

Role of Red Cell Distribution Width-Coefficient of Variation (RDW-CV) in Detection of Iron Deficiency Anaemia in Early Pregnancy: A Case-Control Study

Dr. Sukhendu Dhibar¹, Dr. Piyali Ghosh², Dr. Saumitra Biswas³

¹3rd PGT, Department of Pathology, Calcutta National Medical College (Corresponding Author)

²Assistant Professor, Department of Pathology, Calcutta National Medical College

³HOD, Department of Pathology, Calcutta National Medical College

Abstract: ***Background:** Iron deficiency anaemia (IDA) is a major health concern among pregnant women, especially in developing countries. Early detection is crucial to prevent adverse maternal and fetal outcomes. **Objective:** To evaluate the diagnostic utility of Red Cell Distribution Width-Coefficient of Variation (RDW-CV) in detecting IDA during early pregnancy (≤ 20 weeks) and compare it with serum ferritin and serum iron. **Methods:** A hospital-based case-control study was conducted at Calcutta National Medical College and Hospital (July 2023–December 2024) among 100 anaemic (Hb < 11 g/dL) and 100 non-anaemic (Hb ≥ 11 g/dL) pregnant women. RDW-CV, serum ferritin, and serum iron were analysed. **Results:** Low ferritin (< 30 ng/dL) and low iron (< 72 mcg/dL) were found in 90% and 77% of anaemic women, respectively. RDW-CV $> 14.5\%$ was seen in 71% of cases vs. 14% of controls ($p < 0.001$). RDW-CV showed 76.66% sensitivity, 80% specificity, and AUC=0.79 ($p=0.04$). **Conclusion:** RDW-CV is a simple, reliable, and cost-effective early screening tool for IDA in pregnancy.*

Keywords: Iron Deficiency Anaemia, RDW-CV, Serum Ferritin.

1. Introduction

Anemia is a global public health concern afflicting adolescent girls, pregnant women, women of reproductive age and also children in low to middle income countries. Reduction of anemia is one of the World Health Assembly Global Nutrition Targets for 2025 and of the Sustainable Development Goals. Even though there has been considerable success in lowering anemia, the world is not on track to meet the 2025 goal set by the World Health Assembly of a 50% reduction in anemia among women of reproductive age.¹

Anemia may be defined as a reduction in the concentration of Hemoglobin (Hb) which leads to reduced oxygen carriage and delivery that leads to symptoms such as shortness of breath, exertion, tiredness, headache, or angina if anemia is severe or rapid onset and in elderly^{2,3,4}

Globally 50% of anemia is attributable to iron deficiency and accounts approximately nearly a million death annually worldwide.⁵

Morphologically anemia can be categorized into three groups: Macrocytic hypochromic anemia, which has characteristically increased mean cell volume (MCV) of > 100 femtolitres (fl) and normal mean cell hemoglobin concentration (MCHC). Microcytic hypochromic anemia typically exhibits reduced MCV values < 80 fl as well as reduced MCHC of < 30 picogram (pg).

The etiological ways of categorization include hemolytic anemia, which results in enhanced cell destruction, anemia caused by trauma or injury related blood loss and anemia due to reduced red cell formation.⁶

Anemia is a regular problem during pregnancy and it affects 25% to 50% of the world population and 50% of pregnant women⁷

In more than 80% of population of different countries in the world, the prevalence of anemia in pregnancy is $> 20\%$.⁸ Iron deficiency anemia (IDA) is the most prevalent micronutrient deficiency in the world⁹

Anemia prevalence, etiology and its severity varies among various populations. The pervasiveness of iron deficiency anemia is 35% for women who are not pregnant and 51% for women with pregnancy worldwide¹⁰

According to World Health Organization (WHO), during pregnancy anemia is identified by hemoglobin levels less than 11.0gm/dl and may be divided into three levels of severity: Mild anemia where hemoglobin is 9 to 10.9gm/dl, Moderate anemia hemoglobin level is 7 to 8.9gm/dl and severe anemia where hemoglobin is less than 7gm/dl¹¹

Pregnant women have reportedly died from anemia during pregnancy as a result of cardiac failure, bleeding, infection, and preeclampsia. Intra uterine growth retardation, low birth weight, anemia, and a rise in morbidity and death are some of its effects on newborns.^{12,7,10}

Recent research reveals that even at level of iron storage that are not enough to produce maternal anemia, iron deficiency throughout the periconceptional phase and the first trimester may have a substantial and long-lasting impact on the brain development of the newborn.¹³

Volume 15 Issue 6, June 2026

Fully Refereed | Open Access | Double Blind Peer Reviewed Journal

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When iron stores are reduced as a result of a persistently negative iron balance, iron insufficiency ensues. This decreases iron store such as hemosiderin and ferritin, which has an impact on the body's normal iron turnover and compromise the iron supply to the transport protein apotransferrin.¹⁴

In order to prevent the mother and the fetus from complications caused by iron deficiency anemia early screening and diagnosing is required. The gold standard for assessing iron deficiency is bone marrow analysis, but it is an invasive procedure as a screening tool in the routine clinical practice.¹⁴

The foundation for determining the diagnosis of anemia is the complete blood count (CBC), which includes red blood cell characteristics analyzed with the use of an automated hematology analyzer. Red cell distribution width (RDW) is a new standard parameter in the CBC of the fully automated hematology analyzer.¹⁵ It is an early indicator of red blood cell alterations linked to iron deficient anaemia⁷. Red blood cell distribution width (RDW) represents erythrocyte size distribution, making it a valid indicator of anisocytosis and a key factor in the distinction between micro- and normocytic anemias.¹⁶ This measure is easily, reasonable and rapidly calculated as ratio of standard deviation (SD) of red blood cell (RBC) volume and mean corpuscular volume (MCV) [i.e., $(RDW-SD)/(MCV) \times 100$], with final result expressed as percentage.¹⁷ Hence the CBC can be utilized as a simple and rather cheap test to identify iron deficiency anemia through RDW.¹⁸

Complete blood counts are regularly recommended by doctors during prenatal visits since they are less expensive than serum iron profiles. Red cell distribution width (RDW) is a brand-new, standard parameter in a fully automated hematology analyzer that is used to calculate a complete blood count (CBC). RDW can provide insight into early RBC alterations that go hand in hand with iron deficient anemia. For the early detection and management of iron deficiency anemia, pregnant women can benefit from performing a CBC containing RDW.

"Anaemia is a condition characterized by a decrease in the number of red blood cells or the amount of haemoglobin in the blood, resulting in inadequate oxygen delivery to tissues."¹⁹

In 2019, the global prevalence of anaemia in pregnant women was 36% which was higher as compared to 31% in non-pregnant women.²⁰ Lower middle-income countries (LMICs) face the greatest burden of anaemia, affecting rural populations the most,²¹ South and Southeast Asian countries bear the greatest burden of anaemia, with an estimated prevalence of 52.5% among reproductive-age women²².

Iron deficiency is a nutritional cause of anemia characterized by a decrease in the number and size of red blood cells, leading to inadequate oxygen delivery to tissues and organs.

The function of the RBCs is to deliver oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. This is accomplished by using haemoglobin (Hb), a tetramer protein composed of haemoglobin. Anaemia impairs the body's ability for gas exchange by decreasing the number of RBCs transporting oxygen and carbon dioxide. Anaemia results from one or more of the following processes: defective red cell production, increased red cell destruction or blood loss. Iron is necessary for synthesis of haemoglobin.

Iron deficiency is thought to be the most common cause of anaemia globally, but other nutritional deficiencies (including folate, vitamin B12 and vitamin A), acute and chronic inflammation, parasitic infections, and inherited or acquired disorders that affect Hb synthesis, red blood cell production or red blood cell survival can all cause anaemia. Iron deficiency anaemia results in impaired cognitive and motor development in children and decreased work capacity in adults. The effects are most severe in infancy and early childhood. In pregnancy iron deficiency anaemia can lead to perinatal loss, prematurity and low birth weight (LBW) babies. Iron deficiency anaemia also adversely affects the body's immune response.

Pre- and Periconceptional Iron and the Argument for a Life-Cycle Effect of Nutrients

Ongoing research indicates that a woman's nutritional status heading into pregnancy influences the brain development of the offspring. Periconceptional iron and folate iron intake are both related to the subsequent risk of autism in the offspring with lower intakes associated with higher risks.^{23,24}

Iron plays a crucial role in various physiological processes, including oxygen transport, energy metabolism, and immune function. Its absorption, metabolism, and involvement in haemoglobin synthesis are essential for overall health.

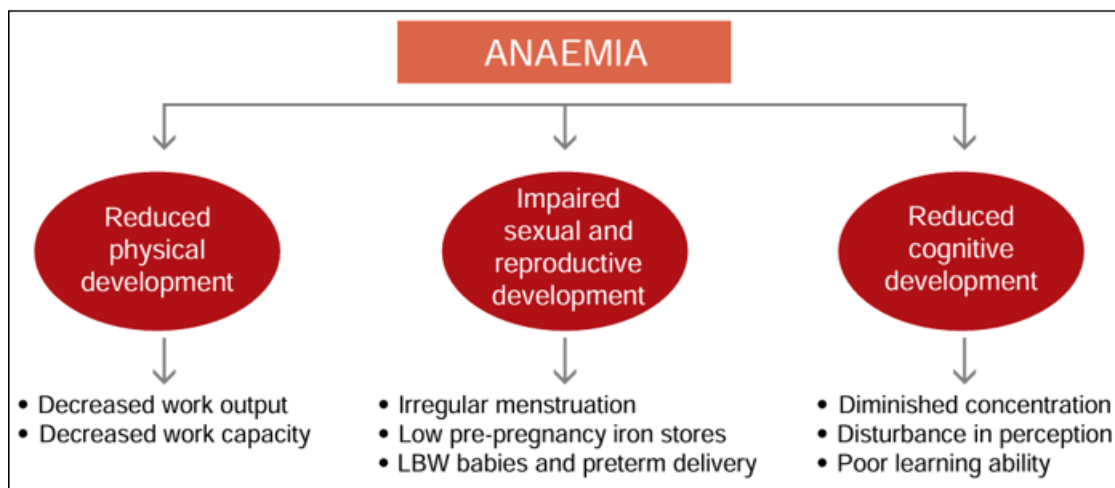


Figure 1.1: Adverse Effects of Anaemia

Causes

- 1) **Inadequate dietary iron intake:** Insufficient consumption of iron-rich foods²⁵.
- 2) **Increased iron requirements:** Pregnancy, lactation, growth spurts, and chronic diseases²⁶.
- 3) **Chronic blood loss:** Menstrual bleeding, gastrointestinal ulcers, cancer, and other conditions²⁷.
- 4) **Malabsorption:** Celiac disease, Crohn's disease, gastric bypass surgery, and other conditions²⁸.

- 5) Headaches
- 6) Cold hands and feet
- 7) Poor appetite
- 8) Restless leg syndrome³¹

Incidence And Prevalence

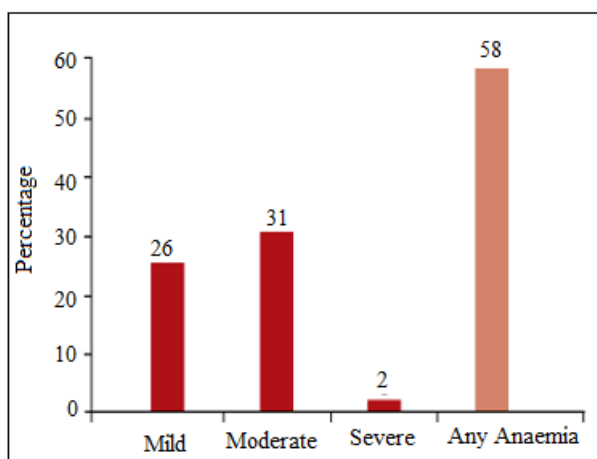
- 1) **Global prevalence:** 1.76 billion individuals (23.67% of the global population)²⁹.
- 2) **Women of childbearing age:** 30% of non pregnant women in this demographic are affected²⁹.
- 3) **Pregnant women:** 37% (32 million) of pregnant women are affected²⁹.
- 4) **Children under 5:** 269 million of children in this age group are affected²⁹.

Diagnostic Tools

- 1) **Complete Blood Count (CBC):** Evaluates haemoglobin, haematocrit, and red blood cell indices³².
- 2) **Serum iron and transferrin saturation:** Assesses iron stores and absorption³²
- 3) **Serum ferritin:** Evaluates iron storage³³
- 4) **Peripheral smear:** Examines red blood cell morphology³⁴

Prevention³⁵

- 1) **Maintain a balanced diet:** Consume iron-rich foods (meat, poultry, fish, beans, lentils, fortified cereals).
- 2) **Enhance iron absorption:** Vitamin C, citric acid, and beta-carotene can enhance iron absorption.
- 3) **Address underlying causes:** Manage chronic blood loss, malabsorption, and other underlying conditions.
- 4) **Iron supplementation:** Consider supplementation for individuals with increased iron requirements or inadequate dietary intake.
- 5) **Regular health check-ups:** Monitor iron stores and address potential deficiencies early.



Source: NFHS, 2005- 06

Figure 1.2: Prevalence of anaemia among pregnant women³⁰

Sign & Symptoms

- 1) Fatigue and weakness
- 2) Pale skin
- 3) Shortness of breath on exertion.
- 4) Dizziness and light-headedness

RDW (RED CELL DISTRIBUTION WIDTH)

RDW is a parameter that measures the variation in the size of red blood cells. It is calculated by dividing the standard deviation of the red blood cell size distribution by the mean red blood cell size.

RDW-CV (RED CELL DISTRIBUTION WIDTH-COEFFICIENT OF VARIATION)

RDW-CV is a more sensitive measure of red blood cell size variation than RDW.³⁶ It is calculated by dividing the standard deviation of the red blood cell size distribution by the mean red blood cell size and multiplying by 100. In Iron Deficiency Anaemia (IDA), RDW and RDW-CV are often elevated, indicating a wide range of red blood cell sizes. This is because IDA leads to a decrease in the production of haemoglobin, resulting in the formation of red blood cells of varying sizes.

Elevated RDW and RDW-CV in IDA indicates a high degree of anisocytosis (variation in red blood cell size) & suggests a poor prognosis and increased risk of complications, may be used to differentiate IDA from other types of anaemia

RDW-CV serves multiple diagnostic functions in IDA:

- **Early Detection:** RDW-CV can detect subtle changes in RBC size before other parameters, such as haemoglobin levels or mean corpuscular volume (MCV), become abnormal. This makes RDW-CV a valuable tool for early diagnosis of IDA.
- **Differential Diagnosis:** Elevated RDW-CV can help differentiate IDA from other types of anaemia, such as thalassemia or anaemia of chronic disease, which typically do not cause significant variation in RBC size.
- **Monitoring Treatment Response:** RDW-CV can be used to monitor the effectiveness of iron supplementation in IDA. A decrease in RDW-CV indicates that the treatment is correcting the iron deficiency and normalizing RBC production.

2. Clinical Applications

- **Diagnostic Protocol Integration:** RDW-CV has become an integral part of modern anaemia diagnosis, particularly in the context of IDA. Its integration into diagnostic protocols includes:
- **Initial Screening:** RDW-CV is included in the complete blood count (CBC) and serves as an early indicator of potential iron deficiency. Elevated RDW-CV levels can prompt further diagnostic testing, such as serum ferritin and iron studies.
- **Diagnostic Algorithm:** RDW-CV is used in conjunction with other parameters, such as MCV, mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC), to differentiate IDA from other types of anaemia. For example, a low MCV with an elevated RDW-CV is highly suggestive of IDA.
- **Monitoring Protocol:** RDW-CV is regularly measured during the treatment of IDA to assess the response to iron supplementation. A decreasing RDW-CV indicates that the treatment is effective in correcting the iron deficiency and normalizing RBC production.

RDW-CV provides valuable information during the treatment of IDA

Response Assessment: RDW-CV can serve as an early indicator of treatment effectiveness. A decrease in RDW-CV levels following iron supplementation suggests that the treatment is correcting the iron deficiency and improving RBC production.

Progress Monitoring: Regular measurement of RDW-CV during treatment allows clinicians to track the progression of IDA and adjust treatment strategies as needed. For example, if RDW-CV levels remain elevated despite iron supplementation, additional diagnostic tests may be required to identify underlying causes of iron deficiency.

Recovery Confirmation: Normalization of RDW-CV levels indicates successful treatment of IDA and the restoration of normal RBC production. Long-term monitoring of RDW-CV

can help detect recurrent iron deficiency and guide prevention of IDA.

Serum iron, transferrin, transferrin saturation in most cases, assay of serum iron and transferrin levels (usually represented by the total iron binding capacity) does not provide any additional benefit to the investigation of iron deficiency, even in pregnancy, since the serum iron levels are subject to many influences such as diurnal, intra-individual and inter-individual variations. Conclusions for iron need are possible only in combination with transferrin levels by determining the percentage of transferrin saturation. If the ferritin levels are within the normal range, but the transferrin saturation is less than 15%, this is indicative of latent iron deficiency since iron is being released in higher quantities from circulating transferrin to maintain erythropoiesis. However, it needs to be remembered that fluctuations in serum iron levels also affect calculation of transferrin saturation and thus may lead to incorrect interpretations. Therefore, it is recommended that the sample be drawn after an overnight fast as dietary iron may influence the percent transferrin saturation.

3. Materials and Methods

Study Design and Setting

This observational case-control study was conducted at the Department of Pathology in collaboration with the Department of Obstetrics and Gynaecology and Department of Biochemistry at Calcutta National Medical College and Hospital, Kolkata, from July 2023 to December 2024.

Study Population and Sample Size

The study included women of reproductive age (18-45 years) attending the antenatal clinic during early pregnancy (≤ 20 weeks gestational age). Sample size was calculated using Cochran's formula with an expected prevalence of 64% from NFHS-5 (2019-2021) data, resulting in approximately 100 subjects per group after accounting for a 10% non-response rate.

Selection Criteria

Cases (n=100): Pregnant women with haemoglobin < 11.0 g/dL in early pregnancy (≤ 20 weeks), willing to participate and provide informed consent.

Controls (n=100): Pregnant women with haemoglobin ≥ 11.0 g/dL in early pregnancy, matched for gestational age.

Exclusion Criteria: Women with known haematological disorders (thalassemia, chronic kidney disease), significant recent blood loss or transfusion, active infections, or those already on iron supplementation.

Laboratory Investigations

Blood samples (4 mL) were collected in EDTA vials under aseptic conditions. The following parameters were analysed:

- 1) **Complete Blood Count:** Performed using SYSMEX XN-550 automated haematology analyser, measuring haemoglobin, red blood cell count, RDW-CV, MCV, MCH, and MCHC.
- 2) **Serum Ferritin and Serum Iron:** Measured using Virto's 5600 Clinical Chemistry Autoanalyzer. Cut-off

values: serum ferritin <30 ng/dL and serum iron <72 mcg/dL indicated deficiency.

3) **Peripheral Blood Smear:** Examined using Leishman stain for red cell morphology assessment.

Statistical Analysis

Data were analysed using SPSS version 20.0 and Microsoft Excel. Descriptive statistics, Chi-square test, Student's t-test, and Pearson correlation coefficient were used. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated. ROC curve analysis was performed to assess diagnostic performance. Statistical significance was set at p<0.05.

Ethical Considerations

The study received approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants, ensuring confidentiality and privacy throughout the study.

4. Results and Observations

The present study entitled “Role of RDW CV in detection of iron deficiency anaemia in early pregnant woman” has been conducted at the department of pathology, Calcutta National Medical College with the assistance of Department of Gynaecology and Obstetrics and Department of Bio-Chemistry at Calcutta National College & Hospital during the period from 01/07/2023 to 31/12/2024.

During this 18-month study period, a total of 100 numbers of pregnant woman <20 weeks of pregnancy having haemoglobin percentage of <11gm% were taken as cases as they had fulfilled the inclusion criteria.

Blood samples were taken in Automated analyser. The details of each patient were studied and all the raw data collected were further organised into tabulated forms categorised and expressed in percentage and other statistical formats accordingly.

Table 5.1: Distribution of IDA cases among pregnant mothers according to age group

Age Group	Percentage of Pregnant Mothers (<=20 weeks)
18 to 25 years	75%
26 to 35 years	14%
36 years and above	11%

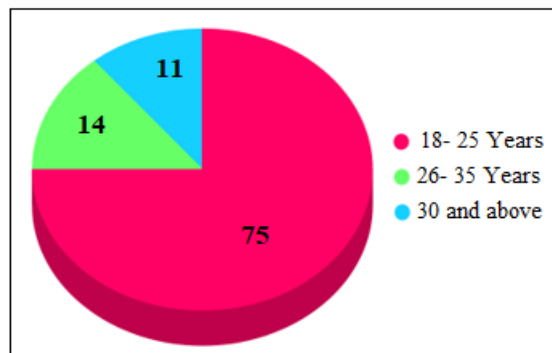


Figure 5.1: Distribution of IDA cases among pregnant mothers according to age group

Interpretation: The above table shows among 100 cases, 75 belong to age group of 18 to 25 age group, 14 cases belong to 26 to 35 age group and 11 cases belong to above 36 years age group.

Table 5.2: Distribution of IDA cases among pregnant mothers according to parity

PARA	Percentage of Pregnant Mothers (<=20 weeks)
Para 0 – 2	74%
Para 3 – 4	3%
Para 4 and above	23%

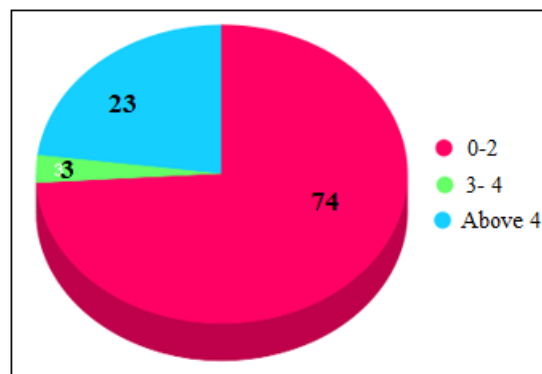


Figure 5.2: Distribution of IDA cases among pregnant mothers according to parity

Interpretation: The above table shows among 100 cases, 74 cases belong to Para 0 - 2, 3 cases belong to Para 3 – 4 and 23 cases belong to above Para 4.

Table 5.3: Socio-economic status of Pregnant mothers

Socio Economic Status	Percentage of pregnant mothers
High	2%
Middle	27%
Low	71%

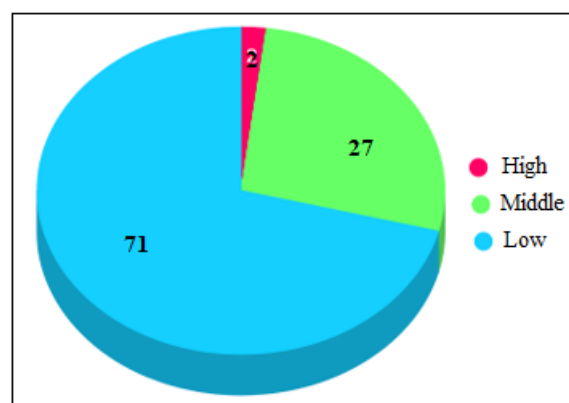


Figure 5.3: Socio-economic status of Pregnant mothers

Interpretation: The above table shows among 100 cases, 2 cases belong to high socio- economic status, 27 cases belong to middle socio-economic status and 71 cases belong to low socio economical status.

Table 5.4: Distribution of Anaemia according to severity

Severity of Anaemia	Percentage of Anaemic Pregnant Mothers
Mild (10 – 10.9 gm/dl)	24%
Moderate (7 – 9.9 gm/dl)	30%
Severe (Below 7)	46%

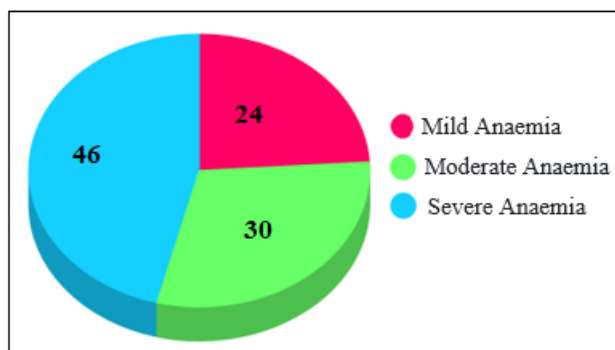


Figure 5.4: Distribution of Anaemia according to severity

Interpretation: The above table shows among 100 cases, 24 cases are having mild anaemia (Hb 10 – 10.9 g/dl), 30 cases are having moderate anaemia (Hb 7 – 9.9 g/dl) and 46 cases are having severe anaemia i.e., (< 7 g/dl).

Table 5.5: Serum ferritin levels among cases (n=100)

Serum ferritin	Cases
Low (<30 ng/dl)	90
Normal	10
Total	100

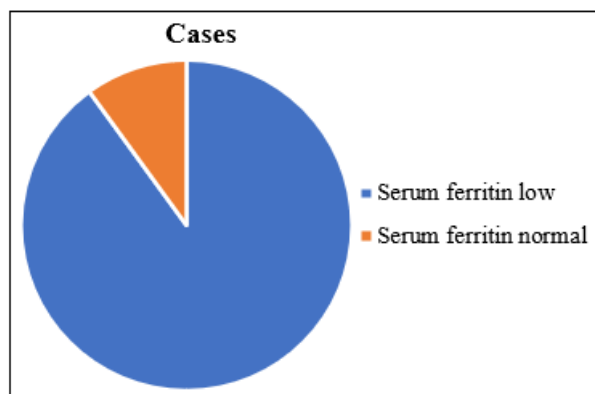


Figure 5.5: Pie chart showing distribution of all cases according to serum ferritin level

Interpretation: Table 5 shows 90 cases out of 100 cases had low serum ferritin level and the same has been depicted in the above pie chart (figure 1), Here I kept normal ferritin level in blood of pregnant women cut-off level is 300 ng /dl

Table 5.6: Serum iron levels among cases (n=100)

Serum iron	Cases (n=100)
Low (<72 mcg/dl)	77
Normal	23
Total	100

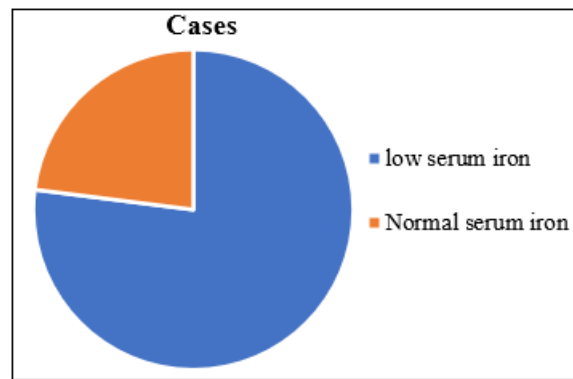


Figure 5.6: Pie chart showing distribution of all cases according to serum iron level

Interpretation: Table 6 shows 77 cases out of 100 cases had low serum iron level and the same has been depicted in the above pie chart (figure 2), Here we kept normal blood serum level of iron the cut -off level is above 72 mcg/dl

Table 5.7: Showing RDW CV wise distribution of cases

RDW CV	Number (n)	Percentage (%)
<11	3	3.0
11-14.5	26	26.0
>14.5	71	71.0
Total	100	100.00

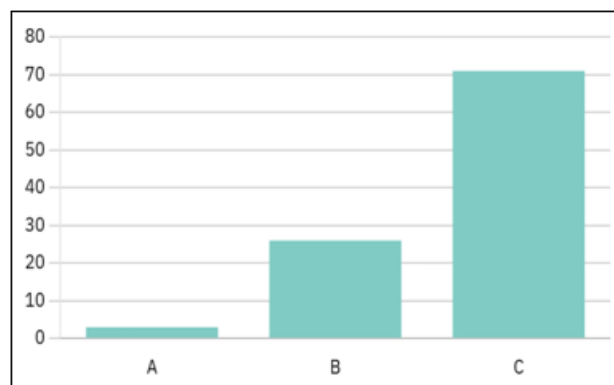


Figure 5.7: Showing distribution of RDW CV among cases

Interpretation: 71% of cases showing increased RDW CV among cases and 29% (3+26) cases showing has normal RDW CV (>14.5%).

Table 5.8: Showing MCV wise distribution of cases

MCV	Number (n)	Percentage (%)
<80	85	85.0
80-100	15	15.0
>100	0	0.0
Total	100	100.00
Mean ± S.D	85 ± 15	

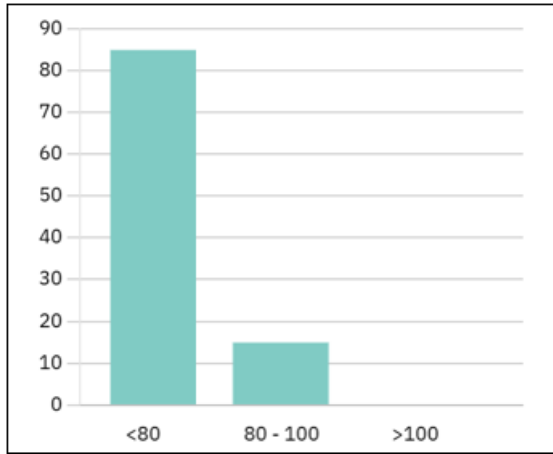


Figure 5.8: Showing distribution of MCV among 100 cases.

Interpretation: The above table shows MCV wise distribution of cases. Out of 100 cases, 85 cases show MCV level of <80 fl, (Low) while 15 cases show MCV between 80 – 100 fl (Normal).

Table 5.9: Showing MCH wise distribution of cases

MCH	Number (n)	Percentage (%)
<27	69	69.0
27-32	31	31.0
>32	0	0.0
Total	100	100.00
Mean ± S.D	85 ± 15	

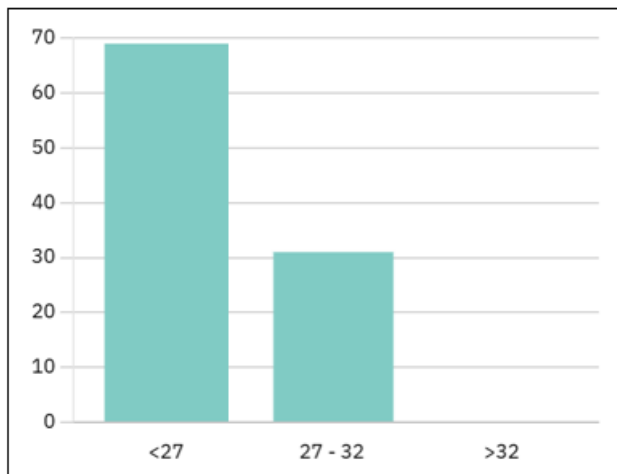


Figure 5.9: Showing distribution of MCH among 100 cases.

Interpretation: The above table shows MCH wise distribution of cases. Out of 100 cases, 69 cases show MCH level of <27 pg while 31 cases show MCV between 27 – 32.

Table 5.10: Showing MCHC wise distribution of cases

MCHC	Number (n)	Percentage (%)
<32	60	60
32 - 35	40	40
>35	0	0
Total	100	100.00
Mean ± S.D	0 ± 0	

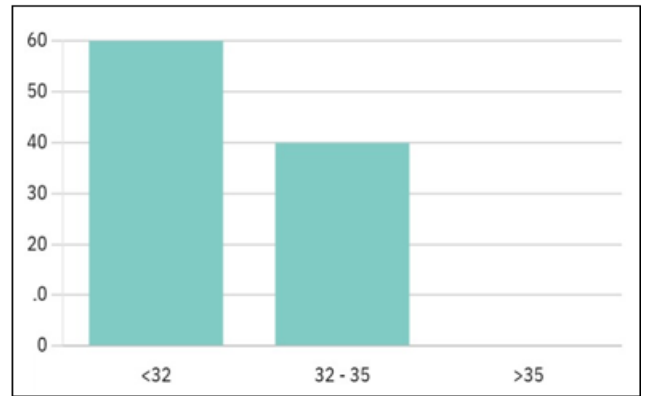


Figure 5.10: Showing distribution of MCHC among 100 cases.

Interpretation: The above table shows MCHC wise distribution of cases. Out of 100 cases, 60 cases show MCHC level of <30 pg while 40 cases show MCV between 30 – 35 pg.

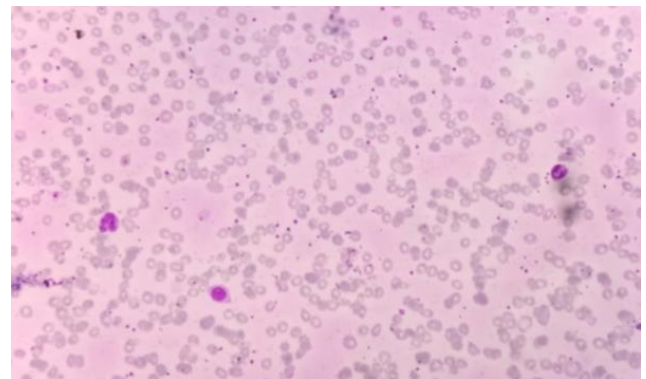


Figure 5.11

"All the pbs was stained with Leishman stain and RBC morphology was noted. The findings were correlated with the Red cell indices report.

Table 5.11: Comparison of PBS with RDW-CV

Anisocytosis	RDW-CV >14.5%	RDW-CV <14.5%	p value
Nil	32 (45.07%)	25 (86.2%)	0.001
Mild	28 (39.43%)	3 (10.34)	
Moderate	11 (15.49%)	1 (3.44%)	
Chromacity of RBC			
Normochromic	22 (30.98%)	26 (89.65%)	0.001
Hypochromic	49 (69.01%)	3 (10.34%)	

Interpretation: The above table shows that among the participants with RDC-CV>14.5 had significantly higher proportion of anisocytosis, hypochromic findings in PBS.

Table 5.12: Distribution of cases and controls according to RDW-CV values

RDW CV	Cases (n=100)	Controls (n=100)
High (>14.5 %)	71	14
Normal	29	86
Total	100	100

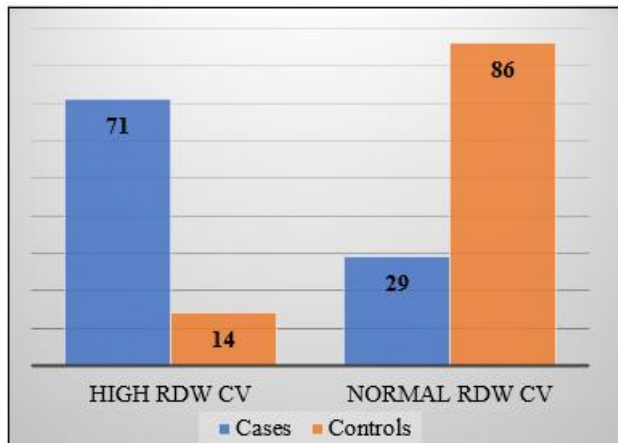


Figure 5.12: Bar diagram showing distribution of cases and controls according to RDW-CV values

Interpretation:

Table 7 and figure 7 show higher RDW-CV values in control anaemic group patient than non-anaemic control group patients. The chi-square statistic is 97.19. The p-value is <.001. The result is significant at $p < .05$. The above table shows 71 cases show higher RDW-CV & 29 cases show normal RDW-CV whereas 14 controls show higher RDW-CV levels & 86 controls showed normal RDW-CV level. Here we kept the cut-off range of RDW-CV is 14.5

Table 5.13: Comparison between Serum ferritin values along with Serum Iron and RDW-CV values of all cases

Serum ferritin	Serum iron		RDW-CV	
	Low	Normal	High	Normal
Low (90)	73	17	69	21
Normal (10)	04	06	02	08
Total	77	23	71	29

Interpretation: The above table 5.13 shows the comparison between low serum ferritin & normal serum ferritin cases according to their serum iron & RDW-CV. Here we show out of 90 low serum ferritin, 73 cases showed low serum iron, 17 cases showed normal serum iron. Out of 10 low serum ferritin cases 4 cases showed normal serum iron & 6 cases showed low serum iron. Among 90 low serum ferritin cases 69 showed high RDW -CV & 21 showed normal RDW-CV. Among 10 low serum iron cases 2 cases showed high RDW-CV & 8 cases showed normal RDW-CV.

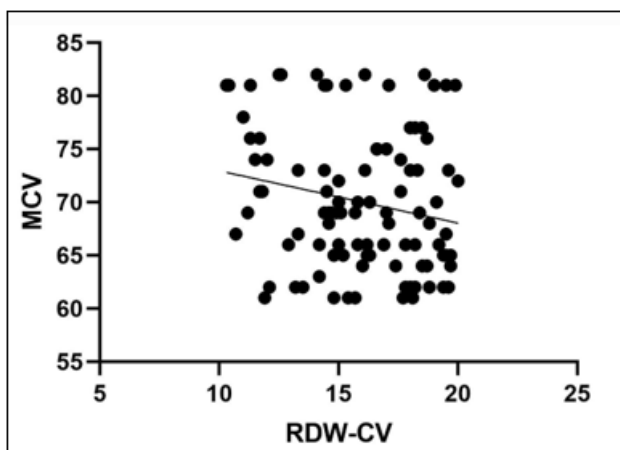


Figure 5.13: Correlation of MCV with RDW CV

Interpretation:

"RDW-CV vs. MCV"

Pearson r

R value = - 0.2026

95% confidence interval, - 0.3838 to - 0.006453

R squared, 0.04105

P value

P (two-tailed) 0.0432

P value summary

Significant (alpha = 0.05)

Number of XY Pairs 100

This study shows RDW CV is negatively correlated with MCV and the correlation is significant.

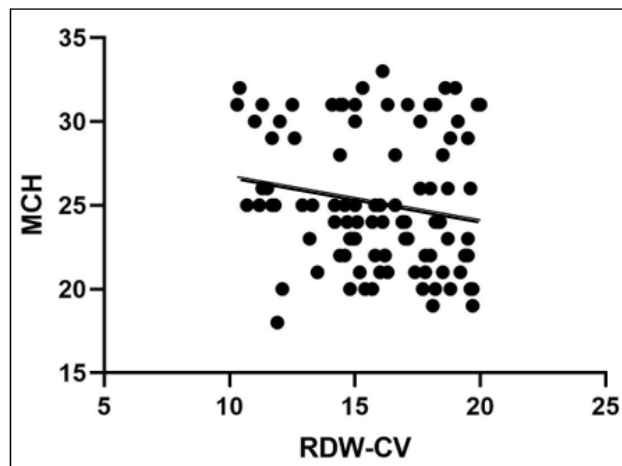


Figure 5.14: Correlation of MCH with RDW CV

Interpretation:

"RDW-CV vs. MCH"

Pearson r

r = - 0.1775

95% confidence interval - 0.3613 to 0.01962

r squared = 0.03150

P value

P (two-tailed) 0.0773

P value summary -

Non Significant (alpha = 0.05)

Number of XY Pairs 100

This study reveals that there is no significant correlation between RDW CV and MCH

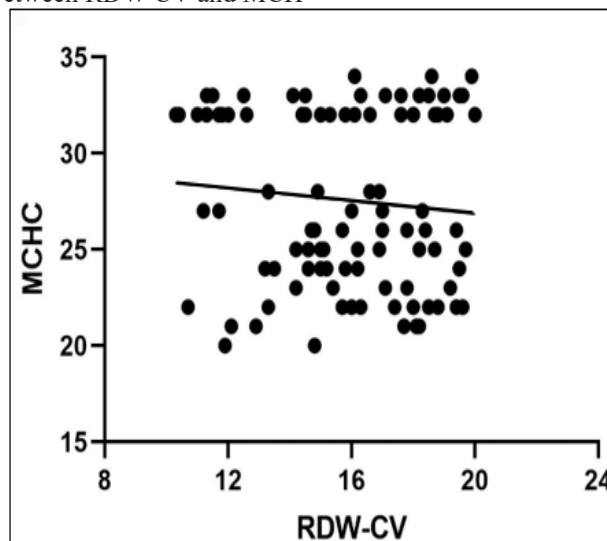


Figure 5.15: Correlation of MCHC with RDW CV

Interpretation:

"RDW-CV vs. MCHC"

Pearson r

r = - 0.09873

95% confidence interval, - 0.2895 to 0.09962

r squared = 0.009747

P value

P (two-tailed) 0.3284

P value summary

Non Significant (alpha = 0.05)

Number of XY Pairs 100

This study reveals that there is no significant correlation between RDW CV and MCHC

Table 5.14: Comparison of Pearson correlation coefficient and p value of MCV, MCH & MCHC

Values	Pearson correlation coefficient	p value
MCV	- 0.2026	0.0432
MCH	- 0.1775	0.0773
MCHC	- 0.09873	0.009747

Interpretation: The above table shows, Pearson correlation co-efficient for MCV, MCH and MCHC are - 0.2026, - 0.1775, - 0.09873, and p value of MCV, MCH and MCHC with respect to RDW CV is 0.0432, 0.0773 and 0.009747.

Table 5.15: Diagnostic utility of Serum iron and RDW-CV in Iron deficiency anaemia

Parameters	Serum iron level	RDW-CV
Sensitivity	81.11%	76.66%
Specificity	60%	80%
Positive predictive value	81.11%	97.18%
Negative predictive value	40%	27.58%
Accuracy	79%	77%

Interpretation: The above table shows serum iron level has slightly better sensitivity and accuracy than RDW-CV but RDW-CV showed much more specificity than serum iron and also much higher PPV & lower NPV than serum iron signifies that a better performance of RDW-CV as a diagnostic tool than serum iron.

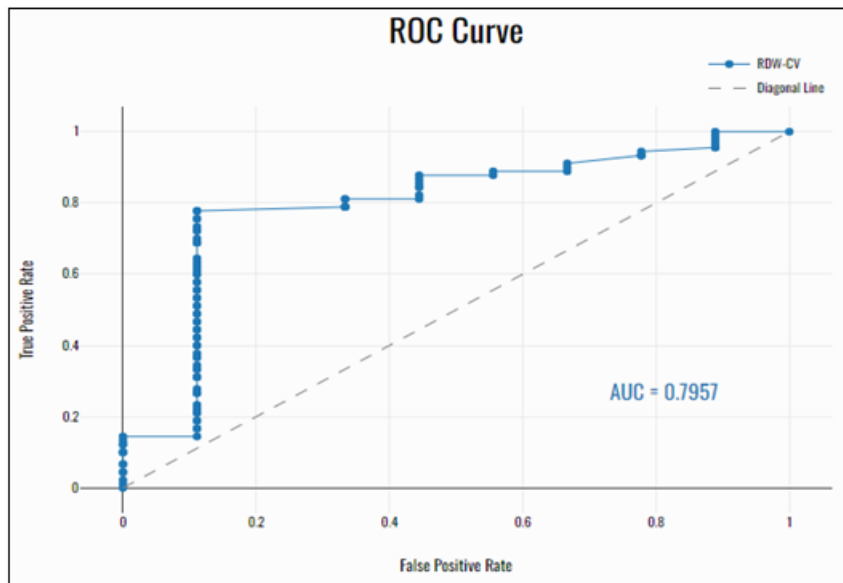


Figure 5.16: ROC curves of RDW-CV

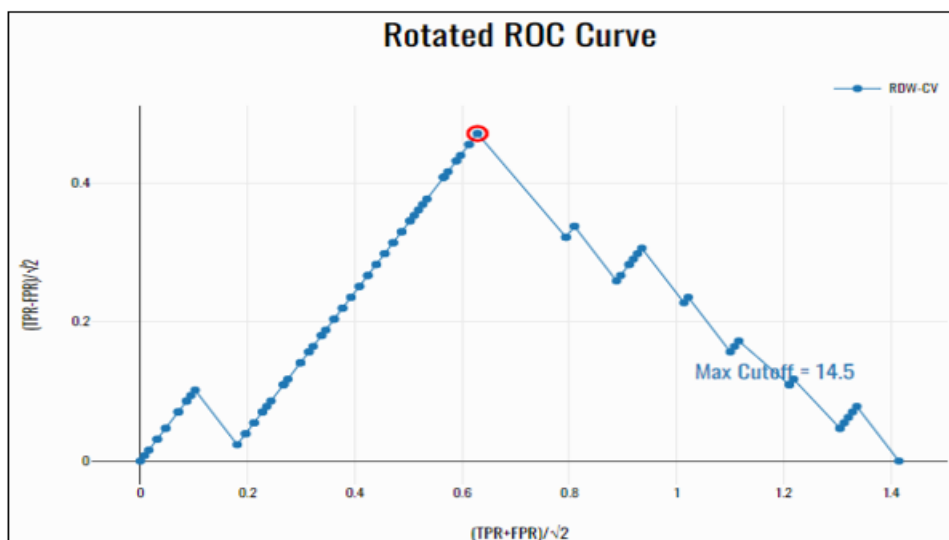


Figure 5.17: Rotated ROC Curve

Interpretation: The ROC curve analysis of RDW-CV showed area under the curve of 0.79 and p value of .04 which was statistically significant.

5. Discussion

All the cases have been selected from the OPD of ANC at the department of gynaecology & OBS between the time period 01/06/23 to 31/12/24. In the stipulated time period total 14379 pregnant women attended for 1st ANC and 4367 of them were within first 20 weeks of gestational age (30.37%). The other pregnant cases were above 20 weeks of gestational age. Among these pregnant women 43 of them had thalassemia and 39 of them had chronic infection & for this they had been excluded from the study as per exclusion criteria. Now the rest 4285 pregnant women had been screened for taking IRON & FOLIC ACID prophylaxis and 3909 (91.22%) of them had been excluded from the study as because iron and folic acid are confounding factors for the study. Now the rest 376 pregnant women had been screened for Hb% and 127(33.77%) of them had Hb% more than 11 gm% & rest 249(66.22%) had Hb% less than 11gm%. Now by feasibility method of non-randomised sampling, 100 cases & 100 controls had been selected from these pregnant women.

Now, all the cases had undergone Serum Ferritin, Serum Iron, RDW CV and CBC (complete blood count) tests. Now the test report had been tabulated as shown in the result and compared accordingly.

Table 1 had shown that among 100 cases, 75 belong to age group of 18 to 25 age group (75%), 14 cases belong to 26 to 35 age group (14%) and 11 cases belong to above 36 years age group (11%).

The above data shows that, 75% cases are of age group 18 – 25 years, 14% cases are belonging to age group of 26 to 35 years and 11% cases are belonging to age group of 36 and above years. That is most of the iron deficiency cases are belonging 18 – 25 years age group. This data is similar to study done by **Jasmin Jasani, Jay Trivedi, Salonee Rajdev & Harsh Pandya**,³⁷ which was done at Central Gujarat in 2019.

Haniff J et al³⁸ in their 2006 study in a total number of 1072 pregnant women found that majority belong to 20 to 30 yrs.

Ahmad N et al³⁹ in their study found that maximum of the iron deficiency pregnant women belongs to the age group of 20 to 24 yrs in a total case of 310 pregnant women.

Gandhi S et al⁴⁰ found in their study that majority of the study populations belongs to the age group of 21 to 25 years with a mean age of 23yrs.

Sultana GS et al⁴¹, in their study in 2019 also stated that mean age was 27+ 5.4 (+SD) in iron deficient and 27+4.0 (+SD) in non-iron deficient pregnant women.

Maji I, Randhawa JK, Bakshi D, Gautam D, Mishra SS⁴² in their study found that the prevalence of anaemia and different grades of anaemia in women of reproductive age (aged 15-49) in NFHS-5. Severe anaemia is found in Assam,

Goa, Gujarat, Kerala, Mizoram, Tripura, West Bengal and Jammu and Kashmir. Moderate anaemia is seen in Maharashtra, Rajasthan, M.P., Telangana, Delhi, Haryana, Punjab, and Tamil Nadu and mild anaemia is found in Kerala, Mizoram, Manipur, Chandigarh and Sikkim. This finding is similar to our study shown in **table 1, table 2, table 3**.

The table 2 shows that among 100 cases, 74 cases are belonging to Para 0 – 2, 3 cases are belonging to Para 3 – 4, and 23 cases are belonging to Para 4 and above, i.e., multiparity having higher risk of iron deficiency anaemia. This data co-relates with the study by Kumar A, et al. (2013) in his study found that Multigravidas (women with 2 or more previous pregnancies) had a higher risk of IDA compared to primigravida (women with their first pregnancy).⁴³

Kimitoshi Imai⁴⁴ et al in his study found that Anemia and low serum ferritin levels occurred more commonly in multiparous than in nulliparas. Further, low SF was a risk factor for anemia development in later pregnancy. This study is similar to our study where we have got that 23% of the IDA pregnant women belong to Para 4 and above shown in Table 2.

In our study, from **Table 3**, we got that 71% of the ida cases belong to low socio-economic condition, 27% belong to middle and rest 2% belong to high socio-economic condition, i.e., This study reveals that low socio-economic condition is closely associated with Iron Deficiency Anemia. **Yan Zhang, Lingli Zhang, Yanping Wang, and Fang Liu et al, 2018.**⁴⁵ in their study found the following risk factors multigravidity, low educational level, and low socioeconomic status are risk factors for IDA in pregnant women.

In another study done by **Lieu X, Chen Y, Li Y, et al 2018,**⁴⁶ found in their study that IDA is a significant public health concern and the study highlights that Multigravidity, low educational level, low socioeconomic status, and lack of iron supplementation were independent risk factors for IDA.

Now the 100 pregnant women who had Hb% less than 11gm% i.e. cases had been undergone for serum ferritin and serum iron estimation and it had been found that 77 of the cases showed low serum iron & 73 of these cases show low serum ferritin & rest 4 cases show normal serum ferritin.

The study concluded that serum ferritin is a better marker for iron deficiency anaemia (IDA) in pregnant women compared to serum iron, due to its higher sensitivity and specificity. This data so similarity with the study conducted by **Gomber S, Kumar S, Rusia U, et al.**⁴⁷.

In their study of Gomber, S., et al. (2018) found that- Serum ferritin had a sensitivity of 92.5% and specificity of 95.5% for diagnosing IDA. Serum iron had a sensitivity of 75.5% and specificity of 80.5% for diagnosing IDA. Serum ferritin was significantly correlated with haemoglobin levels ($r = 0.65$, $p < 0.001$). Serum iron was not significantly correlated with haemoglobin levels ($r = 0.23$, $p = 0.06$).

In our study 100 cases had been examined for RDW-CV & shows that 71 cases had high RDW-CV & 21 cases showed normal RDW-CV & 69 of this showed low serum ferritin. By

using CHI SQUARE TEST it was found that there is strong association among low serum ferritin & high RDW-CV.

Jahnavi Daru, et al 2017⁴⁸ in their study found that serum ferritin is the gold standard for detection of body iron and standard marker for iron deficiency anemia.

The sensitivity and specificity of RDW-CV in my study was 76.66 % and 80% respectively. Several similar studies showed mixed results, as many of them had higher sensitivity & specificity but few also showed lower sensitivity and specificity. In their study, **Esam G Abdelrahman et al**,⁴⁹ investigated the diagnostic value of RDW-CV in iron deficiency anemia (IDA). The study included 100 patients with IDA and 50 healthy controls.

The results showed that RDW-CV was significantly higher in patients with IDA compared to healthy controls. The study concluded that RDW-CV can be used as a diagnostic marker for IDA, especially in cases where other diagnostic tests are not available or are inconclusive.

A study done by **GS Sultana et al, 2018**⁵⁰ showed that in mild and moderate iron deficiency anaemia, RDW was increased progressively though Hb level was reduced. In this study RDW had sensitivity of 82.3% and specificity 97.4%.

But in our study, it had been found that the sensitivity and specificity of RDW CV was 76.66% and 80% respectively. It was also found that the positive predictive value and negative predictive value were 97.18% and 27.58%. Accuracy was found to be 77%.

Calculating the above data, the ROC curve analysis of RDW-CV showed area under the curve of 0.79 and p value of 0.04 which was statistically significant which is similar to the study of **Kai, Yang, et al.**⁵¹

Our Study finding is similar to the study by **Widyastuti W, et al.**⁵² in 2024 in Indonesia and was published in Indonesian Journal of Clinical Pathology and Medical Laboratory. This study aimed to evaluate the effectiveness of RDW-CV and MCV in detecting iron deficiency anemia (IDA). The results showed that RDW-CV and MCV can be used as screening instruments for IDA. Their cross-sectional study involved 100 patients with IDA and 100 healthy controls. Blood samples were collected and analyzed for RDW-CV, MCV, hemoglobin (Hb), and serum ferritin levels.

In their study, they found that RDW-CV was significantly higher in the IDA group compared to the control group ($p < 0.001$), MCV was significantly lower in the IDA group compared to the control group ($p < 0.001$), RDW-CV showed a significant correlation with serum ferritin levels ($r = -0.432$, $p < 0.001$), MCV showed a significant correlation with Hb levels ($r = 0.341$, $p < 0.001$). i.e., RDW-CV and MCV can be used as screening instruments for IDA. The combination of RDW-CV and MCV may improve the diagnostic accuracy of IDA. This result is similar to result of our study.

6. Future Directions

Future research should focus on longitudinal studies following pregnant women throughout gestation to evaluate how RDW-CV changes with iron supplementation and pregnancy progression. Multi-center studies with larger sample sizes across diverse populations would strengthen the evidence base. Development of predictive models combining RDW-CV with other readily available parameters (MCV, MCH, hemoglobin) could further improve diagnostic accuracy. Additionally, cost-effectiveness analyses comparing RDW-CV-based screening strategies with conventional approaches would inform policy decisions.

7. Conclusion

This study demonstrates that RDW-CV is a reliable, sensitive, and cost-effective parameter for early detection of iron deficiency anemia in pregnant women during the first 20 weeks of gestation. With a sensitivity of 76.66%, specificity of 80%, and an impressive positive predictive value of 97.18%, RDW-CV performs comparably to serum iron while offering significant advantages in terms of cost, accessibility, and rapid availability.

The significant negative correlation between RDW-CV and MCV, combined with strong association with low serum ferritin levels, validates RDW-CV as a useful indicator of iron deficiency. Its routine availability as part of complete blood count analysis makes it particularly valuable for resource-limited settings where specialized iron studies may not be feasible.

We recommend incorporating RDW-CV evaluation into routine antenatal screening protocols, particularly in populations at high risk for iron deficiency anemia. While RDW-CV should not replace serum ferritin for definitive diagnosis, it serves as an excellent screening tool that can trigger further investigation and early intervention, potentially preventing the adverse maternal and fetal outcomes associated with iron deficiency anemia.

Early detection and management of iron deficiency anemia remain critical for improving maternal and child health outcomes. RDW-CV represents a practical, accessible tool that can contribute significantly to this goal, particularly in developing countries where the burden of anemia is highest.

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