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Original Research Article

Correlation between maternal haemoglobin and Bishop score at admission, duration of active phase of labour, Apgar score and neonatal birth weight in normal vaginal delivery: a hospital-based observational cross-sectional study

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ABSTRACT

Background: Maternal anaemia is one of the most prevalent nutritional disorders complicating pregnancy, particularly in low- and middle-income countries. It is associated with adverse maternal and neonatal outcomes; however, its influence on intrapartum parameters such as Bishop score and duration of active phase of labour remains inadequately explored.
Methods: A hospital-based observational cross-sectional study was conducted in the Department of Obstetrics and Gynaecology, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, from May 2025 to April 2026. A total of 200 eligible term pregnant women undergoing normal vaginal delivery were enrolled. Maternal haemoglobin was measured at admission using an automated haematology analyser. Bishop score, duration of active phase of labour, Apgar scores at 1 and 5 minutes, and neonatal birth weight were recorded. Data were analysed using Chi-square test and ANOVA.
Results: No statistically significant association was found between maternal haemoglobin levels and Bishop score ($p=0.56$) or duration of active phase of labour ($p=0.38$). Although lower Apgar scores at 1 minute were more frequent among severely anaemic mothers (53.85%), this did not reach statistical significance ($p=0.06$), and 5-minute scores showed no significant difference ($p=0.41$). A highly significant association was observed between maternal haemoglobin and neonatal birth weight ($p<0.0001$), with 88% of severely anaemic mothers delivering low birth weight (LBW) neonates. NICU admission rates were also significantly higher in anaemic mothers ($p=0.004$). An inverse relationship between Bishop score and labour duration was also demonstrated ($p=0.01$).
Conclusions: Maternal haemoglobin levels do not significantly influence Bishop score or the duration of the active phase of labour but have a strong and significant impact on neonatal birth weight and NICU admission rates. Early detection, prevention, and effective management of maternal anaemia during antenatal care are essential to improve neonatal outcomes.

Keywords: Maternal anaemia, Haemoglobin, Bishop score, Active phase of labour, Apgar score, Birth weight, NICU admission, Pregnancy

INTRODUCTION

Pregnancy represents a physiologically demanding state characterised by profound haematological adaptations to meet the increased metabolic requirements of both mother and developing fetus. Maternal haemoglobin concentration plays a pivotal role in ensuring adequate oxygen delivery to the uteroplacental unit and supporting optimal fetal growth and development.[1] Any significant deviation, particularly anaemia, can potentially

compromise these vital processes and lead to adverse maternal and perinatal outcomes.

Maternal anaemia remains one of the most prevalent nutritional disorders complicating pregnancy worldwide, affecting millions of pregnant women annually, particularly in low- and middle-income countries.[2] The World Health Organization (WHO) defines anaemia in pregnancy as haemoglobin concentration below 11 g/dL.[3] The global burden of maternal anaemia is substantial, with prevalence estimates ranging from 31% to 75% depending on geographical location, socioeconomic status, and healthcare accessibility.[3,4] In India, facility-based cohorts have reported anaemia prevalence between 65% and 75%, making it a significant public health challenge.[2]

The pathophysiological consequences of maternal anaemia extend beyond maternal wellbeing to significantly impact fetal development and neonatal outcomes. Reduced oxygen-carrying capacity leads to impaired uteroplacental oxygenation and compromised nutrient transfer to the fetus, potentially triggering intrauterine growth restriction, LBW, preterm delivery, and compromised neonatal adaptation at birth.[5,6]

The Bishop score, a well-established tool for assessing cervical favourability, has not been extensively studied in relation to maternal haemoglobin levels, representing a significant knowledge gap.[7] Similarly, the duration of active labour, Apgar scores, and birth weight-while studied individually-have rarely been evaluated simultaneously within a single cohort alongside haemoglobin status.

This study aims to comprehensively evaluate the correlations between maternal haemoglobin concentration at admission and Bishop score, duration of active phase of labour, Apgar scores, and neonatal birth weight in women undergoing normal vaginal delivery at a tertiary care centre in central India.

METHODS

Study design and setting

This was a hospital-based observational cross-sectional study conducted in the Department of Obstetrics and Gynaecology, Maharani Laxmi Bai (MLB) Medical College, Jhansi, Uttar Pradesh, India, over a period of twelve months from May 2025 to April 2026.

Participants

A total of 200 eligible pregnant women were enrolled after obtaining written informed consent. Inclusion criteria were: singleton pregnancy, cephalic presentation, gestational age ≥37 weeks, spontaneous or induced onset of labour, and normal vaginal delivery. Exclusion criteria were: pregnancy-induced hypertension, diabetes mellitus, antepartum haemorrhage, multiple gestation, malpresentation, caesarean section, known fetal congenital anomalies, and chronic systemic illnesses (cardiac or renal disease).

Sample size

Sample size was calculated using the standard formula for correlation studies, with an anticipated correlation coefficient r=0.2, confidence level of 95% (Zα/2=1.96), and power of 80% (Zβ=0.84), yielding a minimum required sample of 194. A final sample of 200 participants was enrolled.

Data collection

Maternal haemoglobin was measured at the time of admission for delivery using an automated haematology analyser (Sysmex/Beckman Coulter) on 3 mL venous blood samples. Anaemia was classified per WHO criteria: severe (<7 g/dL), moderate (7-9.9 g/dL), mild (10-10.9 g/dL), and non-anaemic (≥11 g/dL).

Bishop score was assessed at admission by a trained obstetrician using standard criteria (cervical dilation, effacement, station, consistency, and position). Duration of the active phase of labour was recorded from 4 cm cervical dilation to full dilation using partograph documentation. Apgar scores were assigned at 1 and 5 minutes post-delivery by paediatric staff using standard criteria. Neonatal birth weight was measured immediately after birth using a calibrated digital scale; birth weight <2500 gm was classified as LBW.

Statistical analysis

Data were entered into SPSS (Statistical package for the social sciences) and analysed using Chi-square test for categorical associations and one-way ANOVA for continuous variables. A $p<0.05$ was considered statistically significant.

Ethical approval

Ethical approval was obtained from the institutional ethics committee (Human Studies), MLB Medical College, Jhansi (Sr. No. 7029/IEC/PG-23-81/2026/SC-1, dated 31/01/2026). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment. Patient confidentiality was maintained throughout.

RESULTS

A total of 200 women were enrolled. The majority (55.5%) were in the 21-25 years age group; 13.5% were ≤20 years and 31.0% were 26-30 years. Regarding gestational age, 73.0% delivered at term (37-42 weeks) and 26.5% delivered preterm. Most participants (39.5%) were primigravida and 43.5% were nulliparous. Regarding

occupation, 79.5% were homemakers; 41.5% had no formal education and 30.0% had only primary-level education (Table 1).

Regarding haemoglobin status, 119 women (59.5%) were non-anaemic (≥11 g/dL), 54 (27.0%) had moderate anaemia (7-9.9 g/dL), 26 (13.0%) had severe anaemia (<7 g/dL), and 1 (0.5%) had mild anaemia (10-10.9 g/dL).

No statistically significant association was found between maternal haemoglobin levels and Bishop score at admission (p=0.56). The distribution of Bishop score categories was broadly similar across all haemoglobin groups, indicating that maternal anaemia does not influence cervical favourability (Table 2).

There was no statistically significant association between maternal haemoglobin levels and the duration of the active phase of labour (p=0.38). The majority of women across all haemoglobin groups experienced labour lasting less than 4 hours, with similar proportions in the severe anaemia group (76.92%) and non-anaemic group (78.15%) (Table 3).

Apgar scores at 1 minute showed a non-significant trend towards lower scores with worsening anaemia (53.85% scored <7 in the severe group vs 32.77% in the non-anaemic group; p=0.06). By 5 minutes, no significant difference was observed (p=0.41), indicating effective neonatal recovery across all groups (Table 4).

A highly significant association was found between maternal haemoglobin levels and neonatal birth weight (p<0.0001). A striking 88% of mothers with severe anaemia and 74.07% with moderate anaemia delivered LBW neonates (<2.5 kg), compared to only 14.29 percentages in the non-anaemic group. Infants weighing >3.0 kg were exclusively born to non-anaemic mothers (Table 5).

Among LBW infants, 50.63% were born to moderately anaemic mothers and 27.85% to severely anaemic mothers, while 85% of normal birth weight infants were born to non-anaemic mothers (Table 6).

A statistically significant association was found between maternal haemoglobin levels and NICU admission (χ^2=12.96, p=0.004). Neonates born to mothers with moderate (34.55 percentages) and severe anaemia (16.36 percentages) accounted for a greater proportion of the NICU admissions, while 72.22 percentages of non-admitted neonates were born to the non-anaemic mothers (Table 7).

A statistically significant inverse association was found between Bishop score and the duration of active labour (p=0.01). Women with the highest Bishop scores (10+) experienced the shortest mean labour duration (2.32±1.28 hours), while those with a score of 4-6 had the longest (3.20±1.01 hours), confirming the predictive value of the Bishop score for labour progression (Table 8).

Table 1: Sociodemographic and obstetric characteristics of study participants, (n=200).

Characteristics	Category	N	Percentages (%)
Age (in years)	≤20	27	13.50
	21–25	111	55.50
	26–30	62	31.00
	31–35	0	0.00
Gestational age (in weeks)	Preterm (<37)	53	26.50
	Term (37-42)	146	73.00
	Post-term (>42)	1	0.50
Gravida	G1 (Primigravida)	79	39.50
	G2	63	31.50
	G3	41	20.50
	G4	15	7.50
	G5	1	0.50
Parity	P0 (Nulliparous)	87	43.50
	P1	68	34.00
	P2	36	18.00
	P3	7	3.50
	P4	1	0.50
Occupation	Homemaker/ unemployed	159	79.50
	Employed	41	20.50
Education	No formal education	83	41.50
	Primary	60	30.00
	Secondary	37	18.50
	Tertiary	20	10.00

Table 2: Maternal haemoglobin versus Bishop score at admission, (n=200).

Bishop score	Severe <7 g/dl (n=26), N (%)	Moderate 7-9.9 g/dl (n=54), N (%)	Mild 10-10.9 g/dl (n=1), N (%)	Non-anaemic ≥11 g/dl (n=119), N (%)	P value
0-3	9 (34.62)	16 (29.63)	0 (0)	32 (26.89)	0.56
4-6	6 (23.08)	13 (24.07)	0 (0)	31 (26.05)	
7-9	5 (19.23)	18 (33.33)	0 (0)	42 (35.29)	
10+	6 (23.08)	7 (12.96)	1 (100)	14 (11.76)	
Total	26 (100)	54 (100)	1 (100)	119 (100)	

Table 3: Maternal haemoglobin versus duration of active phase of labour, (n=200).

Labour duration	Severe <7 g/dl (n=26), N (%)	Moderate 7-9.9 g/dl (n=54), N (%)	Mild 10-10.9 g/dl (n=1), N (%)	Non-anaemic ≥11 g/dl (n=119), N (%)	P value
<4 hours	20 (76.92)	34 (62.96)	1 (100.00)	93 (78.15)	0.38
4–6 hours	6 (23.08)	20 (37.04)	0 (0.00)	25 (21.01)	
>6 hours	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.84)	
Total	26 (100.00)	54 (100.00)	1 (100.00)	119 (100.00)	

Table 4: Maternal haemoglobin versus Apgar score, (n=200).

Apgar score	Severe <7 g/dl (n=26), N (%)	Moderate 7-9.9 g/dl (n=54), N (%)	Mild 10-10.9 g/dl (n=1), N (%)	Non-anaemic ≥11 g/dl (n=119), N (%)	P value
1 min <7	14 (53.85)	24 (44.44)	0 (0.00)	39 (32.77)	0.06
1 min ≥7	12 (46.15)	30 (55.56)	1 (100.00)	80 (67.23)	
5 min <7	4 (15.38)	4 (7.41)	0 (0.00)	7 (5.88)	0.41
5 min ≥7	22 (84.62)	50 (92.59)	1 (100.00)	112 (94.12)	

Table 5: Maternal haemoglobin versus neonatal birth weight, (n=199).

Birth weight (kg)	Severe <7 g/dl (n=26), N (%)	Moderate 7-9.9 g/dl (n=54), N (%)	Mild 10-10.9 g/dl (n=1), N (%)	Non-anaemic ≥11 g/dl (n=119), N (%)	P value
<2.5 (LBW)	22 (88.00)	40 (74.07)	0 (0.00)	17 (14.29)	<0.0001
2.5-3.0	3 (12.00)	14 (25.93)	1 (100.00)	81 (68.07)	
>3.0	0 (0.00)	0 (0.00)	0 (0.00)	21 (17.65)	
Total	25 (100)	54 (100)	1 (100)	119 (100)	

Table 6: LBW versus haemoglobin group (n=199).

Birth weight (kg)	Severe <7 g/dl (n=26), N (%)	Moderate 7-9.9 g/dl (n=54), N (%)	Mild 10-10.9 g/dl (n=1), N (%)	Non-anaemic ≥11 g/dl (n=119), N (%)	Total, N (%)	P value
LBW (<2.5)	22 (27.85)	40 (50.63)	0 (0.00)	17 (21.52)	79 (100)	<0.0001
Normal (≥2.5)	3 (2.50)	14 (11.67)	1 (0.83)	102 (85.00)	120 (100)	
Total	25 (12.56)	54 (27.14)	1 (0.50)	119 (59.80)	199 (100)	

Table 7: NICU admission versus haemoglobin group, (n=200).

NICU admission	Severe <7 g/dl (n=26), N (%)	Moderate 7-9.9 g/dl (n=54), N (%)	Mild 10-10.9 g/dl (n=1), N (%)	Non-anaemic ≥11 g/dl (n=119), N (%)	Total, N (%)	P value
Yes	18 (16.36)	38 (34.55)	0 (0.00)	54 (49.09)	110 (100)	0.004
No	8 (8.89)	16 (17.78)	1 (1.11)	65 (72.22)	90 (100)	
Total	26 (13.00)	54 (27.00)	1 (0.50)	119 (59.50)	200 (100)	

Table 8: Bishop score versus mean duration of active phase of labour, (n=200).

Bishop score	N	Mean active labour duration (hours)±SD	P value
0-3	57	2.90±1.21	0.01
4-6	50	3.20±1.01	
7-9	65	2.66±1.21	
10+	28	2.32±1.28	
Total	200	2.82±1.20	

DISCUSSION

This hospital-based cross-sectional study conducted at a tertiary care centre in central India comprehensively evaluated the relationships between maternal haemoglobin levels and multiple intrapartum and neonatal parameters in a cohort of 200 women undergoing normal vaginal delivery. The key findings were: (i) maternal haemoglobin did not significantly influence Bishop score or active labour duration; (ii) a highly significant association existed between haemoglobin levels and neonatal birth weight; (iii) NICU admission rates were significantly higher in anaemic mothers; and (iv) Apgar scores showed a non-significant trend towards lower values with worsening anaemia.

Maternal haemoglobin and Bishop score

No statistically significant association was found between maternal haemoglobin levels and Bishop score at admission (p=0.56). This is clinically plausible, as cervical maturation is regulated by localised biochemical mediators-prostaglandins, inflammatory cytokines, nitric oxide, and enzymatic collagen remodelling-that are largely independent of systemic oxygen-carrying capacity.[7] Given the absence of published comparative literature on this specific relationship, the present study makes a novel contribution by demonstrating that maternal anaemia does not interfere with cervical favourability, and clinicians should not consider haemoglobin status as a determinant of Bishop score or induction success.

Maternal haemoglobin and duration of active labour

No significant relationship was found between haemoglobin levels and the duration of active labour (p=0.38), with the majority of women across all groups delivering within 4 hours. This is consistent with the understanding that uterine contractility is primarily governed by hormonal factors-oxytocin, prostaglandins, and intracellular calcium dynamics-that may compensate effectively even in the presence of reduced haemoglobin levels. Antrini et al reported a positive correlation between higher haemoglobin and shorter second-stage duration (r=0.416, p=0.006), and Sajjad et al linked anaemia with prolonged labour as a risk factor for postpartum haemorrhage.[8,9] The discrepancy may reflect focus on the second stage or complicated labour rather than the active phase of normal delivery as studied here.

Maternal haemoglobin and APGAR score

A non-significant trend (p=0.06) towards lower 1-minute Apgar scores with worsening anaemia was observed, particularly in the severe anaemia group (53.85% with scores <7 vs 32.77% in the non-anaemic group). By 5 minutes, all groups showed comparable recovery (p=0.41), suggesting effective neonatal physiological adaptation. Paramahamsa et al similarly found no significant association between maternal anaemia and 5-minute Apgar scores.[10] In contrast, Sharma et al and Farooq et al reported significant associations in severe anaemia, and Sekhavat et al demonstrated increased risk of low Apgar scores in anaemic mothers.[11-13] These contrasting results may reflect differences in study populations, anaemia severity profiles, and intrapartum care quality. It is also noteworthy that the Apgar score is a relatively subjective and gross measure of neonatal adaptation and may not capture subtle physiological disturbances arising from moderate anaemia.

Maternal haemoglobin and neonatal birth weight

The most significant finding of this study was the strong association between maternal haemoglobin levels and neonatal birth weight (p<0.0001), with 88% of severely anaemic mothers delivering LBW neonates. This is consistent with a substantial body of evidence. Khan et al reported a moderate positive correlation (r=0.35, p=0.001) between haemoglobin and birth weight, with anaemic mothers having a 3.31-fold higher risk of LBW.[14] Tiwari et al demonstrated a progressive inverse relationship between anaemia severity across trimesters and LBW risk, with third-trimester haemoglobin exerting the strongest effect.[15] Paramahamsa et al reported LBW in 25% of anaemic versus 10.9% of non-anaemic mothers (p<0.05).[10] The underlying mechanism involves reduced maternal oxygen-carrying capacity leading to chronic foetal hypoxia, impaired placental perfusion, and intrauterine growth restriction. Xie et al described a non-linear, inverted U-shaped relationship between haemoglobin and birth weight, suggesting that both low and excessively high haemoglobin values can be harmful-a nuance not evaluated in the present study but important for clinical practice.[16]

Maternal haemoglobin and NICU admission

The significant association between maternal anaemia and NICU admission (p=0.004) found in this study is consistent with findings of Anjanappa et al, who reported higher NICU rates among neonates of anaemic mothers, and Badi et al who documented increased neonatal complications including respiratory distress.[17,18] Increased NICU admissions are likely secondary to LBW, compromised initial neonatal adaptation, and greater susceptibility to perinatal complications, further underscoring the downstream neonatal burden of maternal anaemia.

Bishop score and labour duration

A significant inverse association was found between Bishop score and active labour duration (p=0.01), with higher scores corresponding to shorter labour durations. This finding is consistent with the original seminal work of Bishop and validates the predictive utility of the score in routine obstetric practice.[7] Notably, this relationship was independent of maternal haemoglobin, further

confirming that labour dynamics are primarily driven by cervical factors.

CONCLUSION

Maternal haemoglobin levels do not significantly influence Bishop score at admission or the duration of the active phase of labour in normal vaginal delivery. However, they exert a strong and highly significant impact on neonatal birth weight and NICU admission rates, with a non-significant trend towards lower Apgar scores at 1 minute in severely anaemic mothers. These findings highlight that maternal anaemia primarily affects foetal growth and neonatal wellbeing rather than the mechanics of labour. Early detection, prevention, and effective management of maternal anaemia through routine antenatal screening, iron-folate supplementation, and nutritional counselling are essential to minimise preventable neonatal morbidity. Larger multicentre prospective studies are recommended to further characterise these relationships and establish evidence-based haemoglobin thresholds for optimising perinatal outcomes.

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