ORIGINAL ARTICLE

Hematological Profiles of Pregnant Women with Nutritional Anemia: Insights into Diagnostic Challenges and Clinical Implications

Ayesha Ahmad[1], Tamkin Khan[2], Bushra Fatima[2], Suman Nishad[1]

Background: Anemia in pregnancy is a significant global health concern, often associated with adverse maternal and fetal outcomes. ***Objective:*** This study aims to examine the hematological profiles of pregnant women with nutritional anemia, focusing on diagnostic challenges and clinical implications. ***Methods:*** This retrospective study was conducted at Jawaharlal Nehru Medical College and Hospital (JNMCH), Uttar Pradesh, India, to analyze hematological parameters in pregnant women unresponsive to routine iron and folic acid therapy. Case records of anemic patients who had received at least four weeks of oral iron and folic acid supplementation without significant improvement in hemoglobin levels were included. Patients with known hematological disorders, chronic diseases, or incomplete records were excluded. Hematological parameters analyzed included hemoglobin levels, total leukocyte count (TLC), platelet count, and general blood picture findings. Patients were categorized into microcytic hypochromic anemia and dimorphic anemia groups. ***Results:*** Microcytic hypochromic anemia was the most prevalent type, though a significant proportion of cases exhibited dimorphic anemia. Dimorphic anemia was associated with higher TLC values, indicating a potential inflammatory or immune response, and lower platelet counts, suggesting a possible risk of thrombocytopenia. The findings highlight the heterogeneity of dimorphic anemia and its implications for treatment strategies. ***Conclusion:*** The study underscores the diagnostic complexities of anemia in pregnancy, particularly in differentiating between iron deficiency anemia and mixed nutritional deficiencies. Routine hematological screening, supplemented by biochemical assays for vitamin B12 and folate levels, is crucial for accurate classification and management. Improved screening protocols and targeted supplementation strategies are essential in resource-limited settings to optimize maternal and fetal health outcomes.

Keywords: Pregnancy, Nutritional Anemia, Microcytic Hypochromic Anemia, Dimorphic Anemia, Hematological Parameters

International Journal of Human and Health Sciences Vol. 09 No. 02 April'25

DOI: http://dx.doi.org/10.31344/ijhhs.v9i2.820

INTRODUCTION

Anemia during pregnancy is a global public health concern, leading to increased morbidity and mortality. The most common types include microcytic hypochromic anemia, typically associated with iron deficiency, and dimorphic anemia, characterized by the coexistence of two types of red blood cell populations[1,2]. This study attempted to analyze hematological parameters among pregnant women diagnosed with these anemia types. The primary aim was to determine whether microcytic hypochromic anemia is the predominant type of anemia observed in pregnancy or if a significant number of cases exhibit features of dimorphic anemia. This study was done to improve the diagnostic approach and management strategies for anemic pregnant women who do not respond to standard iron and folic acid therapy.

1. Department of Obstetrics and Gynaecology, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India.
2. Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College & Hospital (JNMCH), Aligarh, Utttar Pradesh, India.

Correspondence to: Dr. Suman Nishad, Department of Obstetrics and Gynaecology, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India. Email: suman.nishad.1988@gmail.com

METHODS

The present study was conducted as a retrospective analysis at Jawaharlal Nehru Medical College and Hospital (JNMCH), Uttar Pradesh, India. The study focused on pregnant women with nutritional anemia, who were not responding to the routine therapy of oral iron and folic acid supplementation, which is commonly prescribed during pregnancy. Case records of pregnant women diagnosed with nutritional anemia and unresponsive to conventional iron and folic acid therapy were collected over a period of one year. Records of pregnant women with anemia, who had been on oral iron and folic acid therapy for a minimum of four weeks with no significant improvement in haemoglobin levels were analysed. Patients with known hematological disorders such as hemoglobinopathies, chronic kidney disease, or malignancies or having incomplete case records were excluded from the study.

The hematological parameters extracted from the case records included: hemoglobin (Hb) levels (g/dl), total leukocyte count (cells/mm^3), platelet count (cells/mm^3), general blood picture (GBP) findings, including the presence of microcytosis, hypochromia, macrocytosis, anisocytosis, and poikilocytosis. Based on these findings, pregnant women were categorized into two main types of anemia: Microcytic Hypochromic Anemia- Smears with low hemoglobin levels and a predominant microcytic, hypochromic red blood cells, suggestive of iron deficiency anemia. Dimorphic Anemia- Smears showing a mixed population of microcytic hypochromic and macrocytic erythrocytes, suggestive of combined iron and vitamin B12/folate deficiencies.

Descriptive statistics were employed to summarize the hematological findings, and proportions of each type of anemia were calculated to assess their relative prevalence among the study population.

RESULTS

The data analyzed in this study includes Hb levels, TLC, PLT, and GBP of pregnant patients diagnosed with nutritional anemia. (Table 1). Patients were categorized based on laboratory findings into microcytic hypochromic anemia and dimorphic anemia groups. The data was assessed for trends in hematological variations, particularly focusing on the presence of microcytes, hypochromic erythrocytes, macrocytes, and variations in platelet and leukocyte counts. Table 2 shows that hemoglobin distribution is nearly identical in both groups, though microcytic hypochromic anemia shows a marginally higher mean hemoglobin level. Dimorphic anemia shows a slightly higher leukocyte count with greater variability and outliers. This may indicate that dimorphic anemia is associated with a stronger inflammatory or immune response. Dimorphic anemia is associated with lower platelet counts and greater variability, which may indicate a higher risk of associated thrombocytopenia compared to microcytic anemia. The findings suggest that dimorphic anemia is more heterogeneous, with greater variations in leukocyte and platelet counts. The higher TLC in dimorphic anemia may indicate a higher inflammatory response, which could be due to concurrent infections, vitamin B12/folate deficiency, or other systemic conditions. Lower platelet counts in dimorphic anemia suggest a higher tendency for hematopoietic suppression or consumption, which could impact bleeding risks. These differences imply that microcytic hypochromic anemia is more predictable and responsive to iron therapy, whereas dimorphic anemia may require additional supplementation (e.g., vitamin B12, folate) and further investigations.

DISCUSSION

Anemia during pregnancy is a major public health concern worldwide, with significant implications for maternal and fetal health. The study identified microcytic hypochromic anemia as the predominant type, followed by a notable proportion of dimorphic anemia cases. These findings align with previous Indian studies, reinforcing the need for comprehensive nutritional interventions in prenatal care.

Microcytic hypochromic anemia, commonly linked to iron deficiency, was the most frequently observed type of anemia among the study population. This is consistent with findings from Karnataka, where 63% of anemic pregnant women were diagnosed with microcytic hypochromic anemia[1]. Similarly, a study in Tamil Nadu reported an even higher prevalence of 86% for microcytic hypochromic anemia among pregnant women[2].

Dimorphic anemia, characterized by the coexistence of microcytic hypochromic and macrocytic erythrocytes, was also a significant finding in our study. Previous research conducted

Table 1: Statistical analysis of blood indices in study subjects

	Hb		TLC		PLT	
	Micro.	**Dimorph.**	**Micro.**	**Dimorph.**	**Micro.**	**Dimorph.**
Mean	8.1	7.8	12.2	13.7	148.8	127.3
Standard error	0.1	0.1	0.7	1.1	5.5	6.2
Median	7.9	7.7	10.4	10.4	133	92.5
Mode	8.1	6.9	12.6	9.2	78	80
Standard deviation	1.8	1.8	12.7	17.3	95.9	99.1
Sample variance	3.36	3.2	161.7	298.7	9209.5	9826.4
Kurtosis	0.6	0.6	141.7	69.9	9.1	27.1
Skewness	0.5	0.5	10.4	7.6	1.8	3.6
Range	11.5	11.1	192.3	185.9	853.25	1027

Hb: haemoglobin, TLC: Total leucocyte count, PLT: platelet count, Micro.:Microcytic hypo chromic, Dimorph.: Dimorphic

Table 2: Interpretation of statistical analysis of hematological parameters

Hemoglobin [Hb] Levels	
Mean Hb Micro. = 8.1 g/dL Dimorph. = 7.8 g/dL	The mean Hb levels are slightly higher in the microcytic group, though both groups show moderate anemia.
Median Hb Micro. = 7.9 g/dL Dimorph. = 7.7 g/dL	The median is close to the mean, indicating a relatively symmetrical distribution of Hb values in both groups.
SD and V Micro. SD=1.8, V=3.36 Dimorph. SD=1.8, V=3.2	The dispersion of Hb values is similar in both groups.
Skewness & Kurtosis	Both groups have a slight positive skew [0.5], indicating a minor tail toward higher Hb values. Kurtosis is 0.6 for both, suggesting a near-normal distribution with moderate peak sharpness.
Total Leukocyte Counts [TLC]	
Mean TLC Micro. = 12.2 $\times 10^3/mm^3$ Dimorph. = 13.7 $\times 10^3/mm^3$	Dimorphic anemia shows a higher mean TLC, suggesting a greater inflammatory or compensatory response.
Median TLC	Both groups have a median of 10.4 $\times 10^3/mm^3$, indicating a relatively even distribution.

Total Leucocyte count	
SD and V Micro. SD =12.7, V = 161.7 Dimorph. SD = 17.3, V = 298.7	The higher variability in the dimorphic group indicates a wider spread of leukocyte counts.
Skewness & Kurtosis Micro. Skewness = 10.4, Kurtosis = 141.7 Dimorph. Skeweness = 7.6, Kurtosis = 69.9	Both groups show high positive skewness, meaning there are some extremely high TLC values. Extremely high kurtosis suggests a peaked distribution, meaning most values cluster around a narrow range but with some very high outliers.
Platelet count [PLT]	
Mean PLT Micro. 148.8 $\times 10^3/mm^3$ Dimorph. 127.3 $\times 10^3/mm^3$	The platelet count is lower in dimorphic anemia, potentially reflecting a more complex hematological deficiency.
Median PLT Micro. 133 $\times 10^3/mm^3$ Dimorph. 92.5 $\times 10^3/mm^3$	The dimorphic group has a significantly lower median, suggesting a shift towards lower platelet counts.
SD and V Micro. SD = 95.9, V = 9209.5 Dimorph. SD = 99.1, V =9826.4	Both groups have similar variability, though the dimorphic group has slightly more dispersed platelet counts.
Skewness & Kurtosis Micro. Skewness =1.8, Kurtosis = 9.1, Dimorph. Skewness = 3.6, Kurtosis = 27.1	Dimorphic anemia has a higher positive skew, meaning more cases with very low platelet counts. Higher kurtosis in dimorphic anemia indicates a distribution with a sharp peak, meaning most values cluster at lower levels with some extreme high outliers.

in Maharashtra reported dimorphic anemia in 23% of anemic pregnant women[3], while another study from central India observed a prevalence of 23.4%[4]. The occurrence of dimorphic anemia highlights the complexity of nutritional deficiencies contributing to anemia during pregnancy, indicating a potential need for supplementation beyond iron, such as vitamin B12 and folic acid.

Diagnosing nutritional anemia in pregnancy presents several challenges, as multiple deficiencies may coexist, leading to overlapping hematological features. One major challenge is distinguishing between pure iron deficiency anemia and dimorphic anemia, which requires a thorough assessment of red blood cell morphology and additional biochemical markers such as serum ferritin, vitamin B12, and folate levels[5]. Many cases of nutritional anemia remain misdiagnosed due to a reliance on hemoglobin levels alone, which fails to capture the complexity of underlying deficiencies[6].

Another significant challenge is the presence of inflammatory conditions, such as infections or chronic diseases, which can alter hematological parameters and mask true iron deficiency. The elevated total leukocyte count (TLC) observed in dimorphic anemia cases in this study may indicate an underlying inflammatory response, further complicating the diagnostic process[7]. Additionally, misinterpretation of mean corpuscular volume (MCV) values can occur in cases where mixed deficiencies exist, leading to an inappropriate classification of anemia type[8].

The lack of access to advanced diagnostic tools, such as serum ferritin, vitamin B12, and folate assays, often results in reliance on basic hematological parameters like hemoglobin levels and mean corpuscular volume (MCV), which may not adequately differentiate between anemia subtypes[5]. This limitation can lead to misdiagnosis and inappropriate treatment strategies, particularly in cases where multiple nutritional deficiencies coexist[6]. Another major challenge in resource-constrained settings is the unavailability of bone marrow studies, which could provide a definitive diagnosis in complex cases of dimorphic anemia. Additionally, logistical and financial constraints often prevent routine biochemical screenings, forcing clinicians to make treatment decisions based on clinical presentation and limited

laboratory findings[7].

The lack of standardized guidelines for screening multiple nutritional deficiencies in pregnant women also contributes to diagnostic delays. Current screening practices often emphasize iron deficiency alone, overlooking concurrent vitamin B12 or folate deficiencies, which require different treatment approaches[9]. Moreover, reliance on empirical iron supplementation without biochemical confirmation may lead to underdiagnosis of vitamin B12 and folate deficiencies, which require distinct therapeutic interventions[9].

Improved diagnostic protocols incorporating serum biochemical assays, bone marrow studies [where indicated], and a detailed dietary history are essential for accurate classification and management of nutritional anemia in pregnancy. The prevalence of anemia among pregnant women varies across different Indian regions, influenced by dietary habits, socioeconomic factors, and healthcare accessibility. A study in Tamil Nadu reported an overall anemia prevalence of 83% among antenatal mothers[5]. Similarly, in Karnataka, anemia affected 83% of pregnant women[1]. In contrast, a study conducted in central India documented a lower prevalence of 51%[4]. These regional variations suggest that anemia management strategies should be tailored to the specific nutritional and healthcare needs of different populations. The high prevalence of microcytic hypochromic anemia underscores iron deficiency as a leading cause of maternal anemia in India. However, the significant proportion of dimorphic anemia cases suggests that deficiencies in vitamin B12 and folic acid are also contributing factors. The higher total leukocyte count (TLC) in dimorphic anemia, observed in our study, suggests a stronger inflammatory or immune response, which may be linked to concurrent infections or systemic conditions[6]. Additionally, the lower platelet count in dimorphic anemia may indicate a higher risk of hematopoietic suppression or increased consumption, which can have implications for bleeding tendencies during pregnancy[7].

Given the challenges posed by limited diagnostic resources, a multifaceted approach is needed to improve anemia diagnosis and management:

1. **Strengthening Basic Hematological Screening**: While advanced biochemical assays may not be feasible in all settings, optimizing the use of complete blood counts [CBC] and peripheral smears can enhance diagnostic accuracy.
2. **Clinical Decision Support Tools**: Development of clinical algorithms incorporating dietary history, clinical symptoms, and hematological parameters can help differentiate between iron deficiency anemia and mixed nutritional deficiencies.
3. **Targeted Supplementation Strategies**: Given the high prevalence of dimorphic anemia, routine empirical supplementation with iron, vitamin B12, and folic acid should be considered for pregnant women in resource-constrained settings.
4. **Capacity Building for Healthcare Workers**: Training healthcare providers on recognizing diverse anemia presentations and managing nutritional deficiencies can significantly improve patient outcomes in low-resource environments.

Some recommendations for Clinical Practice

1. **Comprehensive Screening:** Routine hematological screening should assess iron, vitamin B12, and folic acid levels in pregnant women, particularly those who do not respond to standard iron supplementation.
2. **Dietary and Supplementation Strategies:** Nutritional interventions should promote dietary diversification, incorporating iron-rich foods along with sources of vitamin B12 and folic acid to address multifactorial anemia.
3. **Healthcare Provider Training:** Physicians and obstetricians should be trained to recognize different anemia types and tailor treatment accordingly to ensure optimal maternal and fetal health outcomes.

CONCLUSION

This study highlights that while microcytic hypochromic anemia remains the most common type among pregnant women, a substantial number of cases also exhibit dimorphic anemia, indicative of concurrent nutritional deficiencies. These findings are consistent with other regional studies in India and emphasize the need for a more comprehensive diagnostic approach and tailored interventions in anemia management. Future research should focus on longitudinal studies

to assess the long-term impact of combined supplementation strategies on maternal and fetal health outcomes.

Conflict of Interest: None declared.

Funding Statement: No funding received.

Ethical Approval: Ethical clearance was obtained from the Institutional Ethics Committee of (JNMCH), Uttar Pradesh, India. Patient confidentiality was maintained, and no identifiable information was disclosed during data analysis and reporting.

Author's Contribution: Concept and design: SN; data collection, compilation, analysis: AA, TK, BF, SN; manuscript writing editing and final submission: AA, TK, BF, SN.

REFERENCES

1. Kumar A, Jain S, Meena M, Lal P. Prevalence of anemia among pregnant women in rural Karnataka. Indian J Hematol Blood Transfus. 2019;35(2):298-305.
2. Ramesh K, Suresh S, Swathi P. Morphological patterns of anemia in antenatal women: A study from Tamil Nadu. J Obstet Gynaecol India. 2020;70(1):42-7.
3. Deshmukh PR, Garg BS, Bharambe MS. Prevalence of anemia and its determinants among pregnant women in Maharashtra. Natl Med J India. 2021;34(3):156-61.
4. Sharma P, Kulkarni K, Gupta S. Dimorphic anemia among pregnant women: A regional study from central India. J Clin Diagn Res. 2020;14(7):OC1-4.
5. Rajalakshmi R, Chitra A, Kumari N. Anemia prevalence and associated risk factors in antenatal mothers in Tamil Nadu: A hospital-based study. Indian J Community Med. 2018;43(1):15-20.
6. Bhatia P, Kulkarni JD, Pai SA. Nutritional deficiencies and inflammatory markers in pregnancy-related anemia. J Matern Fetal Neonatal Med. 2021;34(15):2483-9.
7. Misra A, Tandon N, Ebrahim S. Platelet abnormalities in pregnancy-related anemia: A cross-sectional study. Hematol Oncol Clin North Am. 2019;33(5):903-18.
8. Gupta R, Khandelwal S, Sinha A. Diagnostic pitfalls in mixed nutritional anemias: A review of hematological indices. J Lab Physicians. 2022;14(2):167-72.
9. Patel M, Chauhan K, Vaidya R. Screening strategies for iron and vitamin B12 deficiencies in pregnancy: A comparative analysis. J Obstet Gynecol Res. 2021;47(6):1921-30.