Original Article

Study of Morphological Types of Anemia in Antenatal Patients at a Tertiary Care Hospital

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Abstract

Background: Anemia, defined as a decrease in hemoglobin concentration below normal levels adjusted for age, sex, and environment, reduces the blood's oxygen-carrying capacity. It is a major public health issue, especially in developing countries. In India, 52.1% of pregnant women in rural areas and 45.7% of those in urban areas suffer from anemia. This study aimed to classify the morphological types and severity of anemia in antenatal patients and correlate them with pregnancy trimesters.

Methods: At Sir T Hospital in Bhavnagar, a cross-sectional study was carried out between January 1 and December 31, 2022. Automated hematology analyzers were used to examine 226 pregnant women's blood samples. The formula $n = Z^2pq/d^2$ was used to get the sample size.

Results: Microcytic hypochromic anemia was the most common type (36%), followed by dimorphic (23%), macrocytic (21%), and normocytic normochromic (20%). Most common was moderate anemia (55%), which was followed by severe (28%) and mild (17%) anemia. Anemia cases were evenly spread across trimesters, with slightly higher rates in the first and second. Most patients were aged 20 to <30 years.

Conclusion: Anemia in pregnancy remains highly prevalent, with 83% of cases observed in this study, particularly among women aged 18–25. It poses serious risks to maternal and fetal health, including long-term consequences for the child's development and future health.

Keywords: Anemia; Pregnancy; Morphological type; Microcytic anemia; Dimorphic anemia; Macrocytic anemia.

Introduction

Anemia is defined as a reduction in hemoglobin concentration below the expected normal range, adjusted for age, sex, and environmental factors, leading to decreased oxygen-carrying capacity of the blood [1]. Anemia during pregnancy is a widespread public health issue, with an estimated global prevalence of 50% among pregnant women. This burden is significantly higher in developing countries, where the prevalence ranges between 56% and 61%, and at least 50% of cases are attributed to iron deficiency anemia [2]. In India, the condition remains a major concern, affecting 52.1% of pregnant women in rural areas and 45.7% in urban areas [2].

Pregnancy causes hemodilution and physiological anemia, which peaks in the second trimester, when plasma volume rises more than red cell mass [3]. Therefore, hemoglobin levels below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester are considered anemia in pregnancy [1].

The severity of anemia is classified as moderate (7.0–9.9 g/dL), severe (<7.0 g/dL), and mild (10.0–10.9 g/dL; 10.0–10.4 g/dL in the second trimester) [4]. Additionally, it can be categorized by cause, such as hemolytic anemia from diseases like malaria, aplastic anemia from bone marrow problems, and nutritional anemia (such as iron deficiency) [9].

Symptoms vary with severity and may include fatigue, headache, palpitations, and edema. Even mild anemia can impair well-being, exacerbate other conditions, and lower work capacity [5]. It also increases the risk of infections, reduces

tolerance to blood loss during delivery [6], and contributes to poor pregnancy outcomes such as low birth weight, preterm labor, poor APGAR scores, and intrauterine fetal demise [7]. Anemia is implicated in 20–40% of maternal deaths in India and accounts for 80% of anemia-related maternal mortality in South Asia [8].

Iron deficiency anemia is the most common type during pregnancy, responsible for up to 76% of cases [9]. Its causes in developing countries include increased demand by the fetus and maternal tissues, inadequate dietary intake or supplementation, and impaired absorption of nutrients such as folic acid and vitamin B12 [10].

Morphologically, anemia is classified based on red blood cell indices into normocytic normochromic, microcytic hypochromic, macrocytic, and dimorphic types. Each type points to different underlying causes, and assessing RBC morphology alongside clinical features can aid diagnosis and management to improve maternal and fetal outcomes [11]. Therefore, this study was conducted to evaluate the morphological types of anemia among antenatal patients in our setting.

Materials and Methods

Study Design and Setting: The present study was conducted after the Ethics Committee Bhavnagar's approval. This cross-sectional study was conducted in the Hematology Laboratory of Sir T Hospital, Bhavnagar, over a period of one year. The aim was to determine the morphological types of anemia in pregnant women attending routine antenatal check-ups.

Sample Size Calculation: The required sample size was calculated using the formula: $N = Z^2pq/d^2$ Where: Z = standard normal deviate at 95% confidence level (1.96) p = estimated prevalence of anemia among antenatal women (0.55) q = 1 p = 0.45 d = allowable margin of error (0.065) Substituting the values: $N = (1.96)^2 * 0.55 * 0.45 / (0.065)^2 = 0.9516 / 0.004225 = 225$ Thus, a sample size of 225 was determined and included in the study.

Study Population and Selection Criteria: Blood samples were collected from antenatal patients attending routine obstetric visits. **Inclusion Criteria:** Pregnant women with hemoglobin levels below 11 g/dL, as per WHO guidelines for anemia in pregnancy. **Exclusion Criteria:** Patients with diagnosed hemoglobinopathies (e.g., thalassemia, sickle cell disease) were excluded from the study.

Laboratory Analysis: Venous blood samples were collected in EDTA tubes and analyzed using an automated hematology analyzer (HORIBA PENTRA ES60), which operates on impedance and photometric principles. The analyzer was routinely calibrated and maintained as per the manufacturer's recommendations. The following red blood cell (RBC) indices were recorded: Mean Corpuscular Volume (MCV) Mean Corpuscular Hemoglobin (MCH) Red Cell Distribution Width (RDW) Peripheral blood smears were prepared and stained with Leishman stain following standard hematological procedures. Each smear was examined under a light microscope by the principal investigator.

Morphological Classification of Anemia: Morphological types of anemia were classified based on a combination of RBC indices and peripheral smear findings. The following cut-off values were used for classification: **RBC Index-Based Thresholds** MCV $<$ 80 fL: Microcytic 80–100 fL: Normocytic $>$ 100 fL: Macrocytic MCH $<$ 27 pg: Hypochromic 27–33 pg: Normochromic $>$ 33 pg: Hyperchromic RDW $<$ 11.5%: Low variation 11.5–14.5%: Normal variation $>$ 14.5%: High variation **Final Morphological Definitions** *Microcytic Hypochromic Anemia:* MCV $<$ 80 fL and MCH $<$ 27 pg; peripheral smear showing small, pale RBCs. *Macrocytic Anemia:* MCV $>$ 100 fL and MCH $>$ 33 pg; smear showing large, oval red cells ± hypersegmented neutrophils. *Normocytic Normochromic Anemia:* MCV 80–100 fL and MCH 27–33 pg; smear showing normal-sized and normochromic RBCs. *Dimorphic Anemia:* RDW $>$ 14.5% with mixed MCV/MCH values (e.g., microcytic and macrocytic populations); peripheral smear showing dual populations, indicating mixed etiology. This integrative approach allowed for accurate morphological classification of anemia, combining objective hematological indices with subjective microscopic findings.

Results

A total of 226 antenatal patients diagnosed with anemia were included in the study. The mean age of the participants was 28 ± 7 years. The highest proportion (32%) belonged to the 20 to <25 years age group (Figure 1). The mean hemoglobin level across all participants was 8 ± 1.6 g/dl.

Anemia Severity Distribution: Moderate anemia was the most frequently observed severity category, affecting 55% (n=125) of the patients, followed by severe anemia in 28% (n=63), and mild anemia in 17% (n=38) (Figure 2).

Trimester Distribution: The trimester-wise distribution of anemic patients showed a nearly even spread: First trimester: 35% (n=79) Second trimester: 35% (n=78) Third trimester: 31% (n=69) (Figure 3)

Morphological Sub-types of Anemia: Morphological classification revealed the following distribution (Table 1): Microcytic hypochromic anemia: 36% (n=81) Dimorphic anemia: 23% (n=52) Macrocytic anemia: 21% (n=48) Normocytic normochromic anemia: 20% (n=45) Microcytic hypochromic anemia was the most prevalent sub-type across all trimesters.

Notably, 46% of second trimester and 33% of first trimester cases had this morphology. Dimorphic anemia was more prominent in the third trimester (30%). A statistically significant association was observed between trimester and morphological subtype ($\chi^2 = 22.4$, df = 6, p = 0.001), indicating that the distribution of anemia types varied significantly across the trimesters (Table 4).

Association Between Anemia Severity and Morphology: Among patients with severe anemia (n=63), the majority (54%, n=34) had microcytic hypochromic anemia, followed by dimorphic (n=16), macrocytic (n=10), and normocytic normochromic anemia (n=3). The relationship between severity of anemia and morphological subtype was found to be statistically significant ($\chi^2 = 41.2$, df = 6, $p < 0.001$), suggesting that more severe cases were more likely to be associated with microcytic hypochromic and dimorphic patterns (Table 3).

Table 1: Morphological type of anemia in the study participants (n=226)

Morphological subtypes	No. of patients	Percentage (%)
Microcytic hypochromic	81	36
Normocytic normochromic	45	20
Macrocytic	48	21
Dimorphic	52	23

Table 2: Correlation of age distribution with morphological type of anemia (n=226) (%)

Age (years)	Microcytic hypochromic	Normocytic normochromic	Macrocytic	Dimorphic
<20	9 (43)	4 (19)	4 (19)	4 (19)
20 to <25	27 (37)	18 (25)	14 (19)	14 (19)
25 to <30	17 (35)	10 (21)	10 (21)	11 (23)
30 to <35	16 (47)	2 (6)	11 (32)	5 (15)
35 to <40	6 (21)	6 (21)	6 (21)	11 (31)
≥40	6 (29)	5 (24)	3 (14)	7 (33)

Table 3: Correlation of severity and morphological type of anemia (n=226) (%)

Severity	Microcytic hypochromic	Normocytic normochromic	Macrocytic	Dimorphic
Mild	7 (18)	18 (47)	2 (12)	11 (23)
Moderate	40 (32)	24 (19)	36 (29)	25 (20)
Severe	34 (54)	3 (5)	10 (16)	16 (25)

Table 4: Correlation of pregnancy trimester with morphological type of anemia (n=226) (%)

Trimester	Microcytic hypochromic	Normocytic normochromic	Macrocytic	Dimorphic
First	26 (33)	25 (32)	15 (19)	13 (16)
Second	36 (46)	4 (5)	20 (26)	18 (23)
Third	19 (28)	16 (23)	13 (19)	21 (30)

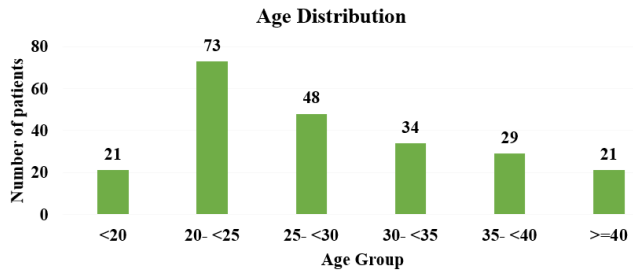

Figure 1: Age distribution of the study participants (n=226)

Discussion

Anemia remains a major public health burden during pregnancy, particularly in low- and middle-income countries. The current study reports an anemia prevalence of 83% among antenatal women, which is significantly higher than national

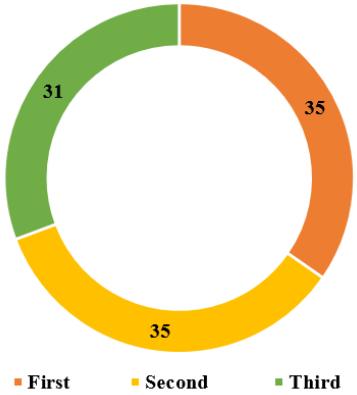

Figure 2: Severity of anemia in study participants (n=226)

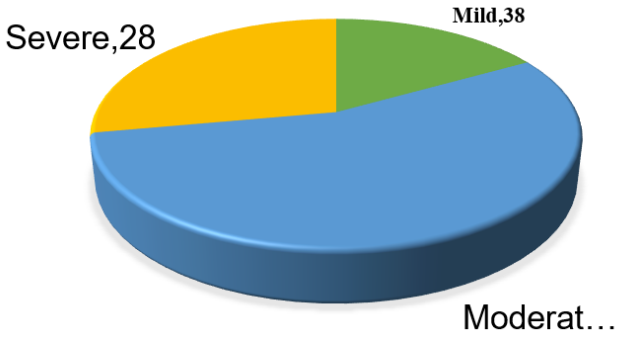

Figure 3: Trimester of pregnancy in study participants (n=226)

and global estimates. According to NFHS-5 (2019–21), 52.2% of pregnant women in India are anemic, indicating little improvement from 50.4% in NFHS-4 (2015–16) despite large-scale interventions such as the Anemia Mukt Bharat initiative [12]. The World Health Organization (WHO) estimates that approximately 48% of pregnant women in the South-East Asia Region (SEAR) are affected by anemia, compared to 40.1% globally [13]. Our hospital-based findings, although not representative of the general population, likely reflect a higher-risk cohort and the use of detailed morphological analysis that captures cases beyond simple hemoglobin estimation.

The most prevalent morphological type observed in this study was microcytic hypochromic anemia (36%), aligning with the well-established predominance of iron deficiency anemia (IDA) as the leading cause of anemia in pregnancy worldwide [14]. However, the noteworthy finding was the high prevalence of dimorphic anemia (23%), which emerged as the second most common morphological type. Dimorphic anemia, typically resulting from coexisting microcytic and macrocytic red blood cell populations, is indicative of concurrent deficiencies, most often involving iron and either folate or vitamin B12 [15].

Several factors may contribute to the high proportion of dimorphic anemia in our cohort. Firstly, multi-nutrient deficiencies are common in India due to dietary patterns low in animal-source foods, limited intake of leafy greens and fruits, and reliance on phytate-rich cereals that inhibit mineral absorption [16]. Secondly, while national programs promote iron and folic acid (IFA) supplementation, vitamin B12 is frequently omitted, despite its critical role in erythropoiesis [17]. Recent studies have demonstrated high rates of B12 deficiency in pregnant Indian women, particularly among vegetarians. For instance, a cohort study from Eastern Maharashtra reported that 40% of pregnant women had iron deficiency, and 30% had B12 deficiency, while folate deficiency was uncommon [18].

Delayed antenatal registration and suboptimal compliance with IFA supplementation may further compound the problem. A large meta-analysis by Sharma et al. (2025) reported a pooled anemia prevalence of 72% among pregnant Indian women, highlighting significant regional disparities and the limited impact of current programs [19]. Our findings reinforce the need for comprehensive antenatal screening protocols that go beyond hemoglobin estimation to include assessments of iron stores (serum ferritin), folate, and vitamin B12 levels, where feasible.

The high prevalence of dimorphic anemia also has important clinical implications. If unrecognized and untreated, combined nutrient deficiencies can increase the risk of maternal morbidity, preterm birth, low birth weight, and impaired neonatal development [20]. Timely diagnosis and a more integrated supplementation approach—incorporating iron, folate, and vitamin B12 from the second trimester—may help reduce the burden of dimorphic anemia.

Despite its strengths, this study has some limitations. Socioeconomic factors, dietary patterns, gestational history, and maternal-fetal outcomes were not analyzed. These variables may provide deeper insights into the etiology and consequences of anemia sub-types. Further longitudinal and interventional studies are warranted to evaluate the effectiveness of tailored micro-nutrient strategies in reducing anemia-related complications during pregnancy.

Conclusion

Anemia in pregnancy remains a critical public health concern in developing countries, with this study reporting a strikingly high prevalence of 83%, particularly among women aged 18–25 years. The predominance of the microcytic hypochromic pattern highlights iron deficiency as a major contributing factor, often associated with moderate to severe anemia. Multiple risk factors—including poor antenatal care awareness, low socioeconomic status, rural residence, multiparity, and inadequate education—further exacerbate the problem.

This study provides valuable insights that can inform targeted public health interventions and policies. The identification of predominant morphological patterns can help guide clinicians toward more precise, evidence-based treatment strategies, such as distinguishing between iron and combined iron-folate deficiencies. Moreover, the findings emphasize the importance of strengthening antenatal care services through routine screening, timely treatment of parasitic infections, and consistent nutritional counseling.

The high prevalence identified in this study should prompt healthcare policymakers and practitioners to prioritize anemia in pregnancy as a key maternal health issue. Integrating anemia screening into standard prenatal protocols, improving health education for women of reproductive age, and addressing structural barriers to healthcare access will be essential in reducing anemia-related maternal and neonatal complications.

Ultimately, the findings of this study contribute to the broader understanding of anemia's impact across generations and highlight the need for a multi-faceted approach—combining clinical, nutritional, educational, and socioeconomic interventions—to effectively combat antenatal anemia and improve maternal-child health outcomes.

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