectively). These findings align with studies showing that increased anemia severity correlates with reduced neonatal anthropometric measurements.^{9,11,15}

The study found a significant correlation between maternal hemoglobin levels and neonatal birth weight, length, and weight-for-length ($p < 0.0001$), consistent with findings by Al-Hajjiah and Al-Mkhadree¹⁵ and Ali SM et al.¹⁶ However, no significant association was observed between maternal gravida and neonatal anthropometry. Maternal malnutrition significantly impacts hemoglobin levels and fetal anthropometry. Mothers with low BMI were more anemic, consistent with Singhal A and Kochar S.¹⁷ Improved BMI correlated with higher birth weight and length, with significant differences, as noted by Chowdhary et al.¹⁸ and Kalk P et al.¹⁹ However, head and chest circumference showed no significant increase with BMI, differing from Kalk P et al.¹⁹ IFA supplementation positively influenced neonatal anthropometry. Maternal calorie intake showed a moderate positive correlation with birth weight and length and a

weak correlation with head circumference, aligning with Gopalan C et al.²⁰ Short inter-pregnancy intervals increased anemia risk, with moderate positive correlations between spacing and birth weight and weaker correlations with other measurements, consistent with prior studies.^{20,21}

The limitations of this study include its single-center design at a tertiary referral center, with a small sample size that may not be representative of the entire population. Additionally, maternal factors such as low height and body mass index were not categorized, which could affect neonatal anthropometric parameters. The study also did not assess maternal hemoglobin levels during the first and second trimesters or umbilical cord hemoglobin. Other limitations include the inability to perform serum folate and Vitamin B12 levels, peripheral blood film microscopy, and serum iron profile due to financial constraints.

Conclusion

In conclusion, the present study showed that maternal anemia during pregnancy negatively affects the anthropometric measurements (birth weight, length, head and chest circumference) of the full-term neonates. However, the severe form of maternal anemia has the most significant effect. This highlights the importance of improving the hemoglobin level during pregnancy using appropriate prenatal and antenatal measures to ensure growth and well-being of the fetus and consequently, the newborn.

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