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Anemia Causes

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Burden of Anemia among Hospitalized Patients: An Observational Study

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Anemia is a major public health issue globally, particularly common in low- and middle-income countries like India, where it contributes significantly to morbidity in hospitalized patients. It is characterized by a reduction in red blood cell count or hemoglobin level, leading to reduced oxygen delivery to tissues. Causes range from nutritional deficiencies to chronic diseases, infections, blood loss and genetic disorders. Women, children, and the elderly are especially vulnerable. The objective of this study is to evaluate the prevalence and hematological patterns of anemia in hospitalized patients at a tertiary care center in South India and identify the most common morphological types across age and gender. Blood samples from 100 hospitalized patients were collected and analyzed using an automated hematology analyzer (sysmex) to assess hemoglobin levels, RBC indices (MCV, MCH, MCHC), and peripheral blood smear morphology. Anemia was diagnosed and classified based on WHO criteria and RBC morphology. The study revealed that microcytic hypochromic anemia was the most prevalent type (54%), followed by normocytic hypochromic (29%) and normocytic normochromic (17%). Females showed slightly higher prevalence and more signs of iron deficiency. Anemia types varied across age groups: Younger patients (10–30 years) showed healthier RBC morphology (normocytic), while older patients had more normocytic hypochromic anemia, indicating chronic disease involvement. The findings emphasize the importance of early detection, regular screening, targeted treatment nutritional intervention, and age and gender-specific management strategies to reduce anemia-related complications.

Keywords: anemia, hemoglobin, rbc, normocytic hypochromic, microcytic hypochromic

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1. Introduction

Anemia is a prevalent yet frequently neglected health issue, particularly among hospitalized adult and older patients aged 15 years and older, respectively [1]. These individuals often experience chronic illness and multiple comorbid condition, rendering them more susceptible anemia and leading to repeated hospital stays. A commonly observed comorbidity in this demographic is anemia [2-6].

Anemia impacts over 1.62 billion individuals around the world [7]. The World Health Organization [WHO] reports that 40% of children aged 6-59 months, 37% of pregnant women, and 30% of women aged 15-49 years are affected by anemia [8]. In 72019, anemia was a responsible for a loss of 50 million healthy life years globally [9]. Despite being a priority on the global health agenda, progress in reducing anemia has been minimal over the last two decades [10]. The WHO aimed to decrease anemia in women of reproductive age by 50% in 2025 but it is unlikely this target will be achieved even by 2030 [11].

Anemia is particularly prevalent in low-and-middle income nations, where issues such as poor nutrition, limited healthcare access, and parasitic diseases are common [8]. The condition impacts both health outcomes and economic productivity, posing a significant developmental challenge [11].

In India, the country holds a considerable portion of the global burden of anemia, with high rates observed among children, women, and rural communities [12]. Data from the National Family Health Survey [NFHS] indicates that the prevalence of anemia among children aged 6-59 months has consistently exceeded 58% across NFHS-3[2005-06] [13], NFHS-4[2015-16] [14], NFHS-5 [2019-21] [15]. The most recent NFHS-5[2019-21] data shows that two-thirds of children under five, more than half of the women, and roughly one fourth of aged 15-49 years are anemic.

Research within the India population points of factor like inadequate iron intake, insufficient essential nutrients, low vitamin-c consumption, multiple pregnancies, extended breast feeding, and reduced access to iron supplements during adolescence and pregnancy.

Anemia is characterized by a reduction in RBCs or hemoglobin level.

The WHO define anemia as when Hb level fall below 13 gm/dl in men and below 12gm/dl in non pregnant women age 15 years and older (Figure-1) [16-17]. The severity of anemia can be classified as mild, moderate, or sever. Mild anemia is indicated by Hb level of 11-12.9gm/dl for males and 11-11.9gm/dl females. Moderate anemia is defined as Hb levels between 7- 10.9gm/dl for both-gender, while severe anemia occurs when Hb levels drop to 7gm/dl or lower.

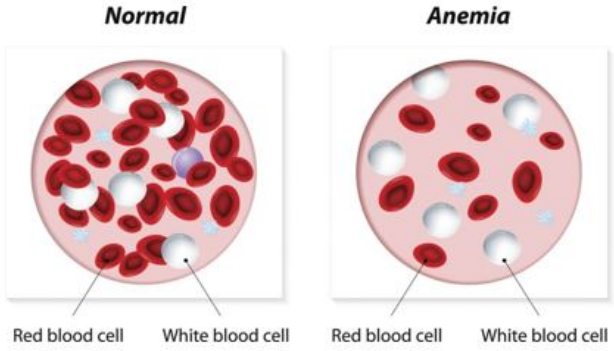

Figure 1: Normal and anemia cell

Anemia can be characterized by based on three main criteria: pathogenesis, RBC morphology, and clinical presentation. In clinical settings, classification based on RBC morphology using fundamental parameter such as MCV, MCH, MCHC is most frequently utilized [19]. MCV assesses the average size of RBCs in femtoliter (fL). MCH measure the average Hb content per RBCs in pictogram (pg), MCHC evaluates the Hb concentration in a specific volume of packed RBCs in gm/dl [20].

According to these parameters, anemia is morphologically classified into:

1. Microcytic hypochromic anemia (MCV<80fl) typically caused by iron deficiency, anemia chronic illness, thalassemia and sideroblastic anemia.
2. Normocytic normochromic anemia (80-100fl) observed in situation like chronic kidney diseases, acute blood loss, hemolytic anemia.
3. Macrocytic anemia (MCV>100fl) frequently associated with vitamin B12, folate deficiencies, liver diseases, chronic alcohol abuse [19,21].

In hospitalized patients, anemia can arise from several factor including nutritional deficits (Iron, vit B12, folate), chronic blood loss on going health conditions, Hemoglobinopathies, and infection like malaria, tuberculosis, HIV, and parasitic diseases [18].

This study aims to evaluate the prevalence and hematological patterns of anemia from a laboratory perspective among hospitalized patients at a tertiary care hospital in South India.

2. Material & Methods

Study Design

This cross-sectional observational study was conducted in the Department of Hematology, at a tertiary care hospital over a period of 6 months (January 2025 to June 2025). Hospitalized patients of all age groups and both genders were included after obtaining informed consent.

This study includes 100 hospitalized patients with suspected anemia (clinically or through initial blood reports). All the patients who had received blood transfusions in the last 3 months & patients with known hematological malignancies were excluded from the study.

Sample Collection & Processing

3-5 mL of venous blood was collected aseptically using sterile disposable syringes into EDTA tube for complete blood count and peripheral blood smear. Samples were analyzed within 2 hours of collection.

3. Methods

Hematological Screening

Initial screening for anemia was done using an automated hematology analyzer (Sysmex XN-1000). The Sysmex XN-1000 utilizes fluorescence flow cytometry combined with impedance and SLS hemoglobin method for accurate CBC measurements. Fluorescent dyes stain cell components, which are then analyzed through a laser- based flow cytometer. EDTA blood sample was mixed properly. Sample was loaded into the analyzer. Complete blood count panel was run. Hb level and RBC indices were recorded. Patients were classified as anemic based on WHO criteria (Hb <13 g/dL in males, <12 g/dL in females, <11 g/dL in pregnant women).

Parameters Measured

- Hemoglobin (Hb)
- Red Blood Cell count (RBC)
- Hematocrit (HCT)
- Mean Corpuscular Volume (MCV)
- Mean Corpuscular Hemoglobin (MCH)
- Mean Corpuscular Hemoglobin Concentration (MCHC)
- Platelet count (PLT)

4. Result

In this observational study, data from approximately 100 hospitalized patients was analyzed to assess the prevalence, morphological types, and hematological patterns of anemia. The dataset included both male and female patients, with recorded values for key hematological parameters such as hemoglobin (Hb), red blood cell (RBC) indices (MCV, MCH, MCHC), and platelet counts (PLT).

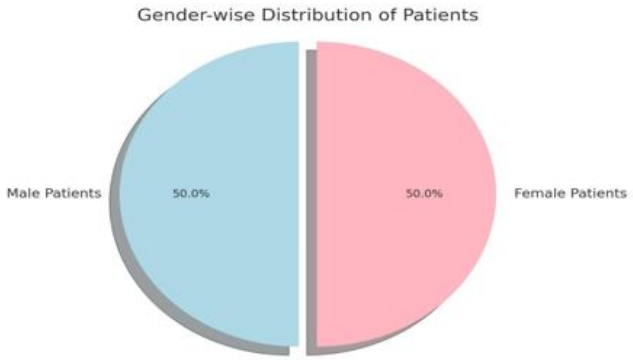

Figure 1: Pie chart Gender-wise Distribution

Male Patient: 50

Female Patient: 50

This nearly equal distribution of male and female participants allowed for meaningful comparative analysis between genders in terms of anemia type and severity.

PARAMETERS	MALE (mean)	FEMALE (mean)	INTERPRETATION
Hb (g/dL)	9.01	9.30	Low in both sexes, suggesting moderate anemia
RBC (10^6/micro L)	3.51	3.66	Low RBC count, consistent with anemia
HCT (%)	29.89	30.54	Decreased HCT, indicating reduced red cell mass
MCV (fL)	82.88	80.63	Microcytic to normocytic range, suggests iron deficiency
MCH (pg)	27.98	25.91	Low MCH, especially in females, indicates hypochromia
MCHC (g/dL)	33.70	31.34	Mild hypochromia, more in females
PLT (×10/L)	153.3	236.86	Mild thrombocytopenia in males; high-normal in females, supports iron deficiency

Table 1: Hematological Parameters in Anemia Patients (Mean Values)

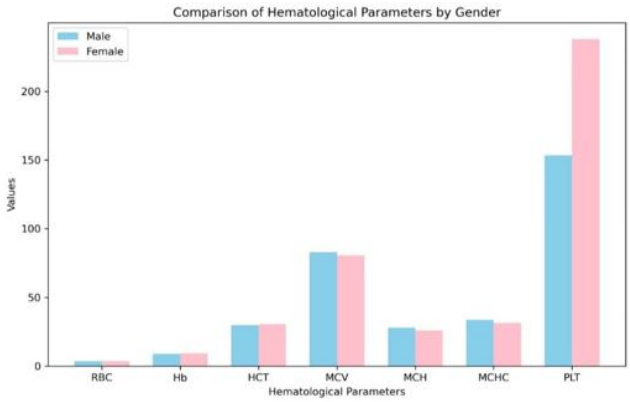

Figure 2: Bar graph representation indicates moderate anemia, predominantly microcytic hypochromic type, especially in females

The findings are consistent with iron deficiency anemia, which is more common in females based on RBC indices and platelet trends.

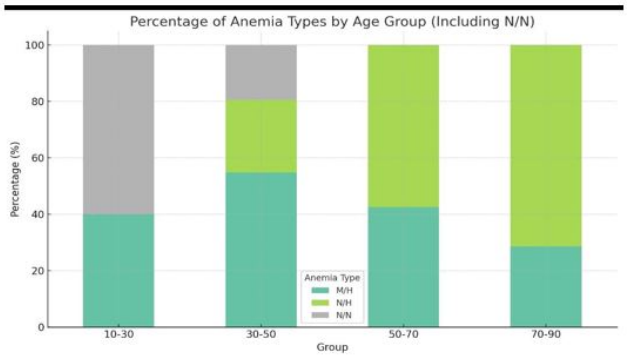

Figure 3: Age wise distribution of anemic patients

This graph indicates that 10-30 Age Group:

- ~60% of patients have N/N anemia (normal RBC size and color).
- ~40% have M/H anemia (small and pale RBCs).
- No N/H detected.

30-50 Age Groups:

- All three types present.
- M/H anemia is most common (~55%).
- N/H is next (~26%), and N/N is ~19%.

50-70 Age Groups:

- N/H anemia dominates (~57%).
- M/H is second (~43%).
- No N/N detected.

70–90 Age Groups:

- N/H is dominant (~71%).
- M/H still present (~29%)
- No N/N type found.

Interpretation:

- Young adults (10–30) show the healthiest RBC profiles, with a large proportion falling in the N/N (normal) category.
- Mild to moderate anemia (M/H) is highly prevalent in the 30–50 group, suggesting nutritional deficiencies or chronic issues.
- As age increases (50+), normocytic hypochromic (N/H) anemia becomes more dominant, likely due to age-related changes, chronic diseases, or reduced bone marrow function.
- No severe anemia (macrocytic types) observed; most cases fall within common clinical anemia patterns. Absence of N/N in older groups suggests that aging correlates with increased anemia prevalence.

Based on red blood cell morphology and hemoglobin levels, three types of anemia were identified:

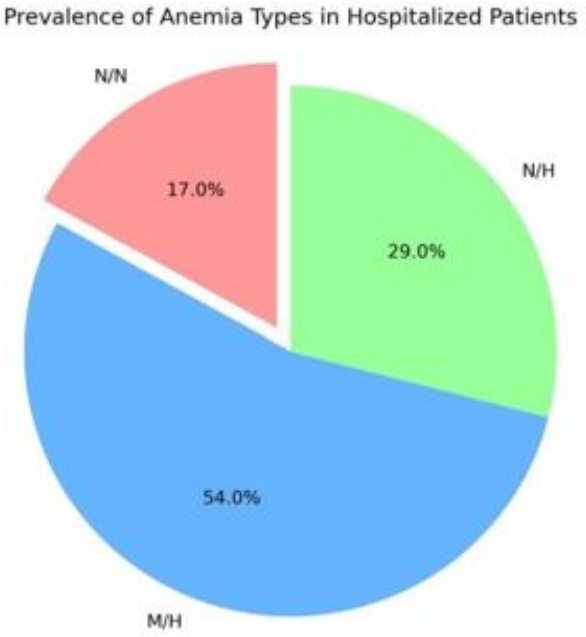

Figure 4: Prevalence of Anemia Types in Hospitalized Patients

Microcytic Hypochromic (M/H) anemia is the most prevalent type, accounting for 54% of cases.

Normocytic Hypochromic (N/H) anemia accounts for 29% of cases.

Normocytic Normochromic (N/N) anemia is the least common, at 17%.

Interpretation:

- This graph indicates that iron deficiency anemia (typically M/H type) is the most common among hospitalized anemic patients.
- The high prevalence of M/H suggests nutritional deficiency or chronic blood loss as common causes.
- The relatively lower prevalence of N/N anemia suggests that fewer patients have anemia due to chronic disease or bone marrow suppression.

Anemia type	Male %	Female %
N/N	~35	~37
M/H	~35	~38
N/H	~92	~95

Table 2: Prevalence of anemia types by gender

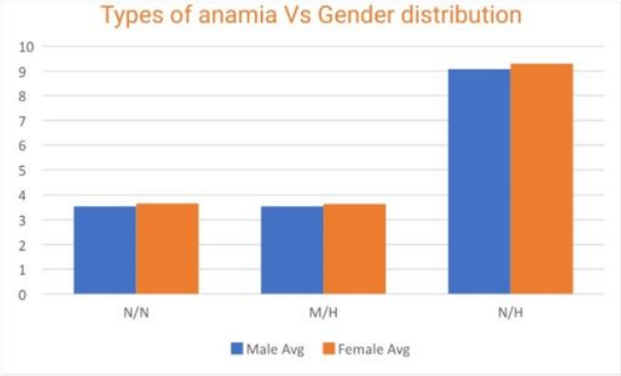

Figure 5: Types of Anemia vs Gender Distribution (Bar Chart)

- All three types of anemia show a nearly equal distribution between males and females, with a slight predominance in females across all types.
- N/H anemia has the highest average occurrence in both genders.
- M/H and N/N types show similar and lower average occurrence across genders. **Interpretation:**
- The slight female predominance across anemia types may be related to factors like menstruation, pregnancy, and nutritional status.
- The consistent presence of N/H anemia in both genders suggests that mixed-type anemias or combined deficiencies may be common.

5. Discussion

The present study highlights the prevalence of anemia among hospitalized patients and the hematological patterns observed through routine blood tests. Anemia is seen in equal numbers of males and females (~50). Both groups showed moderate anemia, though females had slightly higher Hb levels but more signs of iron deficiency evident from lower MCH, MCHC, and higher platelet counts. A 2019 study by Mehta et al. in Gujarat, India, evaluated 300 anemic patients admitted to medical wards and found that M/H anemia was the most common type, especially among women of reproductive age. This pattern reflects underlying nutritional deficiencies, primarily iron deficiency, which is common in premenopausal women due to menstruation and dietary habits. The study highlighted iron deficiency as a major concern in hospitalized female patients. Our findings align with previous studies showing that microcytic hypochromic anemia is the most common type in developing countries. Kumar et al. (2020) analyzed 250 CBC reports from a government hospital in Uttar Pradesh and reported 55% anemia prevalence. Notably, macrocytic anemia was linked to chronic liver disease and alcohol dependence, emphasizing the need for early screening, nutritional support, and liver function monitoring. In contrast, males showed a more balanced distribution of anemia types, including normocytic variants, which may be related to chronic diseases or inflammatory condition. The use of complete blood count (CBC) and peripheral blood smear (PBS) remains central in the morphological classification of anemia. Age-wise analysis showed that younger patients (10–30 years) mostly had normal red blood cell morphology, while older patients (50+) showed a rise in normocytic hypochromic anemia, likely due to chronic diseases or aging-related changes. Among the types, microcytic hypochromic anemia was the most common (54%), indicating iron deficiency as a major cause. Normocytic hypochromic anemia followed, especially in older individuals, hinting at combined deficiencies or chronic illness. Gender-wise distribution was fairly balanced, with a slight female predominance in all anemia types. Overall, the findings highlight iron deficiency and age-related factors as key contributors to anemia in hospitalized patients, emphasizing the need for targeted diagnosis and management.

6. Conclusion

Anemia is a condition in which the body lacks enough healthy red blood cells or hemoglobin to carry adequate oxygen to tissues. Individuals may experience fatigue, weakness, shortness of breath, and decreased physical and cognitive performance. It is not a single disease but a clinical manifestation of various underlying conditions including nutritional deficiencies, chronic infections, and inherited disorders. The most common causes of anemia include iron deficiency, vitamin B12 or folate deficiency, chronic diseases (like kidney disease, tuberculosis, HIV), blood loss, and genetic disorders such as thalassemia or sickle cell anemia. Contributing factors such as poverty, poor dietary intake, repeated pregnancies, menstrual blood loss, parasitic infections, and limited access to healthcare make certain populations more vulnerable.

The hematological analysis-including parameters like MCV, MCH, and MCHC-proved valuable in classifying anemia types and hinting at underlying etiologies.

The combination of complete blood count, peripheral smear, and biochemical test remains essential for accurate diagnosis and management.

Women are disproportionately affected by anemia, particularly in low- and middle-income countries. This higher prevalence in females is mainly due to menstrual blood loss, frequent pregnancies, and nutritional demands during reproductive years, and socio-cultural barriers that limit their access to nutritious food and healthcare services. Additionally, in many Indian households, women are the last to eat, often consuming lesser quantities of iron-rich foods. This study reinforces the fact that anemia continues to be a significant concern among hospitalized patients, with microcytic hypochromic anemia (commonly caused by iron deficiencies) being the most frequent pattern observed. These findings stress the urgent need for comprehensive screening, targeted nutritional interventions, and public health policies that address both the medical and social determinants of anemia especially in high-risk groups like women and the elderly.

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Authors Contribution: KZ: Supervision, Methodology, KM: Conceptualization, Review, WS: Review, Editing, JI: Review & Editing, ZI: Review, SN: Calculations, SK: Conceptualization, SDR: Review.

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