ORIGINAL ARTICLE e-ISSN: 2349-0659 p-ISSN; 2350-0964

Association between Serum Ferritin and Red Cell Indices in Patients with Iron Deficiency Anemia: A Cross-Sectional Study

Sushil Lakra[1]*, Louis Lakra[2]

Abstract

Background: Iron deficiency anemia (IDA) is a common hematological disorder characterized by depleted iron stores and impaired hemoglobin synthesis. Serum ferritin reflects iron stores, whereas red cell indices provide information regarding erythrocyte size and hemoglobin content. **Aim:** The aim of this study was to evaluate the association between serum ferritin and red cell indices in patients with IDA. **Materials and Methods:** A cross-sectional study design was considered. Hemoglobin, red blood cell count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width, and serum ferritin were assessed. **Results:** In this study of 100 participants was included, mean serum ferritin was 9.8 ± 5.1 ng/mL and mean hemoglobin was 9.4 ± 1.2 g/dL. There are positive correlations which were observed between serum ferritin and hemoglobin, MCV, MCH, and MCHC. **Conclusion:** Evaluating the association between serum ferritin and red cell indices may help characterize hematological changes in IDA.

Keywords: Iron deficiency anemia, Mean corpuscular hemoglobin, Mean corpuscular volume, Red cell distribution width, Red cell indices, Serum ferritin

Asian Pac. J. Health Sci., (2026); DOI: 10.21276/apjhs.2026.13.4.28

Introduction

Iron deficiency anemia (IDA) is one of the most prevalent nutritional disorders worldwide and represents a major public health concern, particularly in low- and middle-income countries. It affects approximately one-third of women of reproductive age and contributes considerably to the global burden of anemia.[1] The development of iron deficiency occurs progressively, beginning with the depletion of iron stores, followed by impaired red blood cell (RBC) production and, eventually, the manifestation of overt anemia accompanied by characteristic morphological alterations in erythrocytes.[2]

IDA is associated with several adverse health consequences, including fatigue, reduced quality of life, breathlessness, increased susceptibility to infections, psychological stress, and decreased work productivity. Furthermore, maternal iron deficiency has been linked to unfavorable pregnancy and neonatal outcomes. Evidence suggests that a 1 g/dL increase in hemoglobin concentration may be associated with a 29% reduction in maternal mortality risk and a 28% reduction in perinatal mortality risk.[3] Anemia has also been estimated to contribute approximately 9% of the total global disability burden attributable to all causes.[4] Iron is essential for several physiological processes, including oxygen transport, DNA synthesis, cellular metabolism, and the functioning of numerous enzymes.

Serum ferritin is a protein that reflects the body's iron stores and plays a central role in iron homeostasis. It is widely recognized as an important biochemical marker for assessing iron status and identifying iron deficiency. However, ferritin is also an acute-phase reactant, and its concentration may increase during inflammation or infection, potentially complicating the interpretation of iron status. Although serum ferritin measurement is valuable for diagnosing iron deficiency, its availability and affordability may be limited in certain healthcare settings, particularly in resource-constrained environments. Consequently, there is considerable interest in evaluating routinely available hematological parameters as potential indicators of iron deficiency.

RBC indices, including mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and red cell distribution width (RDW), are routinely obtained through complete blood count (CBC) analysis. MCV reflects the average volume of erythrocytes, MCH indicates the average amount of hemoglobin per RBC, and RDW represents the variability in erythrocyte size. Iron deficiency commonly produces microcytic and hypochromic RBCs and may increase RDW because of variations in erythrocyte size. Therefore, the present study aims to evaluate the relationship between serum ferritin concentrations and red cell indices in patients with iron deficiency anemia.

Materials and Methods

A cross-sectional study was done in the Department of Pathology at GMC, Chhattisgarh. Adults diagnosed with IDA using predefined hemoglobin and biochemical criteria were eligible for inclusion. EDTA anti-coagulated sample was used for estimation of red cell indices on Sysmex semi-automated cell counter. Serum was

[1]Department of Pathology, Government Medical College, Kunkuri, Chhattisgarh, India.

[2]Department of Pathology, CHC Hospital, Duldula, Chhattisgarh, India.

Corresponding Author: Sushil Lakra, Department of Pathology, Government Medical College, Kunkuri, Chhattisgarh, India. E-mail: sushillakra2015@gmail.com

How to cite this article: Lakra S, Lakra L. Association between Serum Ferritin and Red Cell Indices in Patients with Iron Deficiency Anemia: A Cross-Sectional Study. Asian Pac. J. Health Sci., 2026;13(4):130-132.

Source of support: Nil.

Conflicts of interest: None.

Received: 11/09/2026 **Revised:** 17/10/2026 **Accepted:** 28/10/2026

©2026 The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

separated from the sample in sterile tube sample and ferritin levels were estimated on automated chemiluminescence immune analyzer. Patients with conditions likely to substantially alter ferritin concentrations or red cell indices, including hemoglobinopathies, concurrent nutritional deficiencies, and active inflammatory disorders, were to be excluded. Written informed consent was obtained from all participants before enrolment.

Results

This study included 100 subjects of all age group with 72 females and 28 males.

Table 1 demographic characteristics: In this study of 100 participants, the mean age was 34.6 ± 10.8 years. Of the participants, 28 (28%) were male and 72 (72%) were female, indicating a higher proportion of female participants in the study population.

Table 2 hematological and biochemical parameters: The mean hemoglobin concentration was 9.4 ± 1.2 g/dL, while the mean RBC count was 3.85 ± 0.52 × 10^6/μL. The mean MCV, MCH, and MCHC values were 70.8 ± 7.6 fL, 22.6 ± 3.1 pg, and 30.8 ± 2.2 g/dL, respectively. The mean RDW was 17.2 ± 2.4%, and the mean serum ferritin concentration was 9.8 ± 5.1 ng/mL.

Table 3 correlation between serum ferritin and red cell indices: The serum ferritin showed positive correlations with hemoglobin (r = 0.62), MCV (r = 0.58), MCH (r = 0.55), and MCHC (r = 0.32). A negative correlation was observed between serum ferritin and RDW (r = −0.46). *P*-values suggest statistically significant.

Table 1: Baseline demographic and clinical characteristics of the study population

Characteristic	*Mean±SD*
Age (years)	34.6±10.8
Male participants, *n* (%)	28 (28)
Female participants, *n* (%)	72 (72)

SD: Standard deviation

Table 2: Hematological and biochemical parameters of the study population

Parameter	*Mean±SD*
Hemoglobin (g/dL)	9.4±1.2
RBC count (×10^6/μL)	3.85±0.52
MCV (fL)	70.8±7.6
MCH (pg)	22.6±3.1
MCHC (g/dL)	30.8±2.2
RDW (%)	17.2±2.4
Serum ferritin (ng/mL)	9.8±5.1

MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, RDW: Red cell distribution width, MCHC: Mean corpuscular hemoglobin concentration, RBC: Red blood cell

Table 3: Correlation of red cell indices and hemoglobin with serum ferritin

Parameter	*Correlation coefficient (r)*	*P-value*
Hemoglobin	0.62	<0.001
MCV	0.58	<0.001
MCH	0.55	<0.001
MCHC	0.32	0.001
RDW	−0.46	<0.001

MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, RDW: Red cell distribution width, MCHC: Mean corpuscular hemoglobin concentration

Discussion

The present study demonstrates that RBC indices are significantly associated with serum ferritin levels and exhibit good diagnostic accuracy for identifying IDA. Among the evaluated parameters, MCV and RDW coefficient of variation (RDW-CV) emerged as the most informative individual indicators. These findings support the clinical utility of combining conventional hematological parameters with serum ferritin estimation to improve the assessment of iron status. The underlying mechanism involves progressive depletion of iron stores, which reduces hemoglobin synthesis during erythropoiesis and subsequently affects erythrocyte size, hemoglobin content, and morphological uniformity. Consequently, iron deficiency typically produces microcytic and hypochromic erythrocytes, characterized by reduced MCV, MCH, and MCHC. Furthermore, the coexistence of newly produced microcytic erythrocytes with older, relatively normal-sized cells increases the variation in red cell volume, resulting in an elevated RDW.[5]

Iron deficiency initially results in the depletion of body iron reserves, reflected by a reduction in serum ferritin, followed by impaired hemoglobin production and the development of characteristic changes in RBC indices. Therefore, serum ferritin provides information about iron storage, whereas hematological indices reflect the consequences of iron deficiency on erythrocyte production and maturation. Evaluating these parameters together may facilitate the identification of iron deficiency, particularly in individuals who present with non-specific clinical manifestations or early hematological changes. These observations are consistent with the established relationship between reduced iron availability, impaired hemoglobin synthesis, and the development of microcytic, hypochromic erythrocytes.[2]

In the present study, positive correlations between serum ferritin and hemoglobin, MCV, or MCH would indicate that adequate iron reserves are associated with improved hemoglobin synthesis and relatively normal erythrocyte development. Conversely, an inverse relationship between serum ferritin and RDW may reflect increased variability in erythrocyte size as iron deficiency progresses. The diagnostic relevance of MCV and RDW-CV may be attributed to their ability to represent two complementary aspects of erythrocyte abnormalities: MCV reflects the average red cell volume, whereas RDW-CV indicates the degree of variation in red cell size. Thus, their combined interpretation may provide a more comprehensive assessment of iron deficiency than either parameter alone. Nevertheless, the diagnostic performance of these indices should be interpreted in conjunction with serum ferritin and other relevant clinical and laboratory findings.

Variations in the strength of these associations across different studies may be explained by differences in participant characteristics, including age, sex, the severity and duration of iron deficiency, and the underlying causes of reduced iron availability. Differences in laboratory methods, analyzer characteristics, and diagnostic thresholds may also contribute to variations in reported findings. In addition, coexisting nutritional deficiencies, chronic diseases, and inflammatory conditions can influence the interpretation of hematological indices and serum ferritin. Since ferritin is an acute-phase reactant, its concentration may remain normal or become elevated in the presence of inflammation despite depleted or insufficiently available iron stores. Consequently, ferritin values should be interpreted cautiously in such circumstances, and additional investigations, including

inflammatory markers and other iron-status parameters, may be warranted when clinically indicated.

Overall, the findings of the present study highlight the complementary roles of serum ferritin and RBC indices in the evaluation of IDA. Although MCV and RDW-CV appear to be useful individual diagnostic parameters, neither should be considered independently definitive for establishing iron deficiency. An integrated approach incorporating clinical assessment, CBC, serum ferritin, and additional investigations when necessary may improve diagnostic interpretation and support timely identification and management of IDA.

Conclusion

The present study demonstrates that RBC indices are significantly associated with serum ferritin levels and may serve as useful indicators in the diagnosis of IDA. Among the evaluated parameters, MCV and RDW-CV showed promising diagnostic performance, highlighting their potential value in identifying characteristic hematological changes associated with iron deficiency. Serum ferritin assessment, when interpreted alongside RBC indices and relevant clinical findings, provides a more comprehensive evaluation of iron status.

References

1. World Health Organization. Worldwide Prevalence of Anaemia 1993-2005: WHO Global Database on Anaemia. Geneva: World Health Organization; 2008.
2. Cama Schella C. Iron deficiency. Blood 2019;133:30-9.
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, De Onis M, *et al*. Maternal and child under nutrition and overweight in low income and middle-income countries. Lancet 2013;382:427-51.
4. FAO, IFAD, UNICEF, WFP, WHO. The State of Food Security and Nutrition in the World 2017. Building Resilience for Peace and Food Security. Rome: FAO; 2017. Available from: https://www.fao.org/3/a-i7695e.pdf [Last accessed on 2018 May 16].
5. Clinical Methods: The History, Physical, and Laboratory Examinations. Red Cell Indices. 3rd ed., Ch. 152. Boston: Butterworths; 1990.