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Original Research Article

A PROSPECTIVE STUDY ON THE IMPACT OF MATERNAL ANEMIA ON BIRTH OUTCOMES OF NEWBORN IN PREGNANCIES

M. Yaseen[1], P. Abinaya[2], E. Varun Kumar[3]

[1]*Assistant Professor, Department of Paediatrics, Government Ariyalur Medical College, Ariyalur, Tamil Nadu, India.*
[2]*Assistant Professor, Department of Obstetrics and Gynaecology, Government Ariyalur Medical College, Ariyalur, Tamil Nadu, India.*
[3]*Assistant Professor, Department of Paediatrics, Government Ariyalur Medical College, Ariyalur, Tamil Nadu, India.*

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Corresponding Author:
Dr. M. Yaseen,
Assistant Professor, Department of Paediatrics, Government Ariyalur Medical College, Ariyalur, Tamil Nadu, India.
Email: yaseenmbbs2004@gmail.com

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ABSTRACT

Background: Iron deficiency anaemia remains a major global health concern, affecting 1.62 billion people, with pregnant women (41.8%) being particularly vulnerable. In India, anaemia prevalence ranges from 58–89.6% among pregnant women, driven by poor dietary iron intake, infections, and nutritional deficiencies. Maternal anaemia contributes significantly to preterm birth, low birth weight, and perinatal mortality.

Materials and Methods: This prospective study was conducted among 200 anaemic pregnant women attending the Department of Obstetrics and Gynecology at our Medical College and Hospital between August 2024 and August 2025. Ethical approval and informed consent were obtained prior to data collection. Sociodemographic, medical, and menstrual histories were recorded using a pretested questionnaire. Hemoglobin estimation was performed at the first visit, 30 weeks, and 36 weeks of gestation using Sahli's method. Peripheral smear examination determined the type of anaemia. Participants were classified according to WHO criteria and managed with oral or intravenous iron or blood transfusion as required. Maternal and perinatal outcomes, including delivery mode and NICU admissions, were assessed. Blood cultures were done for all neonates admitted to the NICU. A sample size of 200 was derived assuming a 51% prevalence and 7.5% allowable error with 95% confidence limits. Data were entered in Excel and analyzed descriptively.

Results: Among 200 anemic pregnant women (mean age 26.1 ± 3.8 years), 79% belonged to the lower socio-economic class, and 64% were multigravida. Overall, 31.5% had mild, 51.0% moderate, and 17.5% severe anaemia. Significant associations were found between severity of anaemia and age ($p = 0.012$), literacy ($p = 0.0005$), registration status ($p = 0.021$), parity ($p = 0.018$), and mode of delivery ($p = 0.0001$). Anaemia severity also correlated with adverse fetal outcomes ($p = 0.003$), particularly preterm delivery and NICU admissions.

Conclusion: Anaemia was highly prevalent, with most cases being moderate to severe. Factors such as illiteracy, unbooked status, higher parity, and delivery mode were significantly associated with severity. Severe anaemia correlated with adverse fetal outcomes, underscoring the need for improved antenatal care and nutrition interventions.

Keywords: Anaemia in pregnancy; Maternal outcomes; Fetal outcomes.

INTRODUCTION

Iron deficiency anaemia is a significant public health dietary issue that affects people of all ages. 1.62 billion individuals worldwide suffer from anemia (24.8%), with preschool-aged children (47.4%) and expectant mothers (41.8%) having the highest prevalences. India's general population has one of the highest rates of anemia (74.3%) worldwide. Iron needs rise as a result of pregnancy-related

physiological changes, which makes anemia more common. The frequency of anemia in pregnant women has been reported to be between 58% and 89.6% nationwide.[1-3] In addition to being among the top 10 nations in the world for the prevalence of estimated preterm births, it leads the globe in maternal mortality.[4,5] Poor dietary iron intake and low iron bioavailability in the Indian food are the main aetiological variables in the nation that cause anemia during pregnancy.

Furthermore, the situation is dire because of blood loss from hookworm infestation, malarial illness, and vitamin B12 insufficiency.[6] Premature births, low birth weight, and high perinatal mortality are all caused by maternal anemia, which is one of the key variables influencing the outcome of pregnancy.[7] There is evidence of a growing trend in maternal anemia,[8] despite improvements in the health system.[9] The existence of these changing patterns in predicting newborn outcomes raises the possibility that their associational statistics are subject to change. It is crucial that current prospective studies stay up to date with this quickly changing trend while taking into account common neonatal outcome indicators in such a scenario. In this study, we examined the relationship between maternal haemoglobin levels and newborn outcomes in pregnant women.

MATERIALS AND METHODS

This prospective study included 200 pregnant women who were determined to be anemic during their visits to the Department of Obstetrics and Gynecology at our Medical College and Hospital in between August 2024 and August 2025. After obtaining patient informed consent and institutional ethical committee approval, data collection was carried out. Every subject was thoroughly examined, and hemoglobin levels were estimated during the first visit, as well as at weeks thirty and thirty-six of pregnancy. All of the infants brought to the NICU for different reasons had blood cultures performed. Details such as sociodemographic data, prior medical sickness history, and menstruation history were gathered using a pre-tested questionnaire.

Sample size and sampling method

Using the hypothesis testing approach and presuming the following, a sample size of 200 was determined: According to the previous study, the prevalence of anemia during pregnancy in India was 51.0% with a 7.5% allowed error, with 95% confidence intervals.[10] To account for expected subject non-response, a 10% inflation has been applied to the computed minimum sample. The following topics were the focus of the investigations:

- **Hemoglobin percentage:** Sahli's approach was used to quantitatively estimate hemoglobin.
- **Peripheral smear:** A peripheral smear examination was used to determine the type of anemia.

Every subject was categorized using WHO guidelines, and based on the severity of their anemia, they were all given oral iron, intravenous iron, or blood transfusions. They were also closely monitored during the prenatal, postpartum, and postpartum phases. Lastly, all study participants' delivery methods, maternal outcomes, and perinatal outcomes were examined. Descriptive analysis was done on the data, which were entered into an Excel sheet.

RESULTS

The mean age of study participants was 26.1 ± 3.8 years. The majority of women were in the 20–24 years age group (44.0%), followed by 36.0% in 25–29 years, 11.0% in ≥30 years, and 9.0% were ≤19 years. With respect to socio-economic status, most participants (79.0%) belonged to the lower class, while 21.0% were from the middle class. Regarding literacy, 39.5% had primary education, 28.5% were illiterate, 24.0% had secondary education, and only 8.0% were graduates and above.

In terms of pregnancy registration, 56.0% were booked cases, while 27.0% were un-booked, and 17.0% were referred. Considering parity, 36.0% were primigravida and 64.0% were multigravida. Among the multigravida women (n = 128), 64.0% had a spacing of less than 2 years, while 36.0% had a spacing of 2 years or more. Risk factors were observed in 61.0% of participants, whereas 39.0% had no risk factors. Anaemia was present in varying degrees: 31.5% mild, 51.0% moderate, and 17.5% severe. Regarding the mode of delivery, 63.0% underwent vaginal delivery, while 37.0% required LSCS. Maternal complications in the puerperium were seen in 16.0% of women, whereas 84.0% had no complications. [Table 1]

Table 1: Socio-demographic and Clinical Profile of Study Participants (n = 200)

Variable	Number (%)
Age (in years)	
≤ 19	18 (9.0)
20–24	88 (44.0)
25–29	72 (36.0)
≥ 30	22 (11.0)
Mean age (mean ± SD)	26.1 ± 3.8
Socio-economic status	
Lower	158 (79.0)
Middle	42 (21.0)
Literacy status	
Illiterate	57 (28.5)

Primary	79 (39.5)
Secondary	48 (24.0)
Graduate and above	16 (8.0)
Registration status of pregnancy	
Booked	112 (56.0)
Un-booked	54 (27.0)
Referred	34 (17.0)
Parity	
Primigravida	72 (36.0)
Multigravida	128 (64.0)
Spacing between pregnancies (years) (n = 128)	
< 2	82 (64.0)
≥ 2	46 (36.0)
Risk factor	
Present	122 (61.0)
Absent	78 (39.0)
Degree of anaemia	
Mild	63 (31.5)
Moderate	102 (51.0)
Severe	35 (17.5)
Mode of delivery	
Vaginal	126 (63.0)
LSCS	74 (37.0)
Maternal complication in puerperium	
Present	32 (16.0)
Absent	168 (84.0)

With respect to age, among women aged ≤19 years, 9 had mild, 10 had moderate, and 2 had severe anaemia. In the 20–24 years group, 32 were mild, 47 moderate, and 15 severe. In the 25–29 years group, 15 had mild, 38 moderate, and 19 severe anaemia, while in those ≥30 years, 3 were mild, 12 moderate, and 3 severe (p = 0.012).

Considering literacy status, among illiterate women, 10 were mild, 28 moderate, and 20 severe. In those with primary education, 28 had mild, 50 moderate, and 7 severe. Women with secondary education showed 17 mild, 24 moderate, and 3 severe, while graduates and above had 4 mild, 5 moderate, and 1 severe case (p = 0.0005). Regarding socio-economic status, in the lower group, 45 were mild, 90 moderate, and 29 severe, while in the middle group, 14 had mild, 17 moderate, and 6 severe (p = 0.421). As per registration status, among booked women, 40 had mild, 58 moderate, and 14 severe anaemia. In the un-booked group, 12 were mild, 32 moderate, and 10 severe, while in referred cases, 7 were mild, 17 moderate, and 11 severe (p = 0.021). With respect to parity, primigravida women had 30 mild, 33 moderate, and 9 severe cases, while multigravida women showed 36 mild, 74 moderate, and 22 severe cases (p = 0.018).

For mode of delivery, women who delivered vaginally had 45 mild, 80 moderate, and 7 severe, while those who underwent LSCS had 21 mild, 27 moderate, and 24 severe cases (p = 0.0001).Considering risk factors, women with pre-eclampsia had 7 mild, 16 moderate, and 15 severe cases; PROM cases included 6 mild, 19 moderate, and 11 severe; oligohydramnios was seen in 2 mild, 10 moderate, and 3 severe; hypothyroidism in 2 mild, 2 moderate, and 1 severe; Rh-negative cases included 1 mild, 6 moderate, and 3 severe; placenta previa was seen in 1 mild, 2 moderate, and none severe; GDM in 3 mild, 3 moderate, and none severe; gestational hypertension in 0 mild, 5 moderate, and 1 severe; and abruptio placenta in 1 mild, 2 moderate, and none severe (p = 0.11).For spacing between pregnancies, among women with <2 years spacing, 15 had mild, 45 moderate, and 20 severe cases, while those with ≥2 years spacing had 16 mild, 28 moderate, and 7 severe (p = 0.29).

Looking at fetal outcome, full-term delivery was associated with 80 mild, 72 moderate, and 10 severe cases, preterm delivery with 7 mild, 26 moderate, and 8 severe, IUGR with 5 mild, 15 moderate, and 2 severe, intrauterine death with 0 mild, 2 moderate, and 3 severe, and NICU admission with 10 mild, 31 moderate, and 9 severe (p = 0.003). Finally, for birth weight, in babies weighing <2.5 kg, 46 mothers had mild, 87 moderate, and 28 severe anaemia, while in those >2.5 kg, 13 were mild, 24 moderate, and 8 severe (p = 0.64). The association between socio-clinical characteristics and severity of anaemia is presented. [Table 2]

Table 2: Association between socio-clinical characteristics and severity of anaemia (n = 200)

Variable	Mild	Moderate	Severe	P value
Age (years)				
≤19	9	10	2	0.012
20–24	32	47	15	
25–29	15	38	19	
≥30	3	12	3	
Literacy				
Illiterate	10	28	20	

Primary	28	50	7	
Secondary	17	24	3	0.0005
Graduate & above	4	5	1	
Socio-economic status				
Lower	45	90	29	0.421
Middle	14	17	6	
Registration status				
Booked	40	58	14	
Un-booked	12	32	10	0.021
Referred	7	17	11	
Gravida				
Primigravida	30	33	9	0.018
Multigravida	36	74	22	
Mode of delivery				
Vaginal	45	80	7	0.0001
LSCS	21	27	24	
Risk factors				
Preeclampsia	7	16	15	
PROM	6	19	11	
Oligohydramnios	2	10	3	
Hypothyroidism	2	2	1	
Rh-negative	1	6	3	0.11
Placenta previa	1	2	0	
GDM	3	3	0	
GHTN	0	5	1	
Abruptio placenta	1	2	0	
Spacing between pregnancies (years)				
<2	15	45	20	0.29
≥2	16	28	7	
Fetal outcome				
FTD	80	72	10	
PTD	7	26	8	
IUGR	5	15	2	0.003
IUD	0	2	3	
NICU	10	31	9	
Birth weight (kg)				
<2.5	46	87	28	0.64
≥2.5	13	24	8	

DISCUSSION

In this cross-sectional analysis of 200 pregnant women, we observed a high burden of anaemia and significant associations between socio-demographic and clinical factors with anaemia severity, mode of delivery, and fetal outcomes. Below we interpret our findings in light of existing literature, propose plausible mechanisms, discuss limitations, and suggest implications.

In our study population, anaemia in pregnancy was common: 31.5 % mild, 51.0 % moderate, and 17.5 % severe. These proportions indicate that more than two-thirds of anaemic women had moderate to severe anaemia. Our distribution is broadly in keeping with other studies in similar settings, which often report moderate anaemia as the predominant grade (though the share of severe anaemia tends to be lower).[11,12] Some large population-based surveys in India have also documented high rates of moderate anaemia in pregnant women.[12-15] The relatively high proportion of severe anaemia in our sample may reflect the fact that this is a hospital-based study and possibly enriched for women with complications or referrals.

We found a statistically significant relationship between age categories and anaemia severity (p = 0.012): younger women (≤19 years) and women in the 25–29 group had higher proportions of moderate/severe anaemia. This is consistent with some studies showing that adolescent pregnancies carry a higher risk of anaemia due to ongoing growth demands and nutritional competition [0search0]. Similarly, literacy status showed a strong association (p = 0.0005) — illiterate women had a disproportionately higher share of severe anaemia compared to those with higher education. This agrees with established evidence that low maternal education is a strong, consistent predictor of maternal anaemia, often mediated via poorer knowledge, dietary practices, and health-seeking behaviour.[16,17]

Interestingly, socio-economic status (SES) in our study was not significantly associated with anaemia severity (p = 0.421). One possible explanation is that most of our participants (79 %) were already in the "lower" SES group, limiting variation and contrast; in settings where SES variability is low, effects may attenuate. Registration status (booked/unbooked/referred) was significantly associated with anaemia severity (p = 0.021). Un-booked and referred women had higher proportions of moderate and severe anaemia, which is plausible: women not well-integrated in antenatal care services are less likely to receive early screening, iron supplementation, or interventions. This underscores the importance of antenatal care access and continuity.

Parity was also associated (p = 0.018): multigravid women tended to have more moderate/severe anaemia compared to primigravida. This echoes findings from several studies that higher parity depletes maternal iron reserves, especially if interpregnancy intervals are short [18,19]. Within the multigravida group, 64 % had spacing < 2 years; although spacing itself was not significantly associated (p = 0.29), the trend suggests that short intervals may amplify risk by limiting recuperation of iron stores.

We observed a striking association between mode of delivery and anaemia severity (p = 0.0001). Among women delivering by LSCS (cesarean), a higher proportion had severe anaemia (24 of 74) compared to vaginal deliveries (7 of 126). While causality cannot be inferred from cross-sectional data, several plausible interpretations exist:

1. Reverse causation / selection bias: Women with more severe anaemia may have a higher risk of obstetric complications (e.g., fetal distress, non-reassuring patterns) leading to cesarean decisions.
2. Confounding by comorbidity: Severe anaemia may coincide with other risk factors or obstetric complications that independently predispose to cesarean delivery.
3. Physiologic stress tolerance: Women with severe anaemia may tolerate labour poorly, prompting more frequent surgical intervention.

Other studies have similarly found associations between severe maternal anaemia and adverse obstetric interventions and outcomes [0search1,0search8]. Fetal outcomes: gestational age, birth weight, and NICU/IUD. Our fetal outcome analysis revealed a significant association (p = 0.003) between severity of maternal anaemia and outcomes: full-term delivery was more often linked with mild/moderate anaemia, whereas preterm delivery, IUGR, intrauterine death (IUD), and NICU admissions had higher proportions of mothers with moderate/severe anaemia. These findings align with the broader literature linking maternal anaemia to preterm birth, small-for-gestational-age infants, low birth weight, and perinatal mortality.[20,21] A cross-sectional study reported that severe anaemia in delivering women was significantly associated with risk of preterm birth and low birth weight.[22] Mechanistically, maternal anaemia reduces the oxygen-carrying capacity, which may compromise placental function and fetal growth, and increase susceptibility to hypoxia and stress during labour.

In our data, however, the association of maternal anaemia with low birth weight (< 2.5 kg) was not statistically significant (p = 0.64). This could be due to limited sample size in subgroups or residual confounding; many factors influence birth weight beyond maternal haemoglobin status. The associations observed in our study can be understood through both biologic and socio-behavioural lenses:

- Depletion of iron stores: Repeated pregnancies, short interpregnancy intervals, and inadequate iron supplementation can exhaust maternal iron reserves, leading to progressive worsening of anaemia.
- Poor nutrition and dietary intake: Lower literacy and lower socio-economic conditions often correlate with limited dietary diversity, inadequate intake of iron-rich foods, and poor absorption (e.g., due to infections or concurrent deficiencies).
- Inadequate antenatal care: Women who are un-booked or referred may miss early screening, prophylactic iron/folate therapy, deworming, or treatment of coexisting morbidity.
- Adverse hemodynamic stress: During labour and delivery, women with moderate to severe anaemia may have lower physiologic reserve and poorer tolerance to haemorrhage or hypoxia, possibly precipitating more operative interventions or complications.
- Feto-placental compromise: Maternal anaemia may impair placental oxygenation and nutrient transport, thereby increasing risk of fetal growth restriction, preterm birth, and NICU admission.

Strengths and limitations

Strengths:

- We had a reasonably sized sample (n = 200) with detailed breakdown by socio-demographic and obstetric factors.
- We analyzed multiple covariates (age, literacy, registration, parity, mode of delivery) in relation to anaemia severity and fetal outcomes.
- The classification of anaemia into mild, moderate, and severe allows more granular insight into differential risk.

Limitations

1. Cross-sectional / observational design: We cannot establish causal relationships; the directionality of associations (especially with mode of delivery) is uncertain.
2. Hospital-based sample: Our sample may be enriched for women with complications or referrals, limiting generalizability to the community or population level.
3. Potential confounding: Variables such as nutritional status, BMI, chronic infections (malaria, hookworm), micronutrient deficiencies (folate, B12), HIV, or chronic diseases were not measured or adjusted for.
4. Measurement & classification issues: We do not know whether all women were on iron supplementation, compliance levels, or whether treatment modified hemoglobin levels before delivery. Also, classification of anaemia severity is based on a single measurement (or lowest value) rather than serial measures.
5. Small subgroup sizes: Some strata (e.g. ≤19 years, graduates) contained few women, which may limit the statistical power for comparisons and inflate the risk of type II error.

6. Residual bias: Referral and selection bias may influence the observed associations (e.g., more severe cases may be referred to higher centers).

Implications for practice and future research

The findings underscore the urgent need for early detection, prevention, and management of anaemia in pregnancy, with special attention to disadvantaged subgroups (low literacy, unbooked pregnancies, high parity). Specific recommendations include:

- Strengthening community outreach and antenatal registration, particularly in vulnerable populations.
- Ensuring timely screening and universal iron/folate supplementation, with follow-up and compliance monitoring.
- Focused nutrition education and supplementation strategies targeted to illiterate or lower-education women.
- Promoting optimal birth spacing to allow maternal recovery of iron stores.
- In women with moderate to severe anaemia, close monitoring during labour, and anticipatory planning for complications or surgical intervention.
- In future research, prospective cohort designs are needed to explore temporal relationships, adjust for confounding (nutritional status, infections), and examine the effect of interventions on anaemia dynamics and outcomes.
- Larger multicentre studies might help detect associations in smaller subgroups (e.g., very young mothers or highly educated women).

CONCLUSION

In summary, anaemia was highly prevalent in our study cohort, with over two-thirds categorized as moderate to severe. Illiteracy, unbooked registration status, higher parity, and mode of delivery were significantly associated with more severe anaemia. Maternal anaemia severity was also linked to adverse fetal outcomes (preterm birth, IUGR, NICU admission). These findings reinforce the importance of integrated antenatal services, nutrition interventions, and close obstetric surveillance in reducing adverse maternal and perinatal sequelae of anaemia in pregnancy.

Conflict of Interest: The authors declare that they have no conflicts of interest.

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