

Diagnostic Accuracy of Red Cell Distribution Width in Iron Deficiency Anemia, Taking Serum Ferritin as Gold Standard among Pregnant Pakistani Women

RBCs
Distribution
Width in Iron
Deficiency
Anemia

Tayyeba Rehman, Nosheen Maqsood, Saba Iqbal, Rabia Afzal, Sehar Fatima and
Kashifa Bibi

ABSTRACT

Objective: To find the diagnostic accuracy of red cell distribution width in iron deficiency anemia, taking serum ferritin as gold standard among pregnant Pakistani women.

Study Design: A descriptive cross-sectional study

Place and Duration of Study: This study was conducted at the Department of Obstetrics & Gynaecology, Allied Hospital, Faisalabad from April to October 2021.

Methods: A descriptive cross-sectional validation study was carried out at Department of Obstetrics & Gynaecology, Allied Hospital, Faisalabad to determine the diagnostic accuracy of RDW in IDA, taking serum ferritin as gold standard.

Results: In 115 RDW positive patients, 100 (True Positive) had iron deficiency anemia and 12 (False Positive) had no iron deficiency anemia on serum ferritin levels. Among, 88 RDW negative patients, 15 (False Negative) had iron deficiency anemia on serum ferritin levels whereas 73 (True Negative) had no iron deficiency anemia on serum ferritin levels. Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of red cell distribution width in iron deficiency anemia, taking serum ferritin as gold standard was 86.96%, 85.88%, 89.29% 82.95% and 86.50% respectively.

Conclusion: This study concluded that diagnostic accuracy of RDW in diagnosing IDA in pregnant women is very low.

Key Words: Pregnant, Women, RDW, IDA, Accuracy

Citation of article: Rehman T, Maqsood N, Iqbal S, Afzal R, Fatima S, Bibi K. Diagnostic Accuracy of Red Cell Distribution Width in Iron Deficiency Anemia, Taking Serum Ferritin as Gold Standard among Pregnant Pakistani Women. Med Forum 2024;35(2):3-6. doi:10.60110/medforum.350201.

INTRODUCTION

Red cell distribution width (RDW) is a hematological parameter that reflects the variability in the size of circulating red blood cells. While traditionally used as a marker for various hematological disorders, recent studies have suggested its potential role in the diagnosis of IDA. The diagnostic accuracy of RDW, particularly in comparison to the widely accepted serum ferritin levels, which serve as the gold standard for assessing iron stores, is an area of growing interest in the context of pregnant Pakistani women^[1].

Pregnant women in Pakistan face unique challenges, including nutritional deficiencies and limited access to healthcare, making the accurate diagnosis of IDA crucial for appropriate intervention. Establishing RDW as a reliable diagnostic marker for IDA, with serum ferritin as the gold standard, holds promise for enhancing the efficiency of screening programs and improving the overall maternal and fetal health outcomes in this population. One of the most frequent illnesses affecting pregnancy is anemia^[2]. The incidence and causes of anemia during pregnancy vary depending on the geographic region. In underdeveloped nations, anemia is a serious health issue that particularly affects women and is linked to high rates of mortality and morbidity in mothers, as well as low birth weight in babies^[3]. In Africa, anemia accounts for 20% of maternal deaths (Abioye et al., 2016). Anemia has a higher prevalence in developing countries, ranging from 35-75%, than in developed nations, where it accounts for only 19%^[4]. However, there is a need for local data to aid in the development of preventive programs because anemia prevalence varies greatly within and between nations. Anemia is one of the most prevalent nutritional deficiencies globally. According to

Department of Obs & Gynae, Allied Hospital Faisalabad.

Correspondence: Dr. Tayyeba Rehman, Senior Registrar, Obs & Gynae Allied Hospital Faisalabad.

Contact No: 03005373230

Email: dr.Tayyeba8676@yahoo.com

Received: October, 2023

Accepted: December, 2023

Printed: February, 2024

the World Health Organization (WHO), iron deficiency anemia (IDA) is accompanied by low iron reserves and indications of iron-corrupted supply to tissues^[5].

In developing nations, low nutritional intake and blood loss from worm infestation are the main causes of IDA, whereas in developed countries, a vegetarian diet, chronic blood loss, or malabsorption are the main causes^[6]. Pregnancy-related anemia is a severe health concern in Pakistan, where it can occur up to 38% of the time in the final trimester. There is a significant risk of adverse maternal and fetal outcomes^[7]. Early prenatal iron deficiency identification is beneficial for both the mother and unborn baby. Because of the major physiological alterations during pregnancy, some hematological parameters, such as mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC), are not useful markers for detecting anemia/IDA because they are lowered only when anemia is serious or well-developed^[8].

Diagnostic tests for iron deficiency include mean corpuscular volume (MCV), hemoglobin concentration (Hb), mean corpuscular hemoglobin (MCH), red cell distribution width (RDW), zinc protoporphyrin, serum transferrin receptor (Tfr), bone marrow biopsy, and serum ferritin^[9]. Serum iron, serum ferritin, and its percentage saturation decrease during pregnancy, whereas total iron binding capacity increases. Despite being the preferred method for diagnosing IDA, serum ferritin is costly and complicated, and because it is an acute phase reactant, it might cause misunderstanding due to spurious increases. The complete blood count (CBC) also includes the test of red cell distribution width (RDW), a relatively recent and common parameter that is performed in a fully automated hematology analyzer^[9]. Early RBC alterations associated with IDA can be detected using RDW. As a result, the CBC can be utilized as a fast and affordable cost test to identify IDA using the RDW. In different groups of red cell size, RDW displays minute variances and changes. There aren't many published studies that focus on the performance of RDW in identifying IDA during pregnancy. The diagnostic efficacy of RDW in identifying IDA in pregnant women has been the subject of debate in previous investigations^[10].

METHODS

A cross-sectional validation study was carried out at the Department of Obstetrics & Gynaecology, Allied Hospital, Faisalabad from April to October 2021 to assess RDW's efficacy in IDA diagnosis in situations where serum ferritin was the gold standard.

Sample size of 200 cases was calculated with 95% confidence level (CI), taking expected prevalence of IDA in pregnant women as 59.47%, 10% desired precision for sensitivity of 82.30%, and specificity

97.40% of RDW in predicting IDA in pregnant women (Ahmad et al., 2016).

Inclusion and exclusion criteria

- All pregnant women with anemia (as per operational definition) with a gestational age of >12 weeks as assessed on LMP between the ages of 18-40 years having Hb <10 g/dl, being both primiparous and multiparous, were selected for this study.
- Subjects whose medical records included a history of steroids or iron supplements and those with asthma or chronic renal failure were excluded from this study.

Data collection: After obtaining informed consent, 5 ml of blood was aseptically drawn from the antecubital vein in an ethylene diamine tetra acetic acid (EDTA) vial, and an automated hematology analyzer was used to analyze RDW immediately. The same sample was used to assess serum ferritin levels. A specialist hematologist reviewed the findings. For iron deficiency a serum ferritin value of <15ng/ml was taken as positive for IDA and RDW >15.9% was taken positive for IDA.

Statistical Analysis: The collected data were analyzed using SPSS 25.0. Mean and SD are presented for age, gestational age, parity, and BMI. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated using the following formula:

IDA on RDW		IDA on serum ferritin	
		Yes	No
	Yes	True Positive (a)	False Positive (b)
	No	False Negative (c)	True negative (d)

Sensitivity: $a / a+c \times 100$

Specificity: $d / b+d \times 100$

Positive predictive value: $a / a+b \times 100$

Negative predictive value: $d / c+d \times 100$

Diagnostic accuracy: $a+d / a+b+c+d \times 100$

RESULTS

During the study period, 200 pregnant women who fulfilled the study criteria were enrolled. Characteristics of these subjects are shown in table 1.

Table No. 1: Basic characteristics of the pregnant women included in the study at Allied Hospital, Fsd.

Patients' characteristics	Mean SD
Age, years	28.82 ± 5.17
Gestational age, weeks	20.64 ± 4.75
Parity	2.70 ± 1.21
BMI (kg/m2)	28.71 ± 3.96

The age range in this study was 18-40 years with a mean age of 28.82 ± 5.17 years. The mean gestational age was 20.64 ± 4.75 weeks. The mean parity was 2.70

± 1.21. Mean BMI was 28.71 ± 3.96 kg/m². In 115 RDW-positive patients, 100 (True Positive) had iron deficiency anemia and 12 (False Positive) had no iron deficiency anemia on serum ferritin levels.

Among, 88 RDW negative patients, 15 (False Negative) had iron deficiency anemia on serum ferritin levels whereas 73 (True Negative) had no iron deficiency anemia on serum ferritin levels as shown in Table 2.

Table No. 2: Diagnostic accuracy of red cell distribution width in iron deficiency anemia, taking serum ferritin as gold standard.

	Total	Positive result on serum ferritin	Negative result on serum ferritin	P-value
Positive on RDW	115	100 (TP)*	12 (FP)***	0.0001
Negative on RDW	88	15 (FN)**	73 (TN)****	

The overall sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of red cell distribution width in iron deficiency anemia using serum ferritin as the gold standard were 86.96%, 85.88%, 89.29% 82.95%, and 86.50%, respectively (Table 3).

Table No. 3: Performance of RDW in the diagnosis of IDA among pregnant women

Validity test	Percentage
Sensitivity	86.96%
Specificity	85.88%
Positive Predictive Value	89.29%
Negative Predictive Value	82.95%
Diagnostic Accuracy	86.50%

DISCUSSION

Hemoglobin is the most widely used hematological measure and IDA screening test. However, hemoglobin is limited in its ability to identify IDA because a sufficient period is required for iron to cause an impact^[11]. In addition, it can take up to 2 months for low levels of hemoglobin to appear. According to a recent study, during pregnancy, other hematological indicators such as MCV, MCH, and MCHC, which can be measured using a hem analyzer, do not adequately identify IDA^[12]. It is suspected that these red blood cell indices (MCV, MCH, and MCHC) may be mean values that are incapable of adequately representing the minute variation in red cell size that characterizes early iron deficiency. Hence, there is a need for a screening test that is affordable and can accurately and reliably detect iron deficiency^[13]. Therefore, using serum ferritin as the gold standard, this study aimed to evaluate the diagnostic precision of RDW in IDA.

Using serum ferritin as the gold standard, the sensitivity, specificity, positive predictive value,

negative predictive value, and diagnostic accuracy of RDW in detecting IDA were 86.96%, 85.88%, 89.29% 82.95%, and 86.50%, respectively. In the reference research, it was discovered that pregnant women had iron deficiency anemia at a rate of 59.47%, and RDW with a cut-off value of >15.9% had a sensitivity of 82.30% and specificity of 97.40% for identifying IDA^[14]. Because our study's sensitivity and specificity did not match those of the reference publication^[15], our findings were unable to assess the RDW diagnostic accuracy. In a Pakistani study, RDW demonstrated a sensitivity and specificity of 77.0% and 72.0%, respectively^[16]. In another local study, RDA revealed a high sensitivity and specificity of 93.33% and 83.33%, respectively^[17]. There have been reports of different RDW values in different studies. For instance, Aulakh et al. discovered that RDW had a sensitivity of 81.0% and a specificity of 53.4%, whereas van Zeben et al. discovered that RDW had a sensitivity of 94% and a specificity of 59%..

CONCLUSION

This study concluded that the diagnostic accuracy of red cell distribution width in diagnosing iron deficiency anemia in pregnant women is very low.

Author's Contribution:

Concept & Design of Study: Tayyeba Rehman
 Drafting: Nosheen Maqsood, Saba Iqbal
 Data Analysis: Rabia Afzal, Sehar Fatima, Kashifa Bibi
 Revisiting Critically: Tayyeba Rehman, Nosheen Maqsood
 Final Approval of version: Tayyeba Rehman

Conflict of Interest: The study has no conflict of interest to declare by any author.

Source of Funding: None

Ethical Approval: No.48-ERC/2020-21/PHRC/FMU/73 dated 20.02.2021

REFERENCES

1. Abioye AI, Aboud S, Premji Z, Etheredge AJ, Gunaratna NS, Sudfeld CR, et al. Iron supplementation affects hematologic biomarker concentrations and pregnancy outcomes among iron-deficient Tanzanian women. *J Nutrition* 2016;146(6):1162-1171.
2. Ahmad J, Khaliq S, Zafar L. Diagnostic Accuracy of Red Cell Distribution Width in Mild Iron Deficiency Anaemia in Women of Childbearing Age. *J Rawalpindi Med College* 2016;20(4):309-311.
3. Cunningham FG, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, et al. *Maternal Physiology. Williams*

- Obstetrics, 25th ed. New York, NY: McGraw-Hill Education; 2018. <https://accessmedicine.mhmedical.com/content.aspx?bookid=1918§ionid=144754618>.
4. Khan N, Altaf C, Malik HS, Sajjad Z, Khurshid A, Khadim MT. Diagnostic accuracy of reticulocyte haemoglobin equivalent (reth) in detecting iron deficiency anaemia keeping serum ferritin as gold standard. *Pak Armed Forces Med J* 2019; 69(5):1010-14.
 5. Mahmood T, Rehman AU, Tserenpil G, Siddiqui F, Ahmed M, Siraj F, et al. The association between iron-deficiency anemia and adverse pregnancy outcomes: a retrospective report from Pakistan. *Cureus* 2019;11(10): e5854. doi: 10.7759/cureus.5854.
 6. Manzoor M, Manzoor M, Ahmed Q, Ahmed S, Manzoor S. Frequency and causes of iron deficiency anemia in patients visiting gynae outdoor unit: an institutional-based study. *Punjab Univ J Zool* 2017;32(1): 111-115.
 7. Mogahed MM, Abdelwahab SM. Early prediction of iron deficiency in females in child bearing age in central Saudi Arabia. *Alexandria J Med* 2018;54(4):561-566.
 8. Öztürk M, Öztürk Ö, Ulubay M, Kardeşin E, Özgürtaş T, Yenen M, et al. Anemia prevalence at the time of pregnancy detection. *Turkish J Obstet Gynecol* 2017;14(3):176.
 9. Rigvardhan VR, Negi R, Biswal P, Rana Y. Correlation of serum ferritin with red cell indices and hemoglobin in Indian women in second and third trimester of pregnancy. *IJCMR* 2016; 3(10):3069-72.
 10. Sultana GS, Haque SA, Muttalib MM, Rahman MQ. Red Cell Distribution Width (RDW) and Hb% in the Detection of Iron Deficiency Anemia in Pregnant Women. *Anwer Khan Modern Med Coll J* 2018;9(2): 137-141.
 11. Rabbani S, Farooq M, Naeem S, Uddin N, Naeem MA, Jabeen S. Diagnostic efficacy of red blood cell indices in diagnosis of beta thalassemia trait taking haemoglobin electrophoresis as gold standard. *Pak Armed Forces Med J* 2021;71(3): 1006-10.
 12. Sherali A, Ahad A, Tikmani SS, Sohail S. Screening of Iron Deficiency Anemia in Children Using Mentzer Index in Pakistan: A Cross Sectional Study. *Global Pediatr Health* 2023;10:2333794X221130986.
 13. Shams N, Aslam A, Amanullah H, Memon K.. Frequency of Serum Ferritin Level in Non-Anemic Pregnant Women Presenting at Hospital. *Pak J Med Health Sci* 2023;17(04):584-584.
 14. Kılıç M, Özpınar A, Serteser M, Kilercik M, Serdar M. The effect of reticulocyte hemoglobin content on the diagnosis of iron deficiency anemia: A meta-analysis study. *J Med Biochem* 2022; 41(1):1.
 15. Mutua BM. Red Cell Distribution width as a Surrogate Marker of Haemoglobinopathies Among Patients in Aga Khan Hospital, Western Kenya (Doctoral dissertation, MMUST). *Afr J Lab Med* 2022;11(1): 1644. Published online 2022 Apr 29. doi: 10.4102/ajlm.v11i1.1644.
 16. Jbireal JM, Azab AE, Hasan SM. Iron Deficiency Anemia: Insights into the Prevalence, Causes, Iron Metabolism, Manifestations, Diagnosis, and Treatment. *Clin Res Hematol* 2020;3(2):1-8.
 17. Radhika S. Maternal and Fetal Outcomes in Severe Anemia Complicating Pregnancy. (Doctoral dissertation, Kilpauk Medical College, Chennai) 2022. <http://repository-tnmgrmu.ac.in/19293/1/220600422radhika.pdf>