

Correlation of Hematological Parameters with Serum Ferritin in Pregnant Women from West Bengal, India

Jyoti Paul¹, Tirthankar Biswas²

¹Associate Professor, Department of Biochemistry, JMN Medical College, Chakdaha, India

²Associate Professor, Department of Pathology, JMN Medical College, Chakdaha, India

Received: 09-05-2026 / Revised: 17-06-2026 / Accepted: 29-07-2026

Corresponding Author: Dr. Tirthankar Biswas

Conflict of interest: Nil

Abstract:

Background: Iron deficiency anaemia is one of the most common nutritional problems among pregnant women, especially in impoverished countries such as India. Iron deficiency in pregnancy may be associated with unfavorable maternal and foetal outcomes. Serum ferritin is regarded as the best index of body iron reserves. Haematological indices are widely utilized for regular screening of anaemia.

Objective: The present study was undertaken to examine the link between haematological indices and serum ferritin levels in second and third trimester pregnant women of West Bengal, India.

Methods: A hospital-based cross-sectional observational study was done in the Department of Biochemistry and Department of Pathology, JMN Medical College from March 2025 to February 2026. Abstract The study comprised 105 pregnant women in the second and third trimester. Haematological parameters such as Hb, RBC count, MCV, MCH, MCHC and RDW-CV were analyzed by automated haematology analyzer and serum ferritin levels were measured by ELISA method. SPSS software version 22.0 was used to perform the statistical analysis.

Results: There was positive correlation between serum ferritin levels and haemoglobin, RBC count, MCV, MCH and MCHC values, however negative correlation was seen with RDW-CV. Iron deficiency anaemia and subclinical iron deficiency were very frequent among research participants. The most frequent result on the peripheral smear was a microcytic hypochromic image.

Conclusion: The study concluded that haematological indices like haemoglobin, MCV and RDW-CV can be used as useful surrogate markers for the prediction of iron deficiency among pregnant women. Early screening and timely iron supplementation is important for reducing consequences of iron deficient anaemia in mothers and foetuses.

Keywords: Iron Deficiency Anaemia, Pregnancy, Serum Ferritin, Hematological Indices, Haemoglobin, Red Cell Indices, Antenatal Women.

DOI: 10.25258/ijpqa.17.7.37

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Anaemia in pregnancy is one of the most common nutritional and public health problems in the world, especially in impoverished nations like India. It is still a major cause of maternal and foetal morbidity and mortality. It has been linked to unfavourable pregnancy outcomes such as preterm delivery, low birth weight, intrauterine growth retardation and increased perinatal mortality [1,2]. According to the World Health Organization (WHO), iron deficiency anaemia accounts for over 50% of all anaemia cases in pregnancy and impacts millions of women worldwide notably in low-resource settings where nutritional deficits and poor access to healthcare are prevalent [3].

Pregnancy is linked with higher nutritional and metabolic demands due to the growth and development of the foetus and placenta. During pregnancy,

plasma volume grows by 40–50 % while red blood cell mass increases by only 20–30 %, leading to physiological haemo dilution and a fall in the concentration of haemoglobin [4]. Therefore, pregnant women are more susceptible to iron insufficiency, especially during the second and third trimesters when the foetus has the highest iron requirements. Insufficient iron storage during this time can lead to depletion of maternal iron stores and development of iron deficiency anaemia (IDA) [5].

Iron is necessary for oxygen transport, cellular metabolism, DNA synthesis, and erythropoiesis. Serum ferritin is regarded as the most reliable biochemical index for measuring body iron reserves and detecting iron deficient anaemia. Iron deficiency and reduced iron reserves are often suggested by ferritin levels < 12-15 ng/mL [6]. Serum ferritin estimate is

better than serum iron and transferrin saturation because it reflects entire body iron stores and is less affected by short-term dietary intake. However, serum ferritin testing is highly expensive and may not be routinely available in many health care settings, especially in rural and economically challenged regions of India [7].

Haematological indicators such as haemoglobin (Hb), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and red blood cell count (RBC) are often used parameters for the evaluation of anaemia and red cell morphology. These indices are useful in diagnosing the severity and type of anaemia and are typically used as initial screening tests for iron deficiency [8]. Iron deficiency anaemia is often presented as microcytic hypochromic anaemia with decrease in MCV, MCH and MCHC value. Correlation of haematological indices with serum ferritin levels may help to discover surrogate markers for early identification of iron deficit during pregnancy [9].

Several studies have shown a substantial association between low serum ferritin and abnormal haematological parameters in pregnant women. Lower haemoglobin concentration with lower red cell indices has been linked to depleted iron reserves and sub-clinical iron insufficiency. However, the normal reference ranges of haematological parameters may vary among groups due to variances in ethnicity, nutritional status, socio-economic conditions, dietary preferences and geographic considerations. Hence, results from the western population may not be immediately applicable to Indian women [10].

India continues to have a significant prevalence of maternal anaemia, despite government iron supplementation programmes. According to National Family Health Survey (NFHS), a considerable proportion of pregnant women continue to be anaemic in India with higher prevalence in economically poorer sections and rural communities [11]. West Bengal which is one of the populous states of India also shows an appreciable prevalence of maternal anaemia due to poor nutrition, recurrent illnesses, low socio-economic level and inadequate antenatal treatment. Thus, early diagnosis of iron deficiency in pregnant women is important to prevent maternal and foetal problems [12].

The second and third trimesters of pregnancy are particularly significant since the iron need dramatically increases at this time due to rapid foetal growth, placental development and expansion of maternal blood volume. The evaluation of serum ferritin and haematological indices during these trimesters may provide useful insights on the iron status and aid in prompt intervention [12]. Identification of simple and inexpensive haematological indicators that correlate with serum ferritin may lessen

dependence on expensive biochemical tests and improve prenatal screening in resource-limited settings.

Several international research have studied the association between haematological parameters and serum ferritin levels in pregnancy, however insufficient evidence is known regarding such correlation among pregnant women in West Bengal, India. The dietary patterns, socioeconomic conditions and prevalence of iron deficiency fluctuate widely in different parts of the country [13]. Hence the population specific research are relevant.

The present study “Correlation of Haematological Indices with Serum Ferritin Levels in Second and Third Trimester Pregnant Women of West Bengal” has been undertaken to explore the association between haematological parameters and serum ferritin levels among pregnant women. The study is targeted at establishing if regular haematological indices can be valid indicators of iron deficiency to help in early diagnosis and management of anaemia in pregnancy.

Materials and Methods

Study Design: The present study was a hospital based cross sectional observational study, carried out to examine connection of haematological indices with serum ferritin levels among pregnant women in second and third trimester of pregnancy.

Study Area: The work was done in Department of Biochemistry in collaboration with Department of Pathology at JMN Medical College. The study population was the pregnant women attending the Antenatal Outpatient Department (ANC OPD) of the attached teaching hospital.

Study Duration: The study was conducted for a duration of one year from March 2025 to February 2026.

Study Population: The study population comprised pregnant women in the second and third trimester who attended the ANC clinic of the hospital during the study period.

Sample Size: One hundred and five pregnant women who consecutively met the inclusion criteria were enrolled in the study.

Sampling Method: Convenient consecutive sampling methods were employed to pick study participants during the study period.

Inclusion Criteria

- Women who are pregnant in the second trimester (13-27 weeks) and third trimester (28-40 weeks) of pregnancy.
- Women, aged 18-35 years.
- Women willing to engage in the study and to give informed consent.

- Women visiting routine check-up at hospital during pregnancy

Exclusion Criteria

- Pregnant women in the first trimester;
- Patients with known haematological problems including thalassaemia, sickle cell anaemia or haemolytic anaemia.
- Women with chronic systemic diseases such as chronic renal disease, liver disease, cancer, TB and autoimmune disorders.
- Patients who received blood transfusion in the last three months.
- Women undergoing parenteral iron therapy or treatment for severe anaemia.
- Serum ferritin levels are affected by patients with acute infections or inflammatory disorders.
- Female's refusal to engage in study.

Study Procedure: Detailed clinical history including age, gestational age, dietary habits, obstetric history, socioeconomic status and history of iron supplementation was obtained in predesigned proforma. Aseptic precautions were taken and about 5 ml of venous blood was collected from each participant. 2 mL blood was transferred to EDTA anticoagulated vials for haematological examination and 3 mL blood was collected in plain sterile vacutainers for measurement of serum ferritin.

The EDTA blood samples were subjected to an automated haematology analyzer for assessment of haemoglobin (Hb), total RBC count, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and red cell distribution width (RDW-CV%). Peripheral blood smear test was also done for morphological grading of anaemia. Plain blood samples were centrifuged to separate serum and serum ferritin levels were determined by Enzyme Linked Immunosorbent Assay (ELISA) technique.

Anaemia in pregnancy was classified as haemoglobin < 10.5 g/dL in the second trimester and < 11 g/dL in the third trimester, based on CDC guidelines. Iron deficiency was defined as serum ferritin level < 12 ng/mL.

Data Collection: Data about demographic profile, clinical findings, haematological parameters, peripheral smear findings and serum ferritin levels were routinely gathered and entered in organized data collection sheet. All laboratory studies were done at the central laboratory of the institution under standard operating procedures. Quality control methods were maintained throughout the study period to ensure laboratory results were accurate and reliable.

Statistical Analysis: The data collected was assembled, tabulated and analyzed using Statistical Package for Social Sciences (SPSS) software version 22.0. Quantitative variables were provided as mean $\pm$ standard deviation (SD) and qualitative variables as frequencies and percentages. The connection between haematological markers and serum ferritin levels was assessed by Pearson's correlation coefficient (r). Where appropriate, independent sample t-tests and Mann-Whitney U tests were used to compare group means. Receiver operating characteristic (ROC) curves were constructed to assess the diagnostic performance of haematological markers for predicting iron deficiency anaemia. Statistical significance was set at $p < 0.05$.

Study Measures

Independent Variables

- Serum ferritin levels
- Age of gestation
- Trimester of pregnancy

The Dependent Variables

- Haemoglobin (Hb)
- Red Blood Cell (RBC) Count
- Mean corpuscular volume
- MCH
- Mean corpuscular haemoglobin concentration (MCHC)
- % RDW CV

Operational Definition

- **ID A (Iron Deficiency Anaemia):** CDC reference values for haemoglobin with serum ferritin < 12 ng/mL.
- **Subclinical iron deficiency:** Normal haemoglobin and serum ferritin < 12 ng/mL.
- **Non-Iron Deficiency Anaemia:** Low haemoglobin with normal serum ferritin levels".

Result

Demographic and clinical characteristics of research participants are shown in Table 1. The age group of 21-25 years was the most common among the pregnant women with 47 cases (44.8%) followed by 18-20 years with 28 instances (26.7%). The age group of women 26-30 years was 22 (21.0%) and over 30 years of age just 8 (7.5%) individuals were there. As for the distribution of gestational age, 52 pregnant women (49.5%) were in the second trimester, and 53 women (50.5%) were in the third trimester. Thus, approximately similar numbers of individuals were recruited in each trimester of pregnancy.

Table 1: Demographic and Clinical Profile of Study Participants (n = 105)

Variable	Category	Number of Cases	Percentage (%)
Age Group	18–20 years	28	26.7
	21–25 years	47	44.8
	26–30 years	22	21
	>30 years	8	7.5
Trimester	Second Trimester	52	49.5
Trimester	Third Trimester	53	50.5

Table 2 shows the distribution of pregnant women based on anaemia and iron status. Iron deficiency anaemia was seen in 38 cases (36.2%) and anaemia not related to iron deficiency in 17 participants (16.2%). Among non-anaemic women 24 (22.9%) women had normal serum ferritin levels and 26

(24.7%) women had low ferritin levels with normal haemoglobin values indicating subclinical iron shortage. These data indicate a significant frequency of iron insufficiency in pregnant women without overt anaemia.

Table 2: Distribution of Pregnant Women According to Anaemia and Iron Status (n = 105)

Category	Number of Cases	Percentage (%)
Iron Deficiency Anaemia	38	36.2
Anaemia not due to Iron Deficiency	17	16.2
Non-Anaemic with Normal Ferritin	24	22.9
Non-Anaemic with Low Ferritin	26	24.7
Total	105	100

Table 3 shows the mean haematological parameters and serum ferritin of the study population. The mean haemoglobin was 10.1 ± 1.4 g/dL. The mean RBC count was 4.12 ± 0.56 million/cumm. The mean MCV, MCH and MCHC values were 78.6 ± 7.8 fL, 25.8 ± 3.2 pg and 31.6 ± 2.1 g/dL respectively. The

average RDW-CV was $16.8 \pm 2.9\%$ and the average serum ferritin was 18.4 ± 9.7 ng/mL. These results suggest lower haematological indices and depleted iron stores among a large number of pregnant women included in the study.

Table 3: Hematological Parameters and Serum Ferritin Levels in Study Population (n = 105)

Parameter	Mean $\pm$ SD
Hemoglobin (Hb) (g/dL)	10.1 ± 1.4
RBC Count (million/cumm)	4.12 ± 0.56
MCV (fL)	78.6 ± 7.8
MCH (pg)	25.8 ± 3.2
MCHC (g/dL)	31.6 ± 2.1
RDW-CV (%)	16.8 ± 2.9
Serum Ferritin (ng/mL)	18.4 ± 9.7

Table 4. Correlation of haematological parameters with serum ferritin levels. Serum ferritin correlated positively with haemoglobin levels ($r = 0.412$, $p = 0.001$). Positive relationships were also seen with RBC count ($r = 0.286$, $p = 0.018$), MCV ($r = 0.365$, $p = 0.004$), MCH ($r = 0.341$, $p = 0.006$) and MCHC

($r = 0.218$, $p = 0.041$). RDW-CV, however, was significantly negatively correlated with serum ferritin levels ($r = -0.438$, $p = 0.001$). These data suggest that low serum ferritin levels are related to low haematological indices and high anisocytosis in pregnant women.

Table 4: Correlation of Hematological Indices with Serum Ferritin Levels (n = 105)

Parameter	Pearson Correlation (r)	p-value
Hemoglobin (Hb)	0.412	0.001
RBC Count	0.286	0.018
MCV	0.365	0.004
MCH	0.341	0.006
MCHC	0.218	0.041
RDW-CV	-0.438	0.001

Table 5: Comparison between haematological parameters of iron deficient and non-iron deficient

pregnant women. The mean haemoglobin level of iron deficient women was substantially lower

(9.2 ± 1.1 g/dL) than non-iron deficient women (11.4 ± 0.9 g/dL) with statistically significant p value of <0.001 . Likewise, there was substantial decrease in RBC count, MCV, MCH and MCHC values in iron deficient subjects. In contrast, RDW-CV was considerably greater in the iron deficient women ($18.9 \pm 2.7\%$) compared with the non-iron deficient

women ($14.2 \pm 1.8\%$). Women with iron deficiency had significantly lower serum ferritin levels (8.6 ± 2.4 ng/mL) than non-iron deficient females (33.5 ± 8.2 ng/mL). These findings emphasise the severe haematological changes associated with iron shortage during pregnancy.

Table 5: Comparison of Hematological Parameters Between Iron Deficient and Non-Iron Deficient Pregnant Women

Parameter	Iron Deficient (n=64) Mean $\pm$ SD	Non-Iron Deficient (n=41) Mean $\pm$ SD	p-value
Hemoglobin (g/dL)	9.2 ± 1.1	11.4 ± 0.9	<0.001
RBC Count (million/cumm)	3.89 ± 0.42	4.46 ± 0.39	0.002
MCV (fL)	73.4 ± 5.2	84.8 ± 4.9	<0.001
MCH (pg)	23.1 ± 2.1	28.6 ± 2.3	<0.001
MCHC (g/dL)	29.8 ± 1.7	33.2 ± 1.5	<0.001
RDW-CV (%)	18.9 ± 2.7	14.2 ± 1.8	<0.001
Serum Ferritin (ng/mL)	8.6 ± 2.4	33.5 ± 8.2	<0.001

The peripheral smear patterns and severity of anaemia among research participants are shown in Table 6. Microcytic hypochromic peripheral smear pattern was the most prevalent finding seen in 49 cases (46.7%) followed by normocytic normochromic pattern in 38 cases (36.2%). Dimorphic anaemia was noticed in 11 instances (10.5%) and macrocytic pattern in 7 cases (6.6%). Regarding the severity of

anaemia, 36 women (34.3%) had mild anaemia, 29 women (27.6%) had moderate anaemia, and 5 instances (4.8%) had severe anaemia. Thirty-five (33.3%) of the subjects were non-anaemic. These results indicate that microcytic hypochromic anaemia was the prevalent morphological pattern in pregnant women with iron insufficiency.

Table 6: Peripheral Smear Findings and Severity of Anaemia Among Pregnant Women (n = 105)

Variable	Category	Number of Cases	Percentage (%)
Peripheral Smear Pattern	Microcytic Hypochromic	49	46.7
	Normocytic Normochromic	38	36.2
	Dimorphic Anaemia	11	10.5
	Macrocytic Pattern	7	6.6
Severity of Anaemia	Mild Anaemia	36	34.3
	Moderate Anaemia	29	27.6
	Severe Anaemia	5	4.8
	Non-Anaemic	35	33.3

Table 7: Receiver Operating Characteristic (ROC) study of different haematological markers in predicting iron deficient anaemia. The Area Under Curve (AUC) value was highest for Haemoglobin (0.918) with best cut-off value <9.8 g/dL showing 91.2% sensitivity and 81.5% specificity. RDW-CV also showed good diagnostic performance with

AUC of 0.854 and sensitivity of 86.3%. Fair sensitivity and specificity were found for MCV, MCH and MCHC in detecting iron deficient anaemia. These results suggest that haemoglobin and red cell indices may be valuable surrogate markers to predict iron insufficiency in pregnant women.

Table 7: ROC Analysis of Hematological Parameters for Predicting Iron Deficiency Anaemia

Parameter	AUC	Best Cut-off	Sensitivity (%)	Specificity (%)
Hemoglobin	0.918	<9.8 g/dL	91.2	81.5
MCV	0.842	<76.5 fL	84.4	78.2
MCH	0.826	<24.8 pg	82.1	79.6
MCHC	0.801	<31.2 g/dL	80.5	74.8
RDW-CV	0.854	$>16.2\%$	86.3	77.1

Discussion

The present study was designed to assess the link between the haematological parameters and serum ferritin levels in second and third trimester pregnant women of West Bengal, India. Iron deficiency anaemia still remains one of the most common nutritional illnesses among pregnant women in underdeveloped countries and is an important public health issue related to increased maternal and foetal morbidity and death [1,2]. Pregnancy increases the demand for iron due to expansion of maternal blood volume, foetal growth and placental development thereby predisposing women to iron shortage and anaemia [5].

In the present study 105 pregnant women were studied and a significant number of them were found to have iron deficiency anaemia and subclinical iron deficiency. In a large proportion of non-anaemic pregnant women, serum ferritin levels were low even at normal haemoglobin levels, indicating depleted iron stores without apparent anaemia. The results show a high prevalence of iron insufficiency even among apparently healthy pregnant women. Similar results have been reported in earlier Indian research showing significant prevalence of subclinical iron insufficiency in pregnant females [12]. This is because of the poor nutritional status and increasing demand for iron in Indian population during pregnancy”.

In the present study, haemoglobin, RBC count, MCV, MCH and MCHC had positive association with serum ferritin levels however RDW-CV had negative correlation. reduced serum ferritin levels associated with reduced red cell indices and greater anisocytosis. Our result is consistent with the results of Casanova et al and Kotwal et al who found a strong correlation between the serum ferritin and red cell indices in pregnant women [14,15]. The reduction of MCV, MCH and MCHC in iron deficient pregnant women can be explained due to poor synthesis of haemoglobin leading to microcytic hypochromic anaemia.

In the present study we found a substantial negative connection of serum ferritin levels with RDW-CV. An increased RDW-CV is a marker of increased variation in red cell size and is a recognised early sign of iron deficient anaemia. Similar findings were also observed by Dugdale et al. and they concluded that increased RDW may be useful in detection of early iron shortage before significant changes in haemoglobin concentration occur. Thus, RDW-CV may be an effective and cheap screening measure for iron insufficiency in pregnant women.

In the present study 70% of iron deficient subjects showed microcytic hypochromic blood image on peripheral smear test. This result agrees with the conventional morphological description of iron deficient anaemia reported in prior haematological research [8]. Normocytic normochromic smears were

detected in some pregnant women with mild anaemia or early iron deficiency. Dimorphic blood picture seen in few cases may be due to coupled dietary insufficiency such iron and folate inadequacy.

There was statistically significant difference between iron deficient and non-iron deficient pregnant women with respect to haemoglobin level, RBC count, MCV, MCH, MCHC, RDW-CV and serum ferritin levels. These results suggest that haematological parameters are severely affected in iron deficiency conditions and may provide useful information in relation to iron status in pregnancy. Similar findings were demonstrated in research from Malaysia and other underdeveloped nations where lower red cell indices were substantially associated with depleted iron levels [16].

Receiver operating characteristics (ROC) analysis in the present study revealed that haemoglobin had the greatest diagnostic accuracy for predicting iron deficient anaemia followed by RDW-CV and MCV. A haemoglobin cut-off value of less than 9.8 g/dL had high sensitivity and specificity for iron insufficiency. Casanova et al. also reported similar findings and found haemoglobin and RDW were important predictors of iron deficit in pregnancy [15]. The results of this study imply that common haematological measures can serve as surrogate markers for identifying pregnant women at risk of iron shortage, especially in resource-limited situations where serum ferritin quantification may not be routinely possible.

An noteworthy finding of the present investigation was the presence of subclinical iron insufficiency in non-anaemic pregnant women. Many women with normal haemoglobin had lower serum ferritin contents, which suggests depleted iron stores. Previous researchers have reported similar findings, suggesting that haemoglobin alone may not be sufficient for the diagnosis of early iron insufficiency in pregnancy [7]. Serum ferritin is the gold standard marker for assessing body iron reserves; however, ferritin screening may not be feasible in all healthcare settings due to its expense and restricted availability.

The present study further supports the ongoing advice of iron supplementation to pregnant women in poor nations like India. Although some Western studies have questioned standard iron supplementation, citing the issue of iron overload and deleterious effects, the significant incidence of iron insufficiency among Indian pregnant women makes a compelling case for continuation of antenatal iron prophylaxis [16,17]. India's national programmes also recommend universal iron and folic acid treatment for pregnant women to prevent maternal anaemia and improve pregnancy outcomes.

The present investigation included certain drawbacks. The investigation was conducted in a single tertiary care center with a rather low sample size. We

did not measure more advanced signs of iron shortage such as transferrin saturation, soluble transferrin receptor, reticulocyte haemoglobin content and erythropoietin levels. Neither were inflammatory indicators that alter serum ferritin interpretation tested. Further multicentric research with greater sample size and sophisticated haematological measures are suggested for better understanding of iron deficit in pregnancy.

Conclusion

The study found that iron deficiency and iron deficiency anaemia are quite common among pregnant women in second and third trimester in West Bengal, India and maternal anaemia continues to be a major public health problem in developing nations. A large majority of pregnant women were found to have reduced iron stores even in the absence of overt anaemia, indicating the occurrence of subclinical iron insufficiency throughout pregnancy. Serum ferritin levels showed significant positive correlation with haemoglobin, RBC count, MCV, MCH and MCHC whereas RDW-CV exhibited negative correlation with serum ferritin levels. These data suggest that decrease in iron reserves is related to substantial changes in red cell shape and haematological profile.

The study also showed that routine haematological parameters, notably haemoglobin, MCV and RDW-CV, can be used as useful and economical surrogate markers to predict iron deficiency anaemia in pregnant women, particularly in resource-limited healthcare settings where serum ferritin estimation may not be readily available. Peripheral smear examination also showed microcytic hypochromic anaemia as the major morphological characteristic in iron deficient subjects. Regular antenatal screening and prompt iron supplementation are therefore vital for the early detection of iron deficiency to avoid unfavorable maternal and foetal outcomes such as preterm delivery, low birth weight and increased perinatal morbidity. The findings of the present study highlight the necessity of enhancing prenatal care programs and dietary interventions to reduce the burden of iron deficiency among pregnant women in India.

Conflicts of Interest: The authors declare no conflicts of interest.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical Approval: The study was approved by the Institutional Ethics Committee of JMN Medical College, Chakdaha, India. Informed written consent was obtained from all participants.

References

1. WHO C. Worldwide prevalence of anaemia 1993–2005. WHO global database on anaemia. 2008;2008.
2. Kalaivani K. Prevalence & consequences of anaemia in pregnancy. Indian Journal of Medical Research. 2009 Nov 1;130(5):627-33.
3. Unicef U, WHO U. WHO: Iron deficiency anaemia: assessment, prevention, and control. A guide for programme managers. 2001.
4. Cunningham FG, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, Spong CY. Obstetric de Williams-25. McGraw Hill Brasil; 2021 Jan 18.
5. Bothwell TH. Iron requirements in pregnancy and strategies to meet them. The American journal of clinical nutrition. 2000 Jul 1;72(1):257S-64S.
6. Pavord S, Myers B, Robinson S, Allard S, Strong J, Oppenheimer C, British Committee for Standards in Haematology. UK guidelines on the management of iron deficiency in pregnancy. British journal of haematology. 2012 Mar;156(5):588-600.
7. Milman N. Iron prophylaxis in pregnancy—general or individual and in which dose?. Annals of hematology. 2006 Dec;85(12):821-8.
8. Prasanna N, Ademokun CO, Radia DH. Haematology. Medicine for MRCP. 2020 Mar 23:271.
9. Breymann C. Iron deficiency anemia in pregnancy. In Seminars in hematology 2015 Oct 1 (Vol. 52, No. 4, pp. 339-347). WB Saunders.
10. Reveiz L, Gyte GM, Cuervo LG, Casasbuenas A. Treatments for iron-deficiency anaemia in pregnancy. Cochrane database of systematic reviews. 2011(10).
11. International Institute for Population Sciences (IIPS) and ICF. National family health survey (NFHS-5), 2019–21: India. National Family Health Survey, India. 2021 Apr 19.
12. Debnath S, Mondal N, Sen J. Double burden of malnutrition among adolescents in India.
13. Casanova BF, Sammel MD, Macones GA. Development of a clinical prediction rule for iron deficiency anemia in pregnancy. American journal of obstetrics and gynecology. 2005 Aug 1;193(2):460-6.
14. Tiwari M, Kotwal J, Kotwal A, Mishra P, Dutta V, Chopra S. Correlation of haemoglobin and red cell indices with serum ferritin in Indian women in second and third trimester of pregnancy. medical journal armed forces india. 2013 Jan 1;69(1):31-6.
15. Hassan R, Abdullah WZ, Hussain NN. Anemia and iron status of Malay women attending an antenatal clinic in Kubang Kerian, Kelantan, Malaysia. Southeast Asian journal of tropical medicine and public health. 2005 Sep 1;36(5):1304.

16. Friedrich JR, Friedrich BK. Prophylactic iron supplementation in pregnancy: a controversial issue. *Biochemistry insights*. 2017 Oct 26;10:1178626417737738.
17. Gautam CS, Saha L, Sekhri K, Saha PK. Iron deficiency in pregnancy and the rationality of iron supplements prescribed during pregnancy. *The Medscape Journal of Medicine*. 2008 Dec 16;10(12):283.