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ASSOCIATION OF MATERNAL AGE, PARITY AND RED CELL INDICES WITH IRON DEFICIENCY ANEMIA IN EARLY PREGNANCY: A HOSPITAL-BASED CASE-CONTROL STUDY FROM EASTERN INDIA

Hemato-Pathology

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ABSTRACT

Introduction: Iron deficiency anaemia is a major global health problem in developing & under develop countries and leads to serious maternal & foetal complications during pregnancy. So many countries have implemented government interventions, including iron & folic acid supplementation and close antenatal monitoring, to reduce the burden of anaemia and its complications. As our country is a developing country & iron deficiency anaemia is prevalent in developing countries, it is necessary to rule out the association of parity, maternal age, and socioeconomic condition of the pregnant women with the incidence of iron deficiency anaemia & also to find out an easily available diagnostic tool to rule out iron deficiency anaemia. **Aim:** To identify maternal factors such as maternal age and parity. Socioeconomic status to enable stratification of the high-risk group. It is also necessary to find an easily available diagnostic tool for diagnosing iron deficiency anaemia. **Materials & Methods:** Our study is a hospital-based case-control study performed in the dept of Pathology in association with the Dept. of Gynaecology & Obs from March 2023 to Feb 2025. A total of 200 pregnant mothers within 20 weeks of gestation were selected with written consent. The study population comprised pregnant mothers with <11 g/dL, selected as cases & 100 with >11 g/dL, selected as controls. To rule out iron deficiency anaemia, serum ferritin has been chosen as the gold standard. CBC with serum iron & ferritin has been done in every case. Sample size has been calculated from the prevalence using Cochran's formula. Increasing parity was the strongest independent predictor of IDA; compared with primigravidae, women with parity 2 had significantly higher odds of IDA (Adjusted OR=4.11; 95% CI: 1.94–8.71; p<0.001), those with parity ≥4 showing markedly increased odds (Adjusted OR=55.22; 95% CI: 7.47–408.33; p<0.001). Results reveal significantly higher RDW-CV and lower MCV, MCH, and MCHC in cases compared to controls (p<0.001 for all). ROC analysis shows an RDW-CV cut-off of ≥14.5% demonstrated 81% sensitivity and 86% specificity. **Conclusion:** Increasing parity, particularly grand multipara, is highly associated with high rates of iron deficiency anaemia. RDW-CV can be a reliable tool for diagnosing iron deficiency anaemia alongside CBC, rather than serum ferritin.

KEYWORDS

Iron Deficiency Anaemia, Early Pregnant Women, Maternal Age & Parity

INTRODUCTION

Iron deficiency anemia (IDA) is one of the most common nutritional deficiencies worldwide and one of the major public health problems among pregnant women living in low- and middle-income countries[1]. During pregnancy, due to physiological expansion of plasma volume and increased maternal iron demand often result in iron deficiency, which can lead women to develop iron deficiency anemia if iron stores are inadequate[2,3]. The World Health Organisation (WHO) defines anemia in pregnancy as a hemoglobin concentration of lower than 11 g/dL. It estimates that approximately one-third of pregnant women worldwide are anemic with iron deficiency anemia accounting for nearly 50% of all cases among them[4,5]. India continues to bear one of the highest burdens of maternal anemia despite ongoing national iron and folic acid supplementation programs through the government primary healthcare delivery system[6].

Iron deficiency anaemia during pregnancy results in increased maternal morbidity, fatigue, reduced physical work capacity, impaired immunity, postpartum haemorrhage and increased risk of maternal mortality[7,8]. Foetal complications include intrauterine growth retardation, preterm delivery, low birth weight, impaired neurological development and increased neonatal morbidity, which are complications of maternal anaemia. These adverse outcomes highlight the importance of identifying iron deficiency anaemia during early pregnancy, before severe anaemia or its complications develops[9].So it is also important to rule out associated maternal factors for iron-deficiency anaemia.

Serum ferritin is the most reliable laboratory marker of body iron stores and is widely accepted as the reference standard for diagnosing iron deficiency in the absence of chronic inflammation[10]. But serum ferritin estimation is relatively expensive, requires specialised laboratory facilities, and is not routinely available in many peripheral or even district healthcare settings in India, whether in government or private setups. So, there is increasing demand to identify simple, inexpensive haematological parameters that may help recognise women at higher risk of iron deficiency using routinely performed complete blood counts, as well as the associated maternal factors for stratifying high-risk mothers.

Modern automated hematology analysers provide several red cell indices, including mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and red cell distribution width (RDW). Iron deficiency results in progressive microcytosis and anisocytosis, leading to characteristic alterations in these indices. Although RDW CV is getting considerable attention as an early indicator of iron deficiency, changes in conventional red cell indices also reflect the severity and progression of iron depletion and may provide useful diagnostic information for early IDA when being interpreted together[11].

Maternal characteristics, particularly age and parity, are recognised determinants of iron status during pregnancy[12,13]. Repeated pregnancies without adequate restoration of maternal iron stores, closely spaced births, and increasing maternal age may predispose to iron deficiency anaemia[14]. Multiparous women often experience cumulative depletion of iron stores due to repeated transfer of iron from maternal to foetal circulation, and advanced maternal age may further increase vulnerability to iron deficiency15. However, published studies have shown inconsistent results regarding the independent contribution of maternal age and parity to iron-deficiency anemia, especially during early pregnancy.[16,17]

Evaluation of maternal demographic factors, together with routinely available hematological indices, may improve the identification of women at increased risk of iron deficiency before biochemical confirmation becomes available. Such an approach may be particularly useful in resource-limited settings where serum ferritin estimation is not accessible. Early recognition of high-risk women enables prompt intervention with iron supplementation, thereby preventing adverse maternal and fetal outcomes due to iron deficiency anaemia.

Our hospital-based case-control study has therefore been conducted at Calcutta National Medical College, Kolkata, in the Department of Pathology, in association with the Department of Gynaecology & Obstetric from July 2023 to March 2025, to evaluate the association between maternal age, parity, socio economic status and routine red cell indices with iron deficiency anaemia during the early stages of pregnancy. The findings will help clinicians use readily available complete blood count parameters, along with maternal characteristics,

to improve risk assessment & stratification of high risk group in routine antenatal practice.

MATERIALS AND METHODS

Study Design: A hospital-based analytical case-control study was conducted in the Departments of Pathology and Obstetrics & Gynaecology, Calcutta National Medical College and Hospital, Kolkata, West Bengal, India, over a period of one year, following approval from the Institutional Ethics Committee.

Study Population: Pregnant women who attended the antenatal check-up in the outpatient department of gynecology at our college during the first 20 weeks of gestation were recruited after obtaining written informed consent.

Sample Size:- A total of 200 participants hase been included in the study. 100 pregnant women diagnosed with anemia have been selected as cases, and 100 age-matched pregnant women without anemia as controls. The sample size was calculated using Cochran's formula based on the prevalence rate.

Inclusion Criteria:- For cases, pregnant women aged 18-45 years, gestational age <20 weeks, haemoglobin <11 g/dL. Serum ferritin < 15 ng /ml and willing to participate in the study. Controls were selected as pregnant women aged 18-45 years with gestational age < 20 weeks and haemoglobin ≥11 g/dL. serum ferritin>15ng/dl, & apparently healthy and willing to participate.

Exclusion Criteria:- Pregnant women with haemoglobinopathies, megaloblastic anaemia. Anaemia of chronic disease. Chronic kidney disease. Chronic liver disease. acute or chronic infection, history of recent blood transfusion, current iron therapy before enrolment. These criteria are being adopted to minimise confounding factors that affect haematological parameters.

Data Collection:- A detailed clinical history has been recorded using a structured proforma & the variables selected are maternal age, gravida, parity, gestational age, socio-economic condition & obstetric history.

Blood Sample Collection:- Approximately 5 mL of venous blood has been collected under aseptic precautions; 2 mL has been collected in an EDTA vial for complete blood count, and 3 mL has been collected in a plain vial for biochemical investigations serum iron & ferritin)

Laboratory Investigations:- Complete blood count has been performed using an automated five-part haematology auto analyser. Parameters have been analyzed are Hb%, total RBC count, mean Corpuscular Volume (MCV), mean Corpuscular Haemoglobin (MCH) mean Corpuscular Hemoglobin Concentration (MCHC), Red Cell Distribution Width-Coefficient of Variation (RDW-CV) Serum ferritin estimation has been performed by using Chemiluminescent Immunoassay (CLIA)method and Serum iron estimation was carried out by the standard colorimetric method in the Department of Biochemistry.

Outcome Measures: The primary outcome is the association between maternal age, parity, and red cell indices and iron deficiency anaemia. Secondary outcomes included comparison of haematological parameters between cases and controls, Correlation of RDW-CV with serum ferritin, and identification of independent predictors of iron deficiency anaemia.

Statistical Analysis:- Data have been entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean ± standard deviation (SD).

Categorical variables were expressed as frequency and percentage. Student's independent t-test has been used to compare continuous variables. The chi-square test or Fisher's exact test was used for categorical variables. Pearson's correlation coefficient has been calculated to assess the relationship between RDW-CV and serum ferritin. Binary logistic regression was performed to identify independent predictors of iron-deficiency anemia. A p-value <0.05 has been considered statistically significant.

RESULT & INTERPETION: -

Table 1. Baseline Characteristics of Study Participants [n= 200]
(Cases with Anaemia in Pregnancy vs. Non-anaemic Controls)

Characteristic	Cases (n = 100)	Controls (n = 100)	Total (N = 200)	p-value
Continuous variables, mean ± SD				
Age (years)	22.87 ± 5.98	21.20 ± 2.20	22.04 ± 4.51	0.010
Haemoglobin (g/dl)	8.14 ± 1.74	12.49 ± 0.60	10.31 ± 2.55	<0.001
RDW-CV (%)	15.86 ± 2.68	13.35 ± 0.92	14.61 ± 2.44	<0.001
MCV (fl)	70.25 ± 6.49	92.03 ± 3.34	81.14 ± 12.16	<0.001
MCH (pg)	25.42 ± 3.98	28.17 ± 1.32	26.79 ± 3.30	<0.001
MCHC (g/dl)	27.71 ± 4.43	33.75 ± 1.45	30.73 ± 4.51	<0.001
Socio-economic status, n (%)				
High	2 (2.0%)	2 (2.0%)	4 (2.0%)	0.046
Middle	27 (27.0%)	13 (13.0%)	40 (20.0%)	
Low	71 (71.0%)	85 (85.0%)	156 (78.0%)	
Parity, n (%)				
Primigravida (Para 1)	44 (44.0%)	69 (69.0%)	113 (56.5%)	<0.001
Para 2	30 (30.0%)	22 (22.0%)	52 (26.0%)	
Para 3	3 (3.0%)	7 (7.0%)	10 (5.0%)	
Para ≥4	23 (23.0%)	2 (2.0%)	25 (12.5%)	

SD, standard deviation; RDW-CV, red cell distribution width–coefficient of variation; MCV, mean corpuscular volume; MCH, mean corpuscular haemoglobin; MCHC, mean corpuscular haemoglobin concentration.
p-values: independent-samples t-test (Welch) for continuous variables; chi-square test for categorical variables. p < 0.05 considered statistically significant.

Interpretation of Table 1

The table shows the baseline characteristics of cases & controls. It has been found that IDA is more prevalent in older women p=0.010) than in the same age group of controls. MCHC and MCV show lower values, and RDW-CV shows higher values in cases compared with the control group. Age. Parity, RDW-CV, MCV, MCH, MCHC, showing significant association (p=0.0010). Socioeconomic status also shows a significant association (p =0.046).

Table 2. Association between Maternal Age and Iron Deficiency Anaemia (IDA)
(All study participants, N = 200)

≤19	56	31 (55.4%)	25 (44.6%)	55.4%
20–24	108	31 (28.7%)	77 (71.3%)	28.7%
25–29	21	15 (71.4%)	6 (28.6%)	71.4%
30–34	3	1 (33.3%)	2 (66.7%)	33.3%
≥35	12	12 (100.0%)	0 (0.0%)	100.0%
Total	200	90 (45.0%)	110 (55.0%)	45.0%

IDA defined as anaemia (haemoglobin < 11 g/dl) with serum ferritin ≤150 ng/dl among the Case group; participants in the Control group (non-anaemic) were classified as IDA-absent.
Chi-square test for association: $\chi^2 = 34.77$, df = 4, p < 0.001. Mean maternal age was higher among IDA-positive women (23.21 ± 6.09 years) than IDA-negative women (21.07 ± 2.40 years); independent-samples t-test (Welch), p = 0.002.

Interpretation

From the table above, maternal age is statistically significantly associated with iron deficiency anaemia among the study participants (χ^2=34.77, df=4, p<0.001). The prevalence of IDA is highest among women aged ≥35 years (100%), followed by the age group of 25–29 years (71.4%) and ≤19 years (55.4%). In contrast, the 20–24 age group has the lowest prevalence of IDA (28.7%), while 33.3% of women in the 30–34 age group are affected.

The mean maternal age is significantly higher among the age group of women with IDA (23.21±6.09 years) compared to those without IDA (21.07±2.40 years), as demonstrated by the Welch independent-samples t-test (p=0.002). These findings indicate that maternal age is significantly associated with the incidence of iron deficiency anaemia in early pregnant women, with both advanced maternal age and teenage pregnancy clearly showing a higher incidence of IDA compared with women aged 20–24 years.

Table 3. Association Between Parity and Iron Deficiency Anaemia (IDA)
(All Study Participants, N = 200)

Primigravida (Para 1)	113	34 (30.1%)	79 (69.9%)	30.1%
Para 2	52	30 (57.7%)	22 (42.3%)	57.7%
Para 3	10	3 (30.0%)	7 (70.0%)	30.0%
Para ≥4	25	23 (92.0%)	2 (8.0%)	92.0%
Total	200	90 (45.0%)	110 (55.0%)	45.0%

IDA defined as anaemia (haemoglobin < 11 g/dl) with serum ferritin ≤150 ng/dl among the Case group; participants in the Control group (non-anaemic) were classified as IDA-absent.
Chi-square test for association: $\chi^2 = 36.76$, df = 3, p < 0.001, indicating a statistically significant association between parity and IDA. The proportion with IDA was lowest among Para 1 and Para 3 women (~30%) and highest among grand multiparas (Para ≥4, 92.0%).

Interpretation
The present study has shown a statistically significant association between the pregnant mother's parity and iron deficiency anaemia (IDA) (χ^2=36.76, df=3, p<0.001). The prevalence of IDA increased markedly with increasing parity of the pregnant mother. Grand multiparous women (Para ≥4) have shown the highest prevalence of IDA (92.0%), followed by Para 2 women (57.7%), whereas primigravidae (30.1%) and Para 3 women (30.0%) have shown comparatively lower proportions.

The significantly higher prevalence of IDA among pregnant women with higher parity may be attributed to the repeated pregnancies resulting in progressive depletion of maternal iron stores, which may cause inadequate inter-pregnancy recovery, which again results in increased nutritional demands.

Table 4. Association between Socio-economic Status and Iron Deficiency Anaemia (IDA)
(All study participants, N = 200)

High	4	0 (0.0%)	4 (100.0%)	0.0%
Middle	40	19 (47.5%)	21 (52.5%)	47.5%
Low	156	71 (45.5%)	85 (54.5%)	45.5%
Total	200	90 (45.0%)	110 (55.0%)	45.0%

IDA was defined as anaemia (haemoglobin < 11 g/dl) with serum ferritin ≤ 150 ng/dl among the Case group; participants in the Control group (non-anaemic) were classified as IDA-absent.

Interpretation
In the table above, no statistically significant association was observed between the socio-economic status of pregnant mothers and iron deficiency anaemia (IDA) among the study participants (χ^2=3.39, p=0.184). Although participants belonging to the middle and low socio-economic groups showed comparable proportions of IDA (47.5% and 45.5%, respectively), no cases of IDA were observed in the high socio-economic group. However, the high socio-economic category comprised only four participants, resulting in small expected cell counts and limiting the reliability of the statistical comparison. Overall, these findings suggest that socio-economic status alone was not a significant determinant of IDA in the present study. Other factors such as dietary iron intake, parity, maternal age, and antenatal nutritional status may have had a greater influence on the incidence of iron deficiency anaemia.

Table 5. Comparison of Red Cell Indices between Cases and Controls
(Cases with anaemia in pregnancy vs. non-anaemic Controls, N = 200)

RDW-CV (%)	15.86 ± 2.68	13.35 ± 0.92	+2.51	<0.001
MCV (fl)	70.25 ± 6.49	92.03 ± 3.34	–21.78	<0.001
MCH (pg)	25.42 ± 3.98	28.17 ± 1.32	–2.75	<0.001
MCHC (g/dl)	27.71 ± 4.43	33.75 ± 1.45	–6.04	<0.001

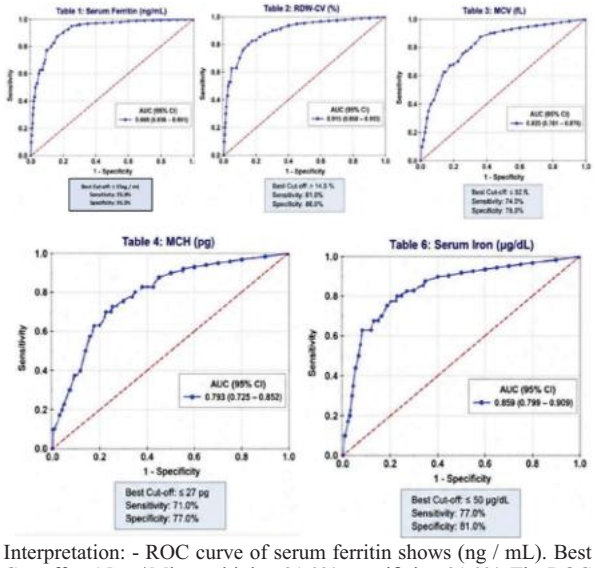
SD, standard deviation; RDW-CV, red cell distribution width–coefficient of variation; MCV, mean corpuscular volume; MCH, mean corpuscular haemoglobin; MCHC, mean corpuscular haemoglobin concentration. Mean difference = Cases – Controls.
p-values from independent-samples t-test (Welch); p < 0.05 considered statistically significant. All four red cell indices differed significantly between Cases and Controls: Cases showed higher RDW-CV (more variable red cell size) alongside lower MCV, MCH, and MCHC, a pattern consistent with microcytic, hypochromic anaemia.

Interpretation
Multivariable binary logistic regression has demonstrated that parity is the strongest independent predictor of iron deficiency anaemia (IDA) after adjusting for maternal age and socio-economic status. Women with Para 2 had approximately four-fold higher odds of developing IDA compared to primigravidae (Adjusted OR=4.11, 95% CI: 1.94-8.71; p<0.001), while women with Para ≥4 had an approximately 55-fold increased risk (Adjusted OR=55.22, 95% CI: 7.47-408.33; p<0.001). Although the odds ratio for Para ≥4 is very high, the wide confidence interval indicates limited precision because of the relatively small number of women in this category.

Maternal age has not shown an independent association with IDA after adjustment (Adjusted OR=0.96, 95% CI: 0.86-1.07; p=0.437). Similarly, socio-economic status no longer retained statistical significance in the multivariable model (Adjusted OR=1.97, 95% CI: 0.91-4.23; p=0.084). The overall regression model is statistically significant (Model $\chi^2 = 43.57$, p < 0.001), indicating good discrimination between women with and without IDA. However, the pseudo-R^2 value (0.158) suggests that additional factors not included in the model may also contribute to IDA.

Chi-square test for association: $\chi^2 = 3.39$, df = 2, p = 0.184, indicating no statistically significant association between socio-economic status and IDA in this sample. Caution: the 'High' category has only 4 participants (expected cell count < 5), so this test may be unreliable for that group.

ROC Curve Analysis



Interpretation: - ROC curve of serum ferritin shows (ng / mL). Best Cut-off: ≤ 15ng / Ml, sensitivity: 91.0%, specificity: 91.0%. The ROC curve for RDW-CV shows the best cut-off at≥ 14.5%, with sensitivity 81.0% and specificity 86.0%. ROC curve of MCV (fl) shows the best cut-off of ≤ 82fl, sensitivity: 74.0%, specificity: 78.0%. ROC curve of MCH shows the best cut-off: ≤ 27 pg; sensitivity: 71.0%, specificity: 77%. The ROC curve for serum Iron shows the best cut-off value of ≤ 50 µg/dL, with sensitivity of 77% and specificity of 81%.

DISCUSSION
The above table shows that among the total study population comprising 100 cases &100 controls. The mean age of the anaemic group was significantly higher than that of the control group (22.87±5.98 vs. 21.20±2.20 years, p=0.010).

The table shows that thet the mean haemoglobin concentration is markedly lower among cases (8.14±1.74 g/dL) than among controls (12.49±0.60 g/dL), which is highly statistically significant (p<0.001). Similarly, the mean RDW-CV was significantly higher in the anaemic group (cases), at 15.86±2.68%, and significantly lower in controls (13.35±0.92%), indicating greater anisocytosis among women with iron deficiency anaemia (p<0.001).

Red cell indices show significant microcytic hypochromic changes in the anaemic group within our study population 18. The mean MCV (70.25±6.49 fL vs. 92.03±3.34 fL), MCH (25.42±3.98 pg vs. 28.17±1.32 pg), and MCHC (27.71±4.43 g/dL vs. 33.75±1.45 g/dL)

clearly show that all parameters are significantly lower among cases than in controls (all p<0.001). These findings are consistent with the haematological profile of iron deficiency anaemia.

Regarding socio-economic status, the majority of the study population belonged to the low socio-economic class. However, the distribution shows a significant difference between the two groups (p=0.046), suggesting that socio-economic status is associated with the incidence of anaemia during pregnancy. This study shows similar result to the studies by Paul S, Gupta AK, and James KS on "Maternal education, health care system and child health: Evidence from India."[19] Banerjee A, Sen S, Khan J, Pal M, Bharati P. on "Decadal change in the association between the status of young mothers' Body Mass Index and anaemia with child low birth weight in India."[20] Uzunov AV, Cîrstoiu MM, Secară DC, Crîngu-Ionescu A, Matei A, Mehedin u C, Varlas VN. on "Mode of Delivery and Neonatal Outcome in Adolescent Pregnancy (13-16 Years Old) Associated with Anemia."[21]

Parity is also significantly associated with anaemia (p<0.001). Primigravida constituted a higher proportion of the control group (69.0%). In contrast, women with parity ≥4 were considerably more frequent among anaemic cases (23.0% vs. 2.0% in controls), indicating that increasing parity is strongly associated with a higher risk of anaemia in pregnancy. This study shows similar result with studies done by Glenzer MM, Correia M, Nhantumbo V, Barnes RF, Luis E, Boaventura I, Manguele N, Silva P, von Drygalski A. on "Postpartum haemorrhage in Sub-Saharan Africa-a prospective study in metropolitan Mozambique."[22]

From our study, we have concluded that socio-economic status did not differ significantly from that of controls (IDA) among the study participants (χ^2=3.39, p=0.184). This result is consistent with the studies of Rohim et al. in Terengganu, Malaysia, in 2022, and Soh et al. in Selangor, Malaysia, in 2023[23].

Based on the ROC curves shown in our study, Receiver Operating Characteristic (ROC) curve analysis has been performed to evaluate the diagnostic importance of serum ferritin and red cell indices for identifying iron deficiency anaemia (IDA) in early pregnant women. The Area Under the Curve (AUC) is a measure of the overall discriminative ability of each parameter. An AUC >0.90 is considered excellent, 0.80–0.90 good, 0.70–0.80 acceptable, and <0.70 poor. In our study, serum ferritin has shown the highest diagnostic accuracy (AUC ≈0.93), confirming its role as the gold-standard biochemical marker of iron deficiency. This finding is consistent with previous studies by Guyatt et al., Van den Broek et al., and WHO recommendations, which recognise low serum ferritin as the most reliable indicator of depleted iron stores in non-inflammatory conditions.

RDW-CV showed great diagnostic performance (AUC ≈0.92) with high sensitivity and specificity for detecting iron deficiency anaemia in early pregnant women in our study, which is consistent with the study by Sultana GS, Haque SA, Sultana T, Rahman Q, Ahmed ANN. In Bangladesh in 2011[24].

MCV demonstrated good diagnostic accuracy (AUC ≈0.82). This result is consistent with the studies of He D, Liu Y, Ke J, Jiang X, Ma H, Shi Y, Yuan W.[25]

Although microcytosis is a classic feature of IDA, MCV tends to decrease later in the disease course, which explains its comparatively lower diagnostic performance compared with RDW and ferritin. This result is consistent with the studies by Ochuwa Adiketu Babah, Chisom Florence Chieme, Ajibola Ibraheem Abioye, Samuel Olusegun Spaine, Titilope Adenike Adeyemo, and Bosede Bukola Afolabi on red blood cell indices versus serum ferritin as surrogate markers of iron deficiency during pregnancy in Nigeria in 202526.

The findings have shown that serum ferritin remains the best diagnostic test, while RDW-CV is the most useful haematological screening parameter. Interpretation of serum ferritin showed the highest diagnostic accuracy (AUC ≈0.93), confirming it as the most reliable marker for diagnosing iron deficiency anemia. RDW-CV has shown diagnostic performance nearly comparable to serum ferritin, making it an excellent, inexpensive screening tool. Serum iron showed good diagnostic utility but was less accurate than serum ferritin. MCV and MCH had comparatively lower diagnostic accuracy because these indices usually become abnormal later. The ROC analysis suggests that RDW-CV may be used as the initial screening parameter, followed by serum ferritin for diagnostic confirmation, particularly in early pregnancy.

CONCLUSION

Our study revealed that iron deficiency anaemia in pregnancy is strongly associated with altered red cell indices, lower haemoglobin levels, socio-economic status, and higher parity, suggesting that these factors are important determinants of iron deficiency anaemia in early pregnancy.

Maternal age, increasing parity and abnormalities in routine red cell indices were significantly associated with iron deficiency anaemia during early pregnancy. Among the routine haematological parameters, RDW appears to be the most useful adjunctive marker for early identification of iron deficiency when serum ferritin estimation is not readily available. Incorporation of complete blood count indices into routine first-trimester antenatal screening may facilitate earlier diagnosis and treatment, thereby improving maternal and foetal outcomes.

The findings clearly show the importance of early antenatal screening, routine iron supplementation to pregnant mothers, early nutritional counselling of pregnant mothers, and targeted routine & regular monitoring of multiparous and grand multiparous pregnant women as a high-risk group to reduce the burden of iron deficiency anaemia and improve maternal and foetal outcomes & prevent postnatal complications.

Limitation

It is a single-centre, hospital-based case-control study, which may limit generalisability, and the sample size is modest (100 cases & 100 controls), which may have reduced the statistical power to detect smaller associations. Inflammatory markers such as C-reactive protein (CRP) have not been measured due to their unavailability in our hospital setting.

Future Prospect of the Study

Instead of relying solely on CBC parameters, digital pathology platforms can automatically analyse scanned peripheral blood smears to detect microcytosis, anisocytosis, and hypochromia. The image-derived features can be correlated with RDW-CV and serum ferritin from our study. Using the study variables of my research, any hospital can build a dashboard that stratifies pregnant women into low-, moderate-, and high-risk groups. Generates automated reminders for iron supplementation and follow-up. Displays trends in hemoglobin and red cell indices over time. Our logistic regression model can serve as the foundation for an explainable AI tool that shows which factors (e.g., parity, RDW-CV, MCV) contribute most tto the prediction of iron deficiency anemia, thereby increasing clinician confidence in AI-assisted decisions. This study would align with current trends in computational pathology, digital hematopathology & AI-assisted laboratory medicine.

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