

To Study Effect of Maternal Haemoglobin on Baby Birth Weight and Apgar Score

Dr Asha Meena, Dr Monica Soni, Dr Shweta Chaudhary,
Dr Shubhechhya Mansagar Wankhade, Dr Kusumlata

Abstract: Background: Maternal anaemia remains common in pregnancy and may compromise placental oxygen delivery, fetal growth and neonatal adaptation. Objective: To determine the association of maternal haemoglobin concentration with neonatal birth weight, APGAR scores and early neonatal outcomes among term singleton births. Methods: This cross-sectional observational study included 283 women with singleton pregnancies delivered at 37-40 weeks in a government tertiary-care hospital in Bikaner. Maternal haemoglobin was classified as normal (≥ 11 g/dL), mild anaemia (9.0-10.9 g/dL), moderate anaemia (7.0-8.9 g/dL) or severe anaemia (< 7 g/dL). Birth weight, 1- and 5-minute APGAR scores, need for resuscitation, neonatal intensive care unit (NICU) admission and early neonatal death were compared using chi-square tests and analysis of variance. Results: Normal haemoglobin was present in 49 (17.31%) women; 139 (49.12%) had mild, 67 (23.67%) moderate and 28 (9.89%) severe anaemia. Mean birth weight declined stepwise from 2789.24 ± 405.38 g in the normal group to 2145.42 ± 462.18 g in severe anaemia ($p < 0.001$). Mean 1-minute APGAR scores were 7.24 ± 1.83 , 7.21 ± 1.62 , 5.42 ± 1.96 and 4.54 ± 2.12 , respectively ($p < 0.001$); corresponding 5-minute scores were 8.35 ± 1.61 , 8.12 ± 1.30 , 6.94 ± 1.80 and 5.04 ± 2.67 ($p < 0.001$). Severe anaemia was associated with higher NICU admission (42.9%), resuscitation (14.3%) and early neonatal death (25.0%). Conclusion: Lower maternal haemoglobin showed a graded association with reduced birth weight, poorer APGAR scores and adverse early neonatal outcomes. Antenatal detection and correction of anaemia should remain a priority.

Keywords: maternal anaemia; haemoglobin; birth weight; APGAR score; neonatal outcome

1. Introduction

Pregnancy produces substantial physiological changes in maternal blood volume and erythropoiesis. Plasma volume expands more than red-cell mass, causing physiological haemodilution; when iron supply is inadequate, this adaptation progresses to anaemia. The World Health Organization defines anaemia in pregnancy as haemoglobin below 11 g/dL and classifies severity because increasingly low concentrations are linked with maternal and fetal risk. [1, 2] Iron requirements rise to support maternal erythropoiesis, placental development and fetal growth. In India, nutritional deficiency, short interpregnancy intervals, infection and limited antenatal supplementation sustain a high burden of anaemia. [3,4]

Maternal haemoglobin is central to oxygen transport. Reduced oxygen-carrying capacity may cause chronic fetoplacental hypoxia, restrict nutrient transfer and impair fetal growth. Epidemiological studies have associated maternal anaemia with low birth weight and preterm delivery, although the strength of association varies with gestational age, population, severity and confounding. [5-9] Birth weight is an accessible marker of intrauterine growth and a strong determinant of neonatal survival. The APGAR score provides a rapid standardized assessment of neonatal adaptation immediately after birth; persistently low scores identify infants needing urgent support and closer observation. [10]

Evidence linking graded maternal haemoglobin categories simultaneously with birth weight, APGAR scores and early neonatal morbidity in term pregnancies remains locally relevant. Studying term singleton births reduces the direct influence of prematurity and helps clarify the relationship between anaemia severity and neonatal condition. Such information can strengthen antenatal screening, nutritional

counselling, treatment adherence and delivery planning in resource-constrained facilities.

Aim: To assess the relationship between maternal haemoglobin concentration and neonatal birth weight, APGAR score and early neonatal outcomes among women delivering at a government health-care facility in Bikaner. **Objectives:** (1) to compare birth weight across maternal haemoglobin categories; (2) to evaluate 1- and 5-minute APGAR scores; and (3) to examine resuscitation, NICU admission and early neonatal death according to anaemia severity.

2. Materials and Methods

Study design and setting: A hospital-based cross-sectional observational study was conducted in the Department of Obstetrics and Gynaecology, S.P. Medical College and Associated Group of Hospitals/P.B.M. Hospital, Bikaner. The study enrolled 283 pregnant women who delivered at term. The sample size was calculated using an expected prevalence of 22.6%, 95% confidence and 5% absolute precision, with an additional allowance, yielding a target of 283 participants.

Participants: Women aged over 18 years with singleton pregnancies delivered between 37 and 40 completed weeks were eligible. Women who declined participation and those with multiple pregnancy, major congenital fetal anomaly, hypertensive disorders, diabetes, heart disease, thyroid disorder, placenta previa or placental abruption were excluded to reduce major competing influences on fetal growth and neonatal status. Relevant demographic, obstetric and clinical information was recorded using a structured proforma.

Exposure classification: Maternal haemoglobin measured around delivery by the hospital laboratory was categorized as normal (≥ 11 g/dL), mild anaemia (9.0-10.9 g/dL), moderate anaemia (7.0-8.9 g/dL) and severe anaemia (< 7 g/dL). The principal neonatal outcomes were birth weight and APGAR scores at 1 and 5 minutes. Additional outcomes were need for resuscitation, NICU admission and early neonatal death. Birth weight was also categorized as < 1.5 kg, 1.5-2.5 kg and > 2.5 kg.

Statistical analysis: Data were entered in Microsoft Excel and analysed using descriptive and inferential statistics. Continuous variables were summarized as mean $\pm$ standard deviation and categorical variables as frequency and percentage. Analysis of variance compared means across the four haemoglobin groups; chi-square testing assessed categorical associations. A two-sided p value < 0.05 was considered statistically significant. The observational design permits assessment of association but does not by itself establish causation. Participant confidentiality and standard institutional ethical safeguards were maintained.

3. Results

Among 283 women, 234 (82.69%) were anaemic: mild anaemia was most frequent (49.12%), followed by moderate (23.67%) and severe anaemia (9.89%) (Table 1). The groups were broadly comparable for maternal age, gestational age, residence, booking status, parity and mode of delivery; none of these comparisons reached statistical significance (Table 2).

Birth weight decreased progressively with anaemia severity. Mean weight was 2789.24 ± 405.38 g in women with normal

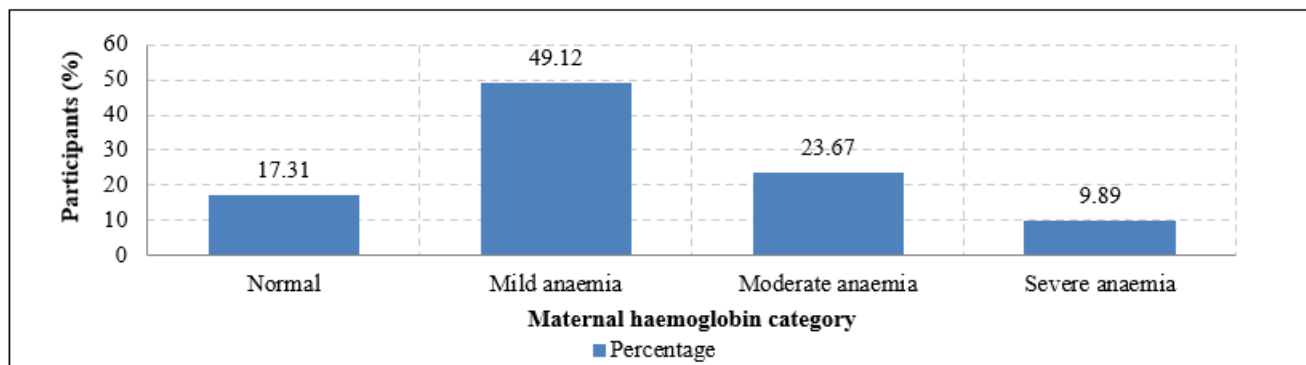
haemoglobin and fell to 2548.56 ± 421.64 g, 2316.35 ± 438.72 g and 2145.42 ± 462.18 g in mild, moderate and severe anaemia, respectively ($p < 0.001$). Only 21.4% of neonates in the severe group weighed > 2.5 kg compared with 77.6% in the normal group. Conversely, birth weight ≤ 2.5 kg occurred in 78.6% of the severe group and 22.4% of the normal group (Table 3).

A similar graded relationship was observed for neonatal adaptation. Mean 1-minute APGAR remained approximately 7.2 in the normal and mild groups but declined to 5.42 in moderate and 4.54 in severe anaemia. At 5 minutes, mean scores were 8.35, 8.12, 6.94 and 5.04 across the four groups; both trends were statistically significant ($p < 0.001$) (Table 4).

Adverse early neonatal events were concentrated in severe anaemia. NICU admission increased to 42.9% compared with 12.2% in the normal group ($p < 0.001$). Resuscitation was required in 14.3% versus 2.0% ($p = 0.022$), and early neonatal death occurred in 25.0% versus 4.1% ($p < 0.001$). Moderate anaemia also showed poorer birth weight and APGAR results than normal or mild anaemia, supporting a severity-dependent association (Table 5).

Table 1: Distribution of participants by maternal haemoglobin category

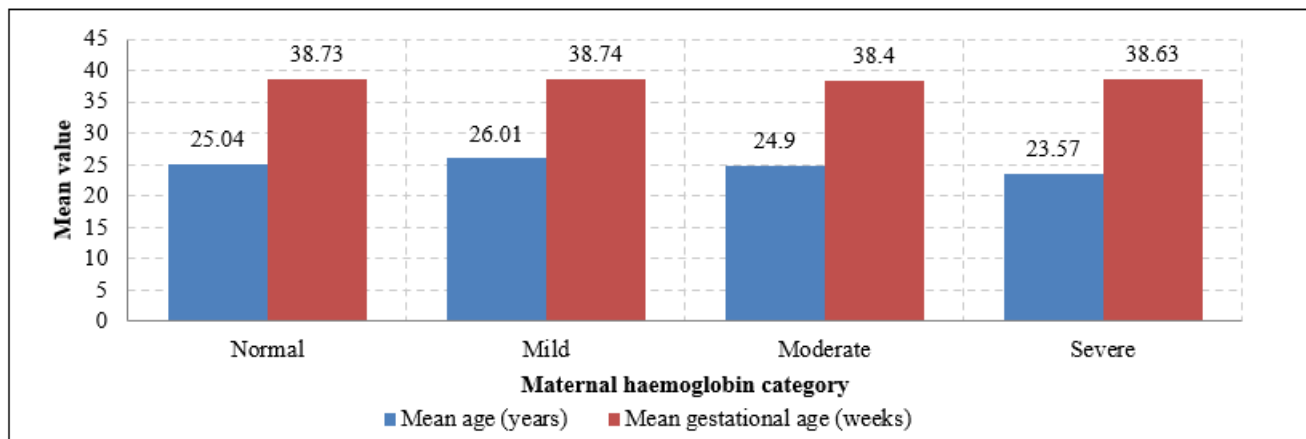
Haemoglobin group	Definition	n	%
Normal	≥ 11 g/dL	49	17.31
Mild anaemia	9.0-10.9 g/dL	139	49.12
Moderate anaemia	7.0-8.9 g/dL	67	23.67
Severe anaemia	< 7 g/dL	28	9.89
Total	—	283	100



Graph 1: Distribution of participants by maternal haemoglobin category

Table 2: Baseline characteristics across maternal haemoglobin groups

Characteristic	Normal	Mild	Moderate	Severe	p value
Age, years (mean $\pm$ SD)	25.04 $\pm$ 4.87	26.01 $\pm$ 5.49	24.90 $\pm$ 5.03	23.57 $\pm$ 4.75	0.107
Gestational age, weeks (mean $\pm$ SD)	38.73 $\pm$ 0.86	38.74 $\pm$ 0.87	38.40 $\pm$ 0.99	38.63 $\pm$ 0.98	0.081
Residence (rural/urban)	Comparable	Comparable	Comparable	Comparable	0.799
Booking status (booked/unbooked)	Comparable	Comparable	Comparable	Comparable	0.991
Parity (primi/multigravida)	Comparable	Comparable	Comparable	Comparable	0.14
Mode of delivery (vaginal/cesarean)	Comparable	Comparable	Comparable	Comparable	0.13

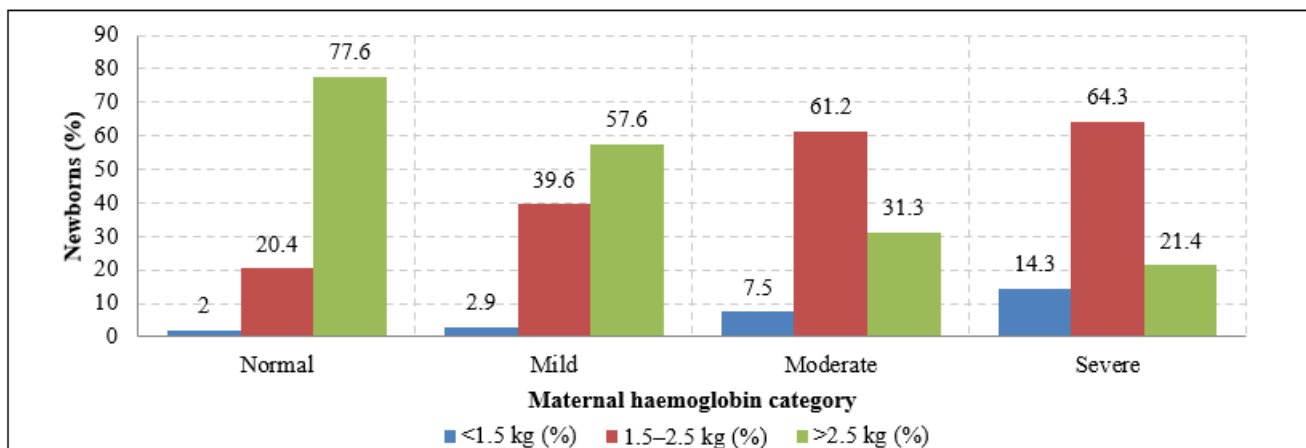


Graph 2: Baseline characteristics across maternal haemoglobin groups

Table 3: Birth-weight outcomes according to maternal haemoglobin category

Birth-weight outcome	Normal (n=49)	Mild (n=139)	Moderate (n=67)	Severe (n=28)	p value
Mean birth weight, g (mean±SD)	2789.24±405.38	2548.56±421.64	2316.35±438.72	2145.42±462.18	<0.001
<1.5 kg, n (%)	1 (2.0)	4 (2.9)	5 (7.5)	4 (14.3)	<0.001*
1.5-2.5 kg, n (%)	10 (20.4)	55 (39.6)	41 (61.2)	18 (64.3)	
>2.5 kg, n (%)	38 (77.6)	80 (57.6)	21 (31.3)	6 (21.4)	

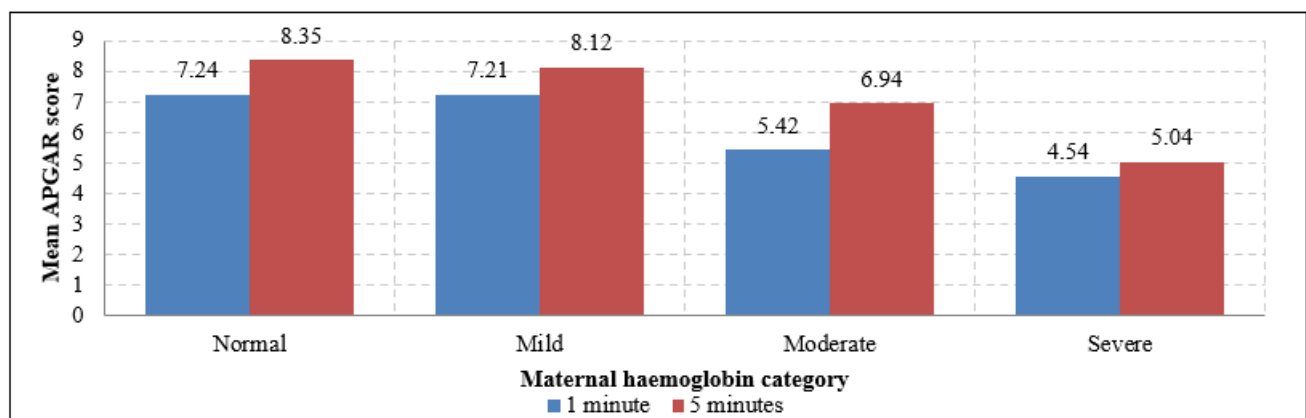
*Overall chi-square comparison for birth-weight categories.



Graph 3: Birth-weight outcomes according to maternal haemoglobin category

Table 4: APGAR scores according to maternal haemoglobin category

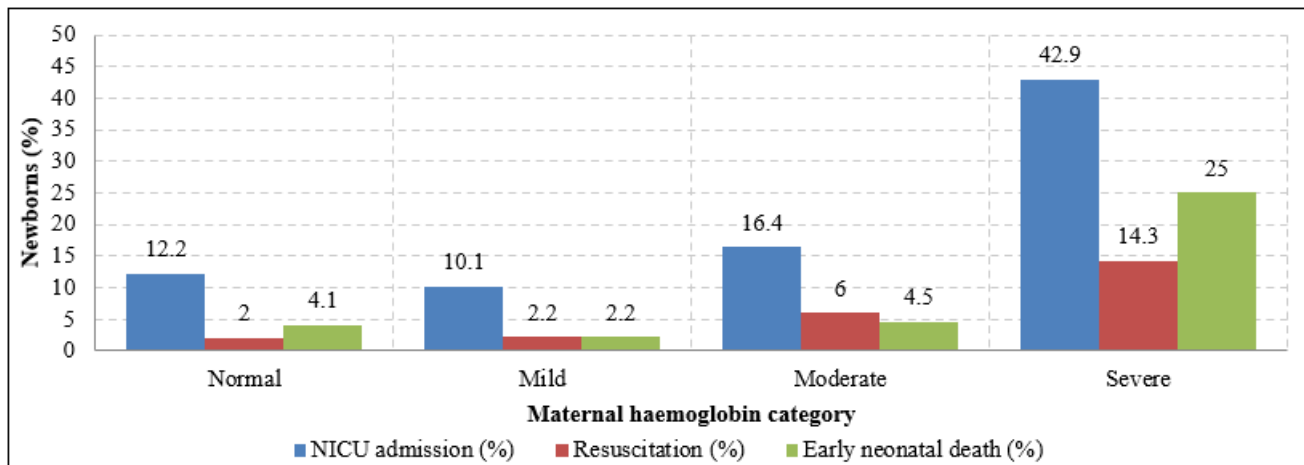
APGAR assessment	Normal (n=49)	Mild (n=139)	Moderate (n=67)	Severe (n=28)	p value
1 minute, mean±SD	7.24±1.83	7.21±1.62	5.42±1.96	4.54±2.12	<0.001
5 minutes, mean±SD	8.35±1.61	8.12±1.30	6.94±1.80	5.04±2.67	<0.001



Graph 4: APGAR scores according to maternal haemoglobin category

Table 5: Early neonatal outcomes according to maternal haemoglobin category

Outcome, n (%)	Normal (n=49)	Mild (n=139)	Moderate (n=67)	Severe (n=28)	p value
NICU admission	6 (12.2)	14 (10.1)	11 (16.4)	12 (42.9)	<0.001
Resuscitation	1 (2.0)	3 (2.2)	4 (6.0)	4 (14.3)	0.022
Early neonatal death	2 (4.1)	3 (2.2)	3 (4.5)	7 (25.0)	<0.001

**Graph 5:** Early neonatal outcomes according to maternal haemoglobin category

4. Discussion

This study demonstrated a graded association between maternal haemoglobin and neonatal wellbeing among term singleton births. Mean birth weight declined by approximately 644 g from the normal-haemoglobin group to the severe-anaemia group, while the proportion weighing >2.5 kg fell from 77.6% to 21.4%. These findings are biologically plausible: inadequate maternal iron and haemoglobin reduce oxygen transport, may alter placental development and can constrain fetal nutrient utilization. [3,5] Similar associations between anaemia, low birth weight and adverse perinatal outcome have been reported in South Asian and other low-resource populations. [6-9, 11, 12]

The APGAR findings add clinically important evidence. Scores were relatively preserved in normal and mild anaemia but deteriorated substantially with moderate and severe anaemia at both 1 and 5 minutes. Severe anaemia was also accompanied by marked increases in NICU admission, resuscitation and early neonatal death. APGAR score is influenced by several intrapartum and neonatal factors and should not be interpreted as a diagnosis by itself; nevertheless, lower scores together with increased neonatal intervention suggest impaired immediate adaptation. [10] The severity gradient agrees with observations that adverse outcomes become more evident when maternal anaemia is moderate or severe. [11,14-17]

A key strength was the simultaneous evaluation of birth weight, APGAR scores and early neonatal outcomes across four clinically recognizable haemoglobin categories. Restriction to term singleton pregnancies and exclusion of several major maternal disorders reduced important sources of heterogeneity. However, the cross-sectional single-centre design cannot establish causality. Haemoglobin around delivery may not reflect anaemia throughout pregnancy, and residual confounding from nutrition, socioeconomic status, infection, supplementation adherence or unmeasured

obstetric factors may remain. The relatively small severe-anaemia group also widens uncertainty around rare outcomes, particularly mortality.

Clinically, the data support early haemoglobin screening, timely iron-folic acid treatment, dietary counselling, adherence monitoring and repeat testing. Women with moderate or severe anaemia may benefit from intensified antenatal surveillance, delivery in facilities with neonatal resuscitation capability and anticipatory NICU coordination.

5. Conclusion

Maternal haemoglobin concentration was significantly associated with neonatal birth weight, APGAR scores and early neonatal outcomes in this cohort of 283 term singleton pregnancies. A consistent severity gradient was evident: as haemoglobin decreased from normal to severe anaemia, mean birth weight fell, low-birth-weight categories became more frequent and mean APGAR scores at both 1 and 5 minutes deteriorated. Severe anaemia identified the group with the greatest clinical burden, including substantially higher NICU admission, need for resuscitation and early neonatal death.

These findings reinforce maternal anaemia as a practical, measurable marker of neonatal risk. Because the study was observational, the results should be interpreted as associations rather than proof that haemoglobin alone caused each outcome. Even so, haemoglobin estimation is inexpensive and widely available, making it valuable for antenatal risk stratification. Universal early screening, correction of nutritional deficiencies, adequate iron-folic acid supplementation, counselling to improve adherence and repeat assessment later in pregnancy should be strengthened. Moderate and severe anaemia warrant prompt evaluation of the cause, appropriate treatment and delivery planning where skilled obstetric and neonatal support are available. Larger prospective multicentre studies that measure haemoglobin serially and adjust for nutritional, socioeconomic and

obstetric confounders are recommended to quantify independent effects and assess whether timely correction improves birth weight and neonatal adaptation.

development, and early childhood parameters. *Nutrients*. 2020;12(2):447.

References

- [1] Chandra S, Tripathi AK, Mishra S, Amzarul M, Vaish AK. Physiological changes in hematological parameters during pregnancy. *Indian J Hematol Blood Transfus*. 2012;28(3):144-146.
- [2] World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva: World Health Organization; 2011.
- [3] Bothwell TH. Iron requirements in pregnancy and strategies to meet them. *Am J Clin Nutr*. 2000;72(1 Suppl):257S-264S.
- [4] Kalaivani K. Prevalence and consequences of anaemia in pregnancy. *Indian J Med Res*. 2009;130(5):627-633.
- [5] Allen LH. Biological mechanisms that might underlie iron's effects on fetal growth and preterm birth. *J Nutr*. 2001;131(2 Suppl 2):581S-589S.
- [6] Levy A, Fraser D, Katz M, Mazor M, Sheiner E. Maternal anemia during pregnancy is an independent risk factor for low birthweight and preterm delivery. *Eur J Obstet Gynecol Reprod Biol*. 2005;122(2):182-186.
- [7] Rahman MM, Abe SK, Rahman MS, Kanda M, Narita S, Bilano V, 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.
- [8] Bondevik GT, Lie RT, Ulstein M, Kvale G. Maternal hematological status and risk of low birth weight and preterm delivery in Nepal. *Acta Obstet Gynecol Scand*. 2001;80(5):402-408.
- [9] Steer P, Alam MA, Wadsworth J, Welch A. Relation between maternal haemoglobin concentration and birth weight in different ethnic groups. *BMJ*. 1995;310(6978):489-491.
- [10] Casey BM, McIntire DD, Leveno KJ. The continuing value of the Apgar score for the assessment of newborn infants. *N Engl J Med*. 2001;344(7):467-471.
- [11] Malhotra M, Sharma JB, Batra S, Sharma S, Murthy NS, Arora R. Maternal and perinatal outcome in varying degrees of anemia. *Int J Gynaecol Obstet*. 2002;79(2):93-100.
- [12] Lone FW, Qureshi RN, Emanuel F. Maternal anaemia and its impact on perinatal outcome in Pakistan. *Trop Med Int Health*. 2004;9(4):486-490.
- [13] Goldenberg RL, Culhane JF. Low birth weight in the United States. *Am J Clin Nutr*. 2007;85(2):584S-590S.
- [14] Pavan Kumar N, Pabbati J. Effects of maternal hemoglobin on fetal birth weight. *Int J Pediatr Res*. 2016;3(10):748-752.
- [15] Aggarwal M, Jain P, Mahadik K. Maternal anaemia and neonatal outcome: an observational rural study. *Indian J Obstet Gynecol Res*. 2021;8(3):371-376.
- [16] Singla PN, Tyagi M, Kumar A, Dash D, Shankar R. Fetal growth in maternal anaemia. *J Trop Pediatr*. 1997;43(2):89-92.
- [17] Means RT Jr. Iron deficiency and iron deficiency anemia: implications and impact in pregnancy, fetal