Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(3), 148-152 | ISSN:2251-6727

Association between Maternal Hemoglobin Levels During Pregnancy and Neonatal Birth Weight: A Cross-Sectional Observational Study

Dr. Pranavi Gude[1], Prof. Dr. Rohini[2]

[1] Postgraduate, Department of Obstetrics and Gynaecology, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India

[2] Professor, Department of Obstetrics and Gynaecology, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India

Corresponding Author: *Prof. Dr. Rohini, Professor, Department of Obstetrics and Gynaecology, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India.*

(Received: 16 March 2026 Revised: 14 April 2026 Accepted: 01 May 2026)

KEYWORDS

Maternal anemia, Hemoglobin, Birth weight, Low birth weight, Pregnancy, Cross-sectional study

ABSTRACT:

Introduction: Reduced maternal hemoglobin (maternal anemia) is a common condition among pregnant women worldwide, with consequences that extend beyond the mother to adversely affect neonatal outcomes—most notably suboptimal birth weights. This study aimed to examine how hemoglobin concentrations measured in the final weeks of pregnancy relate to birth weight outcomes in newborns.

Objectives: To evaluate the relationship between maternal hemoglobin concentrations in late pregnancy and neonatal birth weight, and to examine the risk of low birth weight across different categories of maternal anemia severity.

Methods: A cross-sectional observational study was conducted on 120 pregnant women delivering at a tertiary hospital. Maternal hemoglobin levels were obtained from obstetric records within two weeks of delivery and categorized per WHO criteria as normal (≥11 g/dL), mild (10–10.9 g/dL), moderate (7–9.9 g/dL), and severe (<7 g/dL). Birth weight was recorded immediately after delivery. Pearson's correlation, ANOVA, and chi-square tests were used for analysis with SPSS v25.0.

Results: Anemia was identified in 48.3% of study participants. A statistically significant, though modest, direct association was observed between maternal hemoglobin concentration and neonatal birth weight ($r=0.24$, $p=0.008$). Mean birth weight declined with increasing anemia severity ($p=0.012$): non-anemic 3.08±0.42 kg, mild 2.92±0.39 kg, moderate 2.81±0.47 kg, and severe 2.65±0.51 kg. Neonates of anemic mothers had substantially higher rates of low birth weight (29.3% vs 8.1%, $p=0.003$).

Conclusions: This study demonstrates a positive correlation between maternal hemoglobin level and neonatal birth weight. Moderate or severe anemia is associated with markedly elevated risk of low birth weight, underscoring the critical need for routine antenatal anemia screening as a public health measure to optimize newborn health.

1. Introduction

Anemia in mothers presents a significant public health issue globally, most notably in nations classified as low- to mid-income, with nearly 37% of pregnant individuals suffering from anemia internationally [1]. According to WHO criteria, anemia in pregnant women is diagnosed when hemoglobin concentrations fall below 11.0 g/dL. Anemia during pregnancy is attributed to a multitude of causes such as nutritional deficiencies (primarily iron, folate, and vitamin B12 deficiency), parasitic infections, and chronic inflammation [2]. In consideration of the physiological demands imposed upon mothers during pregnancy (such as increased blood volume and developing fetus requirements for iron), an increased likelihood of developing or worsening anemia exists during a critical period in which maternal health directly influences fetal development [3].

Birth weight is a leading indicator of newborn vitality and predictive of both immediate survival and long-term neurodevelopmental and metabolic health [4]. Low birth weight (LBW) is defined as birth weight below 2,500 grams and accounts for a substantial percentage of neonatal mortality globally, strongly associated with intrauterine growth restriction (IUGR) [5]. Maternal

Journal of Chemical Health Risks
www.jchr.org
JCHR (2026) 16(3), 148-152 | ISSN:2251-6727

anemia causes impaired fetal growth through multiple biological pathways, with fetal hypoxia being particularly significant. Insufficient maternal hemoglobin results in decreased oxygen transfer to the uteroplacental unit, exacerbating reduced transfer of nutrients and oxygen to the fetus [6]. Fetal hypoxia forces cardiovascular adaptations that ultimately limit proper fetal growth and compromise placental development and function [7]. Notably, iron deficiency itself can impair fetal development through mechanisms independent of anemia, as iron is vital for placental vasculature formation and fetal tissue oxygenation [8].

Despite documented associations between third-trimester maternal hemoglobin concentrations and birth weight outcomes, the overall relationship varies between studies, suggesting that other factors contribute. Systematic reviews support that moderate to severe anemia increases the risk of LBW and/or premature birth; however, greater variability exists in findings regarding mild anemia [9]. Multiple potential confounders including maternal, socioeconomic, antenatal care, and comorbidity factors may interact to influence these relationships [10]. Furthermore, the timing of hemoglobin assessment during pregnancy is critical, as the relationship between hemoglobin concentrations and neonatal outcomes appears to follow a U-shaped curve where both low and high hemoglobin levels are associated with adverse outcomes [11].

This study was conducted to evaluate the relationship between maternal hemoglobin levels during late pregnancy and neonatal birth weight at a tertiary teaching hospital. The results may further reinforce the value of universal antenatal anemia screening and provide evidence for designing targeted interventions to improve neonatal health.

2. Objectives

- To evaluate the association between maternal hemoglobin levels in late pregnancy and neonatal birth weight.
- To compare mean birth weights across WHO anemia severity categories.
- To determine the incidence of low birth weight among anemic versus non-anemic mothers.

3. Methods

Research Design and Setting: This cross-sectional observational study was conducted within the Department of Obstetrics and Gynaecology of a tertiary referral institution across a two-month data collection period.

Study Population and Sample Size: The study enrolled 120 mother-neonate dyads delivered at the study institution. Sample size calculation was based on a correlation coefficient estimate of r=0.25, 80% statistical power, and a significance threshold of α=0.05, yielding a minimum required sample of 113 participants.

Inclusion Criteria: Singleton pregnancy; delivery at term (≥37 weeks gestation); maternal Hb measurement within two weeks prior to delivery.

Exclusion Criteria: Multiple pregnancies; preeclampsia, diabetes mellitus, or fetal congenital anomaly; chronic disease (e.g., chronic kidney disease) or known blood disorder.

Data Collection: Maternal Hb values were abstracted from the most recent antenatal care record. Neonates were weighed immediately after delivery on a calibrated digital scale. Maternal age, parity, socio-economic status (modified Kuppuswamy scale), pre-pregnancy BMI, and gestational age (first-trimester ultrasound) were recorded from hospital records.

Operational Definitions: Participants were classified per WHO anemia thresholds: non-anemic (Hb≥11 g/dL); mildly anemic (Hb 10.0–10.9 g/dL); moderately anemic (Hb 7.0–9.9 g/dL); and severely anemic (Hb<7 g/dL). Neonates weighing below 2.5 kg at birth were classified as low birth weight.

Statistical Analysis: All statistical computations were performed using SPSS version 25.0. Continuous data are reported as mean±SD, and categorical data as counts with proportions. Pearson's correlation coefficient evaluated the linear association between maternal Hb and neonatal birth weight. One-way ANOVA with post-hoc Tukey tests compared birth weight across anemia severity groups. Chi-square tests evaluated differences in LBW frequency between anemic and non-anemic groups. Significance was set at $p<0.05$.

Ethical Considerations: Ethical clearance was obtained from the Institutional Human Ethics Committee

Journal of Chemical Health Risks
www.jchr.org
JCHR (2026) 16(3), 148-152 | ISSN:2251-6727

(Reference: IHEC-I/084/11 & 2025). A waiver of individual informed consent was granted given the retrospective review of anonymized, routinely collected clinical data.

4. Results

The complete dataset consisted of 120 mother-child pairs. Mean maternal age was 26.4±4.2 years, and mean gestational age at delivery was 38.5±1.1 weeks. Anemia (Hb<11 g/dL) was identified in 48.3% of participants. The distribution by severity was: mild anemia 22.5% (n=27), moderate anemia 20.8% (n=25), severe anemia 5.0% (n=6). Mean neonatal birth weight was 2.95±0.45 kg. Pearson's analysis showed a weak positive correlation between maternal hemoglobin and neonatal birth weight (r=0.24, p=0.008).

Table 1: Neonatal Birth Weight by Maternal Hemoglobin Category

Hemoglobin Category	n	Mean Birth Weight (kg) ± SD	p-value (vs. Normal)
Normal (≥11 g/dL)	62	3.08 ± 0.42	-
Mild Anemia	27	2.92 ± 0.39	0.089
Moderate Anemia	25	2.81 ± 0.47	0.007*
Severe Anemia	6	2.65 ± 0.51	0.002*

**p<0.05; ANOVA overall p-value = 0.012*

Birth weights were progressively lower with each increase in maternal anemia severity. Post-hoc Tukey analyses revealed that neonates of mothers with moderate or severe anemia had significantly lower birth weights than those born to non-anemic mothers, while no significant difference was observed between neonates of mildly anemic and non-anemic mothers.

In total, 22 neonates (18.3%) met the definition for low birth weight. Among anemic mothers, 29.3% delivered LBW neonates compared with only 8.1% among non-anemic mothers (χ^2=8.92, p=0.003).

Table 2: Incidence of Low Birth Weight by Anemia Status

Maternal Anemia Status	Total Neonates (n)	LBW Neonates (n)	LBW Incidence (%)	p-value
Anemic (Hb<11 g/dL)	58	17	29.3%	0.003
Non-Anemic (Hb≥11 g/dL)	62	5	8.1%	

Maternal age, parity, and pre-pregnancy BMI did not show significant independent associations with birth weight in multivariate linear regression. Only hemoglobin category remained a significant predictor.

5. Discussion

This research found a statistically significant but weak relationship between maternal hemoglobin concentration in late pregnancy and neonatal birth weight. A clear dose-response pattern was evident: as anemia severity increased, mean birth weight decreased and the incidence of low birth weight rose. The findings align with the current pathophysiological understanding whereby maternal anemia limits fetal access to oxygen and nutrients, leading to inadequate fetal growth [7,8].

The 48.3% prevalence of anemia documented in this study is consistent with the high rates seen in other low-resource settings [1,3]. The decline in mean birth weight across anemia categories supports a dose-dependent relationship, consistent with reports from sub-Saharan Africa and South Asia that have shown moderate/severe anemia is associated with a substantially increased risk of LBW [10,13]. Rahman et al. reported in a meta-analysis that mean birth weight in the severe anemia group was over 400 grams lower than the non-anemic group [10].

While maternal hemoglobin contributes to low birth weight, the weak correlation coefficient (r=0.24) indicates that the variance in birth weight explained solely by maternal hemoglobin is limited. Fetal growth is multifactorial, and maternal micronutrient status (e.g., zinc, vitamin B12), prepregnancy nutritional reserves,

Journal of Chemical Health Risks
www.jchr.org
JCHR (2026) 16(3), 148-152 | ISSN:2251-6727

gestational weight gain, and psychosocial stressors are additional determinants [14,15]. The lack of an observed association between maternal BMI and birth weight is inconsistent with the broader literature [16], possibly due to sample size or homogeneity of the cohort.

The association of mild anemia with LBW did not reach statistical significance in pairwise comparison, consistent with prior controversy. While several studies cite a linear association, Zhang et al. described a U-shaped association between hemoglobin concentrations during pregnancy and adverse birth outcomes [12,17]. Because the current study evaluated only delivery hemoglobin levels, it could not assess the U-shape or hemoglobin trajectory throughout pregnancy.

The significant association between anemia and low birth weight (29.3% vs 8.1%) emphasizes the public health importance of anemia control efforts, particularly given that LBW is a major contributor to neonatal mortality [6,18]. WHO recommendations for iron and folic acid supplementation during pregnancy are supported; however, integrated approaches addressing multiple micronutrient supplementation, deworming, and malaria prevention in endemic areas may yield greater impact [3,19].

Limitations include the cross-sectional design, which precludes causal inference, and the use of a single hemoglobin measurement close to delivery, which does not reflect the true burden of anemia during key periods of fetal development. Unmeasured confounders (detailed dietary intake, supplementation compliance, inflammatory markers) may further affect the results. Being conducted at a single tertiary care hospital, the findings may not generalize to community settings. Strengths include the use of objective clinical data, WHO classification, and a priori sample size determination, providing strong local evidence.

6. Conclusion

Maternal hemoglobin levels during pregnancy are directly associated with neonatal birth weight, and moderate to severe anemia significantly increases the risk of low birth weight. These findings reinforce the integration of anemia screening into routine antenatal care. Future research should adopt prospective longitudinal designs to track hemoglobin trajectories across trimesters and evaluate the effects of comprehensive nutritional interventions—including iron and micronutrient supplementation—on neonatal birth weight outcomes.

References

1. World Health Organization. Anaemia in women and children: WHO global anaemia estimates, 2021 edition. Geneva: World Health Organization; 2021.
2. WHO. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011.
3. Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian SV. Anaemia in low-income and middle-income countries. Lancet. 2011;378(9809):2123-35.
4. Bothwell TH. Iron requirements in pregnancy and strategies to meet them. Am J Clin Nutr. 2000;72(1 Suppl):257S-264S.
5. Christian P, Lee SE, Donahue Angel M, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. Int J Epidemiol. 2013;42(5):1340-55.
6. Blencowe H, Krasevec J, de Onis M, et al. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. Lancet Glob Health. 2019;7(7):e849-e860.
7. Hutter D, Kingdom J, Jaeggi E. Causes and mechanisms of intrauterine hypoxia and its impact on the fetal cardiovascular system: a review. Int J Pediatr. 2010;2010:401323.
8. Burton GJ, Jauniaux E. Pathophysiology of placental-derived fetal growth restriction. Am J Obstet Gynecol. 2018;218(2S):S745-S761.
9. Allen LH. Biological mechanisms that might underlie iron's effects on fetal growth and preterm birth. J Nutr. 2001;131(2S-2):581S-589S.
10. Rahman MM, Abe SK, Rahman MS, et al. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis. Am J Clin Nutr. 2016;103(2):495-504.
11. Stevens GA, Finucane MM, De-Regil LM, et al. Global, regional, and national trends in

haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995-2011: a systematic analysis of population-representative data. Lancet Glob Health. 2013;1(1):e16-e25.

12. Zhang Q, Ananth CV, Li Z, Smulian JC. Maternal anaemia and preterm birth: a prospective cohort study. Int J Epidemiol. 2009;38(5):1380-9.
13. Kidanto HL, Mogren I, Lindmark G, Massawe S, Nystrom L. Risks for preterm delivery and low birth weight are independently increased by severity of maternal anaemia. S Afr Med J. 2009;99(2):98-102.
14. Muthayya S. Maternal nutrition & low birth weight—what is really important. Indian J Med Res. 2009;130(5):600-8.
15. Black RE, Victora CG, Walker SP, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427-51.
16. Han Z, Mulla S, Beyene J, Liao G, McDonald SD; Knowledge Synthesis Group. Maternal underweight and the risk of preterm birth and low birth weight: a systematic review and meta-analyses. Int J Epidemiol. 2011;40(1):65-101.
17. Dewey KG, Oaks BM. U-shaped curve for risk associated with maternal hemoglobin, iron status, or iron supplementation. Am J Clin Nutr. 2017;106(Suppl 6):1694S-1702S.
18. Kozuki N, Lee AC, Silveira MF, et al. The associations of birth intervals with small-for-gestational-age, preterm, and neonatal and infant mortality: a meta-analysis. BMC Public Health. 2013;13 Suppl 3:S3.
19. Pasricha SR, Drakesmith H, Black J, Hipgrave D, Biggs BA. Control of iron deficiency anemia in low- and middle-income countries. Blood. 2013;121(14):2607-17.