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Original Research Article

A Clinical Evaluation of Anemia in Adults with Focus on Etiological Distribution

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Abstract:

Background: Anemia is a common hematological disorder in adults, associated with significant morbidity and influenced by nutritional deficiencies, chronic diseases, and hemoglobinopathies. Understanding its prevalence and etiology is crucial for timely diagnosis and management.

Aim: To evaluate the clinical spectrum, morphological types, and etiological profile of anemia in adult patients.

Methodology: A hospital-based prospective observational study was conducted in the Department of General Medicine, Katihar Medical College and Hospital, Bihar, India, enrolling 80 adult patients (≥18 years) diagnosed with anemia per WHO criteria. Detailed clinical evaluation, laboratory investigations including hematological parameters, iron profile, vitamin B12/folate levels, and hemoglobin electrophoresis were performed. Anemia was classified morphologically and etiologically.

Results: Among 80 patients, males slightly predominated (55%). Pallor (90%), fatigue (85%), and dyspnea (62.5%) were common clinical features. Microcytic anemia was most frequent (55%), followed by normocytic (27.5%) and macrocytic (17.5%). Etiologically, iron deficiency anemia accounted for 42.5% of cases, anemia of chronic disease 22.5%, megaloblastic anemia 15%, hemoglobinopathies and CKD-related anemia 7.5% each, with 5% mixed/unclassified.

Conclusion: Adult anemia is prevalent and multifactorial, predominantly due to iron deficiency and chronic disease. Thorough etiological evaluation is essential to guide targeted interventions, improve patient outcomes, and reduce public health burden.

Keywords: Anemia, Adults, Chronic Disease, Iron Deficiency, Morphology, Vitamin B12.

Introduction

Anemia is one of the largest hematological manifestations in the world and is a significant global health problem with significant clinical, social and economic implications [1]. According to the definition determined by The World Health Organization (WHO), anemia is a state where the number of red blood cells (RBCs) or their ability to carry oxygen as indicated by hemoglobin content is not sufficient to meet the metabolic needs of body tissues. This can cause hypoxia in tissues and physical impairment, mental dysfunction and high morbidity and mortality. Globally, close to a quarter of the population is affected with anemia with the highest prevalence being encountered in lower and middle-income environments [2]. Although anemia is often considered as a problem of children and women of reproductive age, anemia of adults is a severe, yet neglected issue, particularly in clinical practice where it is a frequent occurrence alongside chronic disease [3]. Thus, it is significant to comprehend the burden and spectrum of etiologies of anemia in adult patients to diagnose it early, treat it effectively, and avoid secondary complications.

Adult anemia has a complex etiological pattern, which varies according to the geographic location, nutrition, socioeconomic status, and burden of chronic diseases. Generally, there are three causes which can be classified liberally as diminished red blood cell production, excess red blood cell destruction and blood loss [4]. The most frequent etiological factors worldwide are the nutritional deficiencies, iron deficiencies, vitamin B12 deficiencies, or folic acid deficiencies. Iron deficiency anemia is the most common cause worldwide, most caused by inadequate dietary intake or blood loss through the gastro-intestinal tract or in women, by blood loss during menstruation. Notably, large etiological roles may be played by megaloblastic anemia secondary to vitamin B12 or folate deficiency, particularly in

areas with little dietary variety or syndromes of malabsorption [5]. Besides the consideration of nutritional deficiency, anemia of chronic disease is usually observed in adults especially those with an infectious process, malignancies or chronic inflammatory disorder where the impaired erythropoiesis and iron metabolism alteration are the leading factors [6]. Hemolytic anemia is not very common but can develop as a result of genetic defects like thalassemia or sickle cell disease, or a process like autoimmune hemolysis.

In a clinical setting, anemia is normally never a disease as such but a symptom of underlying pathological mechanisms. The diagnosis of adult patients with anemia can be very wide and it can include simple nutritional deficiencies to malignancies that can be life-threatening [7]. Gastrointestinal malignancies, such as, and peptic ulcer disease, and chronic kidney disease can cause anemia in advance of more acute symptoms regarding an underlying cause. Owing to this, etiological assessment of anemia is therefore crucial in adults since treatment depends on the realization of the underlying problem observed later and may have been suitable, and in certain instances may be lifesaving when a severe illness is realised [8]. The clinical consequences of untreated anemia in adults could also be enormous, such as a decreased working capacity, impaired immunity, poor quality of life, and the risk of hospitalization.

Malnutrition, a large burden of infectious diseases and difficulties in accessing health care interact to augment the prevalence and intricacy of anemia in regions like South Asia and Sub-Saharan Africa. Adult anemia in developed nations is becoming a disease resultant to chronic disease, aging modifications, or malignancy in the adult population. Therefore, etiologic profiling of anemia is quite contextual and there is need to conduct studies locally to capture the specifics of anemia. The use of clinical studies on adult patients is thus a major precursor in identifying the distribution of etiology, presentation features and morbidity related to the same to formulate the necessary action to be taken on a public health basis and clinical management directions.

A clinical study of anemia in adult patients focusing on the etiological profile is very important due to various reasons. First, it helps clinicians distinguish between common and uncommon causes, which results in a prioritization of assessing the uncommonly rare etiologies as potential diagnoses in low resource settings. Second, it highlights the role of avoidable nutritional deficiencies as causes of anemia and gives a reason to enhance food and supplementation of at-risk populations. Third, it focuses on screening of anemia in the high-risk groups (eg chronic kidney disease, malignancies, long standing infections). Lastly, it also adds to the current body of information on anemia, and perhaps even a study on area variations that can result in effective prevention and treatment measures of the population.

Here, the current clinical report attempts to assess anemia in adults with special consideration to its prevalence, clinical manifestation, and etiological characterization. The study will attempt to give a detailed insight into the distribution, risk factors and clinical implications of anemia by systematically examining the underlying factors that cause this situation in this group of people. This information will not only help clinicians to diagnose and specifically treat anemia at an early stage, but also facilitate wider health policy initiatives to minimize its burden on adults.

Methodology

Study Design: This was a hospital-based prospective observational study conducted to evaluate the clinical spectrum and etiological profile of anemia in adult patients.

Study Area: The study was carried out in the Department of General Medicine, Katihar Medical College and Hospital, Katihar, Bihar, India from January 2007 to December 2007

Inclusion and Exclusion Criteria

Inclusion Criteria

- Adult patients aged 18 years and above.
- Patients with clinically suspected anemia confirmed by laboratory investigations as per WHO criteria (hemoglobin <13 g/dl in men and <12 g/dl in women).
- Patients willing to give informed consent.

Exclusion Criteria

- Patients who had received blood transfusion within the last 12 weeks.
- Patients on chemotherapy or radiotherapy.
- Pregnant and lactating women.
- Patients with known hematological malignancies.

Sample Size: A total of 80 patients fulfilling the inclusion and exclusion criteria were enrolled during the study period.

Procedure: All patients fulfilling the selection criteria were enrolled after obtaining informed consent. A detailed clinical history including demographic details, dietary habits, medical history, and family history was recorded in a structured proforma. Complete general and systemic examinations were performed. Laboratory investigations included complete blood count (hemoglobin, hematocrit, red cell indices, reticulocyte count, white blood cell and platelet count, and peripheral smear for morphology). Serum iron profile (serum iron, ferritin, and total iron-binding capacity) was performed in all cases. Vitamin B12 and folate levels were estimated

in patients with macrocytic or dimorphic anemia. Hemoglobin electrophoresis was done in cases with microcytosis and normal iron profile to rule out hemoglobinopathies. Bone marrow aspiration and/or biopsy was undertaken when indicated, particularly in unexplained, refractory, or pancytopenic cases. Renal and liver function tests were carried out in all patients to identify systemic causes of anemia. Additional investigations such as gastrointestinal endoscopy, radiological imaging, thyroid function tests, and tissue biopsies were performed wherever clinically indicated. Patients were categorized into types of anemia based on mean corpuscular volume (MCV) into microcytic, normocytic, and macrocytic groups, and etiological classification was done accordingly.

Statistical Analysis: All data were entered in Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 27.0. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as frequency and percentage. Differences in proportions were analyzed using the Chi-square test, while differences in means were analyzed using Student's t-test or one-way ANOVA, as appropriate. A p-value of <0.05 was considered statistically significant.

Result

Table 1 shows the age and gender distribution of the study participants, with a total of 80 individuals, comprising 44 males (55%) and 36 females (45%). The highest representation was observed in the 51–60 years age group with 20 participants (25%), followed by the 18–30 years and 41–50 years groups, each contributing 16 participants (20%). The 31–40 years and >60 years groups accounted for 14 participants each (17.5%). Across all age categories, males outnumbered females, with the largest male predominance seen in the 51–60 years group (15% males vs. 10% females), while the 18–30 years group had more females (12.5%) than males (7.5%). This indicates a fairly balanced gender distribution overall, with a slight male predominance, and a peak participation in the middle-aged and early elderly population.

Table 1: Age and Gender Distribution

Age Group (years)	Male (%)	Female (%)	Total (%)
18–30	6 (7.5%)	10 (12.5%)	16 (20%)
31–40	8 (10%)	6 (7.5%)	14 (17.5%)
41–50	10 (12.5%)	6 (7.5%)	16 (20%)
51–60	12 (15%)	8 (10%)	20 (25%)
>60	8 (10%)	6 (7.5%)	14 (17.5%)
Total	44 (55%)	36 (45%)	80 (100%)

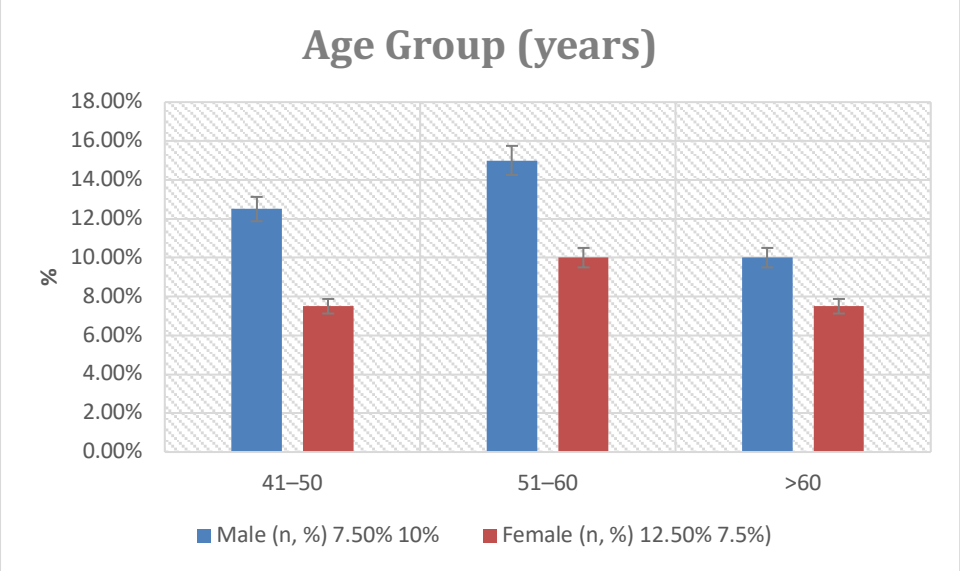

Figure 1: Age and Gender Distribution

Table 2 highlights the clinical presentation of anemia among the studied patients, showing that pallor was the most common clinical finding, observed in 90% of cases, followed closely by fatigue and weakness reported in 85% of patients. Dyspnea on exertion was also frequently noted, affecting 62.5% of individuals, while palpitations were present in 42.5%. Less common but still notable features included pedal edema in 25% and other symptoms such as headache and dizziness in 22.5% of patients.

These findings indicate that while pallor and fatigue are the predominant manifestations of anemia, a considerable proportion of patients also experience cardiopulmonary and systemic symptoms, reflecting the varied clinical spectrum of the disease.

Table 2: Clinical Presentation of Anemia		
Symptoms / Signs	**Frequency (n)**	**Percentage (%)**
Fatigue / Weakness	68	85%
Dyspnea on exertion	50	62.50%
Palpitations	34	42.50%
Pallor (clinical)	72	90%
Pedal edema	20	25%
Others (headache, dizziness etc.)	18	22.50%

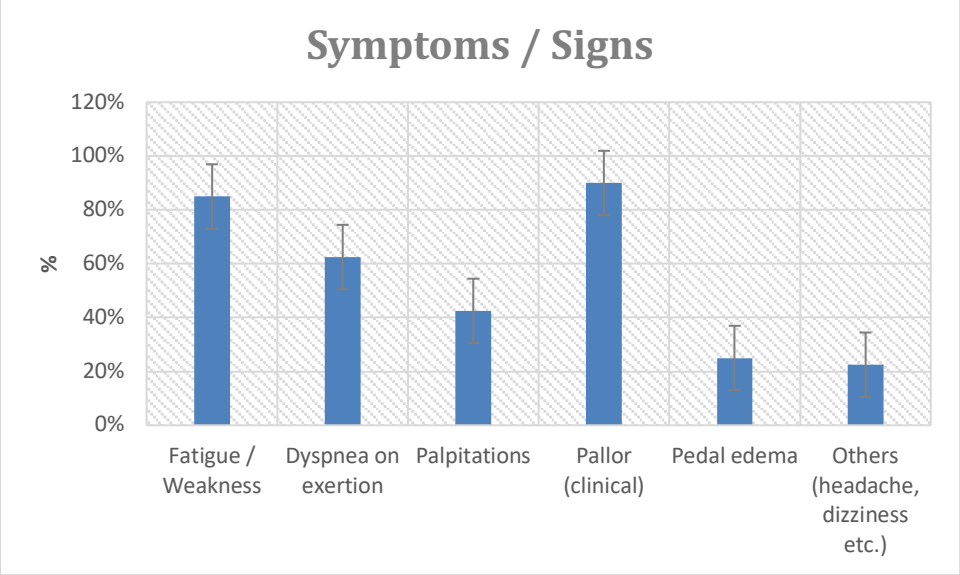

Figure 2: Clinical Presentation of Anemia

Table 3 presents the hematological parameters of 80 patients, showing a mean hemoglobin level of 8.4 ± 1.5 g/dl, indicating a prevalence of anemia among the study population, with values ranging from 5.2 to 11.9 g/dl. The mean hematocrit was 28.6 ± 4.2%, with a range of 18 to 36%, further supporting the presence of reduced red cell mass. The mean corpuscular volume (MCV) averaged 74.2 ± 9.6 fl, ranging from 60 to 100 fl, suggesting a predominance of microcytic to normocytic red blood cells. The mean corpuscular hemoglobin (MCH) was 24.5 ± 3.8 pg, within a range of 18 to 32 pg, reflecting relatively low hemoglobin content per red cell. Reticulocyte counts were low, with a mean of 1.2 ± 0.5% and a range of 0.4 to 2.5%, indicating a modest bone marrow response to anemia in the study group.

Table 3: Hematological Parameters of Patients (n=80)		
Parameter	**Mean ± SD**	**Range**
Hemoglobin (g/dl)	8.4 ± 1.5	5.2 – 11.9
Hematocrit (%)	28.6 ± 4.2	18 – 36
Mean Corpuscular Volume (MCV, fl)	74.2 ± 9.6	60 – 100
Mean Corpuscular Hemoglobin (MCH, pg)	24.5 ± 3.8	18 – 32
Reticulocyte count (%)	1.2 ± 0.5	0.4 – 2.5

Table 4 presents the distribution of anemia among the 80 adult patients based on morphological classification using mean corpuscular volume (MCV). The data show that microcytic anemia was the most prevalent type, affecting 44 patients, which accounts for 55% of the study population. Normocytic anemia was observed in 22 patients, representing 27.5%, while macrocytic anemia was the least common, occurring in 14 patients or 17.5% of the total. This distribution shows the microcytic type of anemia prevailing in the studied population, with the normocytic and macrocytic anemia came into the second and third place, respectively.

Table 4: Distribution of Anemia by Morphological Type (MCV based) (n=80)		
Type of Anemia	**Number of Patients (n)**	**Percentage (%)**
Microcytic anemia	44	55%
Normocytic anemia	22	27.50%
Macrocytic anemia	14	17.50%
Total	**80**	**100%**

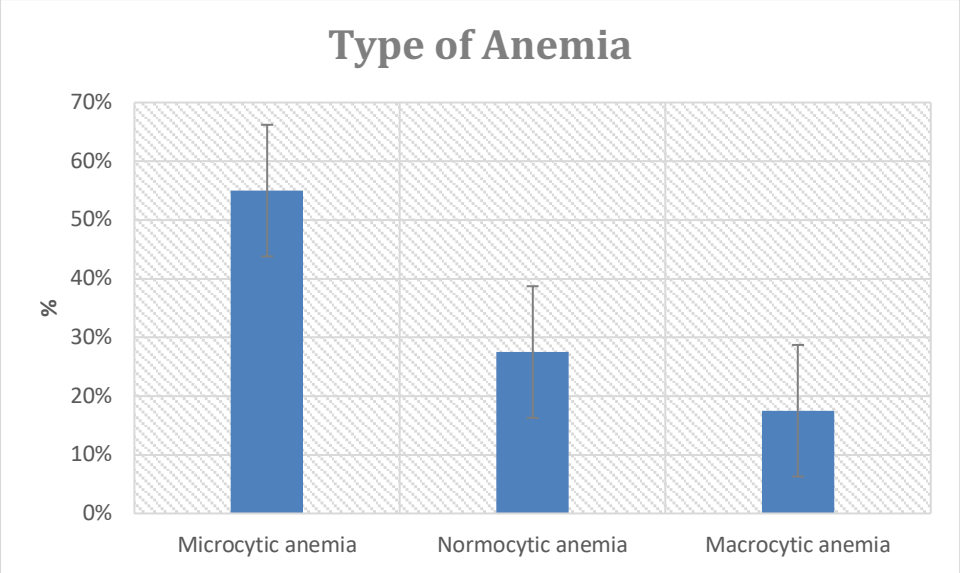

Figure 4: Distribution of Anemia by Morphological Type

Table 5 shows an etiological profile of anemia in the members of the study. The most common was iron deficiency anemia with 34 patients and that is 42.5 percent of the cases. This was followed by anemia of chronic disease (ACD) in 18 patients (22.5) and anemia of megablastics secondary to vitamin B12/folate deficiency in 12 patients (15%). Thalassemia and anemia associated with chronic kidney disease (CKD) had 6 cases each, which were 7.5% and 7.5% respectively. Also 4 patients (5%), had mixed or unclassified causes of anemia. At large, the statistics suggest that the most common causes of anemia in this group are nutritional deficiencies and chronic diseases.

Table 5: Etiological Profile of Anemia		
Etiology	**Number of Patients (n)**	**Percentage (%)**
Iron Deficiency Anemia	34	42.50%
Anemia of Chronic Disease (ACD)	18	22.50%
Megaloblastic Anemia (Vit. B12 / Folate)	12	15%
Hemoglobinopathies (e.g., Thalassemia)	6	7.50%
Chronic Kidney Disease (CKD) related	6	7.50%
Mixed / Unclassified	4	5%
Total	80	100%

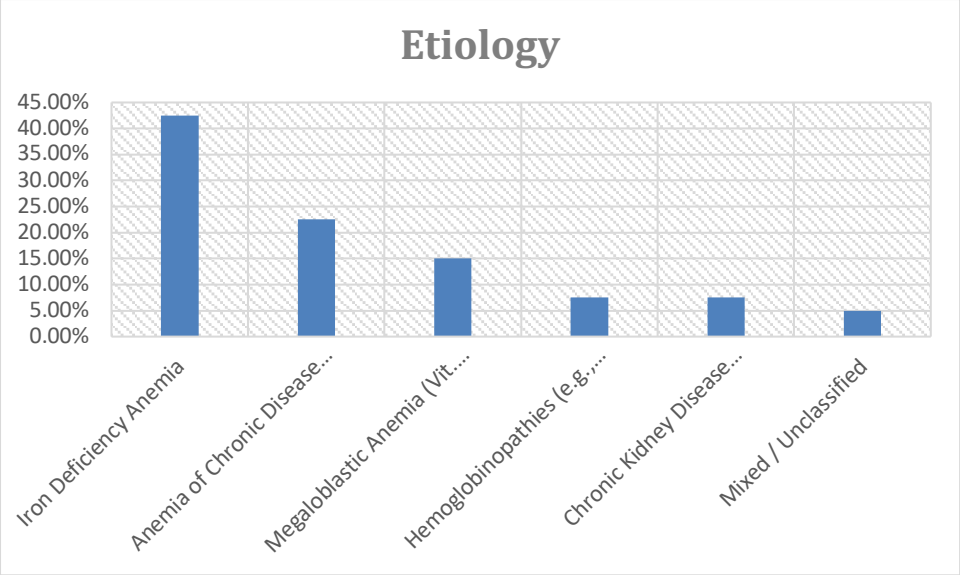

Figure 5: Etiological Profile of Anemia

Discussion

The current paper has evaluated the demographic, clinical, hematological, morphological, and etiological features of anemia in 80 adult patients. The age and gender distribution showed that there was a slightly more prevalence in males (55) than in females (45) with majority of the participants being in the middle and early elderly category (51-60 years, 25%). This pattern aligns with prior studies indicating that anemia is more frequently observed in middle-aged and elderly populations due to cumulative nutritional deficiencies, chronic diseases, and age-related decline in hematopoietic efficiency. Interestingly, the youngest age group (18–30 years) demonstrated a relatively higher female representation, likely reflecting iron deficiency due to menstrual blood loss and dietary insufficiencies, consistent with epidemiological trends in developing countries.

Findings from the present study, involving 214 hospitalized patients aged >60 years, indicate that the prevalence of anemia is 73.3%. This study corroborates the high prevalence of anemia in hospitalized cases previously reported in studies at various hospitals, demonstrating prevalence rates of anemia ranging between 33% to 67% (Nandigam et al., 2004) [9]. The prevalence of anemia in our cohort of hospitalized geriatric patients was greater than that reported in community-dwelling older adults (Mozaffarian et al., 2003; Silverberg et al., 2000) [10,11]. This might reflect the higher risk of geriatric patients with an illness necessitating hospitalization to present to the hospital setting and higher burden of comorbidities in the group of hospitalized patients. In our study, a majority of patients enrolled had moderate and severe anemia.

Clinically, the study found pallor to be the most common presenting feature (90%), followed by fatigue and weakness (85%), and dyspnea on exertion (62.5%). Palpitations were reported in 42.5% of patients, whereas less frequent manifestations included pedal edema (25%) and systemic symptoms like headache and dizziness (22.5%). These findings highlight the variable clinical spectrum of anemia, where non-specific symptoms such as fatigue and dyspnea may dominate and subtle signs like pallor provide crucial diagnostic clues. The high prevalence of cardiopulmonary symptoms reflects the physiological compensatory mechanisms triggered by reduced oxygen-carrying capacity of the blood, which is consistent with established pathophysiological understanding of chronic anemia.

Our studies align with findings from Barron et al. 2001, who identified a cause of anemia due to iron, folate/Vitamin B12 depletion in 77 cases (32.62%). They utilized depletion of iron stores from the bone marrow as a measure of deficiency [12]. A study from South India identified ACD (48%) as the most common anemia, followed by IDA (30%) (Van et al., 2001) [13]. Klee (2000) similarly identified ACD as the most prevalent (n=50, 55.56%) with IDA (n=27, 30%) also prevalent as a cause of anemia, but one major study limitation was serum B12 and folate levels were not part of the study protocol and as a result was unable to identify the various causes of nutritional anemia [14].

Hematologically, the mean hemoglobin of 8.4 ± 1.5 g/dl and hematocrit of 28.6 ± 4.2% confirm the presence of moderate anemia in the study population. The predominance of microcytic red blood cells (mean MCV 74.2 ± 9.6 fl) and low MCH (24.5 ± 3.8 pg) indicates that iron deficiency is the principal hematologic pattern, while low reticulocyte counts (1.2 ± 0.5%) suggest an inadequate bone marrow response, which may be due to chronic nutrient deficiency or underlying chronic disease. These results are consistent with prior reports in which

microcytosis and hypochromia were strongly associated with iron deficiency anemia, while normocytic and macrocytic patterns often indicated chronic disease or vitamin B12/folate deficiency, respectively.

Charlton et al., 2004 [15] diagnosed a nutritional folate deficiency in 20 of the 95 (>21%) anemic patients and Cobalamin deficiency in 11 (11.6%) of the same 95 hospitalized patients. However, Wadia et al. 2000 reported a 3% B12 deficiency and a 2% folate deficiency [16]. Siffledeen et al. 2003 also reported a very low prevalence of Vitamin B12 and folate deficiency in 2 (1.9%) and 1 (0.9%) patients, respectively [17]. A possible reason for this discrepancy is that the Vitamin B12/folate assays used were for dimorphic and macrocytic anemias and B12/folate deficiency anemia can also be normocytic or microcytic. Classical diagnostic algorithms for anemia based on the MCV may not be accurate for older adults because they were developed to identify single etiology; however, anemia in older adults is often multifactorial due to multiple concomitant morbidities (Asobayire et al., 2001) [18].

Morphologically, microcytic anemia was the most prevalent type (55%), followed by normocytic (27.5%) and macrocytic anemia (17.5%). This distribution mirrors the etiological profile, as iron deficiency remains the dominant cause of anemia worldwide, particularly in resource-limited settings. Normocytic anemia, observed in over one-fourth of cases, is typically associated with chronic diseases, renal insufficiency, or mixed etiologies, whereas macrocytic anemia predominantly arises from megaloblastic deficiencies of vitamin B12 or folate, as confirmed in the study.

The etiological analysis revealed iron deficiency anemia in 42.5% of patients, making it the most common cause, followed by anemia of chronic disease (22.5%) and megaloblastic anemia (15%). Hemoglobinopathies and CKD-related anemia were less frequent, each accounting for 7.5% of cases, while mixed or unclassified etiologies comprised 5%. These findings underscore the multifactorial nature of anemia, with nutritional deficiencies and chronic illnesses being the principal contributors. The prominence of iron deficiency aligns with dietary insufficiency patterns, menstrual blood loss in females, and chronic blood loss due to gastrointestinal or other underlying conditions. Anemia of chronic disease was notable in patients with comorbidities such as infections, inflammatory disorders, and chronic kidney disease, reflecting impaired iron utilization and suppressed erythropoiesis. Megaloblastic anemia, though less prevalent, highlights the continued relevance of vitamin B12 and folate deficiency, often secondary to inadequate intake, malabsorption, or chronic alcoholism.

Chronic renal failure is another common cause of anemia in our cohort (9.3%). The relative significance of CKD has increased as a proportion of the total global anemia burden. In 2003, Coresh et al. diagnosed anemia secondary to renal failure in 17.9% based on a criterion of <40 mL/min/1.73 m2 [19]. Prevalence of anemia secondary to renal disease varied between 12.3% and 21% in other studies (McClellan et al. 2004; Li et al. 2005) [20, 21]. The lower prevalence of anemia of renal origin in our cohort could partially be due to using a lower renal function threshold. Another explanation may be its association with iron/B12 deficiency which allowed it to be classified in the group of multifactorial anemia. Public health interventions aimed at reducing the risks associated with the development of CKD, such as diabetes and hypertension control may also assist with reducing the burden of anemia in the elderly.

Overall, the study findings emphasize the importance of a systematic approach to anemia, integrating demographic, clinical, hematological, and etiological assessment for accurate diagnosis and effective management. Early identification of iron deficiency and nutritional deficiencies is crucial, especially in young women and elderly populations, while recognizing chronic disease-related anemia facilitates appropriate management of underlying comorbidities. The results also suggest that targeted interventions such as iron supplementation, vitamin replacement, and management of chronic illnesses could substantially reduce the burden of anemia in adult populations.

Conclusion

This study highlights the high prevalence and multifactorial nature of anemia among adult patients, with a slight male predominance and peak incidence in the middle-aged and early elderly population. Clinical manifestations were dominated by pallor, fatigue, and dyspnea, reflecting the systemic impact of reduced oxygen-carrying capacity. Hematological findings confirmed moderate anemia, with microcytic morphology being the most common, consistent with iron deficiency as the leading cause. Anemia of chronic disease and megaloblastic anemia due to vitamin B12 or folate deficiency were also significant contributors, while hemoglobinopathies and CKD-related anemia were less frequent. These findings underscore the necessity of thorough etiological evaluation to guide targeted interventions, including nutritional supplementation and management of chronic illnesses, ultimately improving patient outcomes and reducing the public health burden of anemia in adult populations.

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