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# A Cross-Sectional Observational Study on the Prevalence and Profile of Anemia in Type 2 Diabetes Mellitus Patients at a Tertiary Care Teaching Hospital in Jaipur

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**KEYWORDS**

Anemia, Social Class, Diabetes mellitus, Type 2 diabetes mellitus, Haemoglobin, Hba1c, hyperglycaemia

**ABSTRACT:**

AIM

This study aims to study the anemia profile in type 2 diabetes mellitus patients in Jaipur's tertiary care teaching hospital.

MATERIAL AND METHODS

The study involved 210 type 2 diabetes patients. The study was a prospective, cross-sectional observational study on type 2 DM. All the necessary data were collected through a data collection form and analyzed in SPSS v.27 (IBM). P value <0.05 was considered statistically significant.

RESULTS

The study was carried out over six months among JNUIMSRC patients and patients. The patients were evaluated for demographic information, laboratory factors, and diabetes mellitus complications, as shown in the table. A total of 210 individuals were investigated, with (49%) male and (51%) female. Diabetes mellitus has become more common as people get older. Diabetes affects 4(6.55%) of people between the ages of 15 and 30 and 26(42.62%) of people over the age of >62 years. The most common type of anemia observed was normocytic. The total number of anemic patients observed was 79.52%. It was observed in this study that the prevalence of anemia was more common in the socioeconomic upper lower (IV) class and was statistically significant (0.014).

CONCLUSION

The study found a higher prevalence of anemia, especially in females, with normocytic anemia being most common. Anemia increased with age, particularly in Type 2 Diabetes Mellitus patients. Socioeconomic factors also played a role, with the upper-lower class showing the highest prevalence. These findings highlight the need for targeted interventions based on gender, age, and socioeconomic status.

## INTRODUCTION

Diabetes mellitus is a serious, long-term condition in which a person's blood glucose levels increase due to inadequate or absent insulin production in their body, or their body's inability to use the insulin it produces. Type 2 diabetes mellitus is a rapidly growing global health issue, affecting millions of people worldwide. Diabetes is a complex disease that impacts multiple organ systems. As a type of metabolic disorder, diabetes mellitus has a significant global influence [1]. Type 2 diabetes tends to run in families and is heritable. The likelihood of siblings of a patient with T2DM also having the condition is 2-3 times higher than the general population, but this ratio increases to 30 if two siblings have T2DM [2]. Additionally, if the mother has the condition, the risk of the children having T2DM is higher compared to when the father has the disease [3].

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Diabetes mellitus is the main cause of end-stage renal illness because a large proportion of its patients have renal issues. Anemia may contribute to the development of diabetes-related problems and is an important indicator of renal disease [4]. Diabetes-related chronic hyperglycemia can induce a hypoxic state in the retinal interstitium, which hinders peritubular fibers' capacity to make erythropoietin and increases the risk of anemia [5]. Type 2 diabetes mellitus (DM2) is becoming more and more common, which is a serious public health concern. Due to factors like population and urbanization growth, rising rates of obesity and sedentary lifestyles, and longer patient survival rates, the number of people with diabetes has been rising. [6]

Type 2 diabetes is becoming more commonplace worldwide, and in many nations, it has reached epidemic proportions. In 2030, there will be 552 million diabetic people globally, according to a recent prediction by the International Diabetes Federation. From 2011 to 2030, there is a 50.7% expected rise in population, growing at a rate of 2.7% annually, or 1.7 times the global adult population growth yearly. In just India and China, there is a 48 percent chance that the number of diabetics worldwide would rise to 186 million. Diabetes is expected to affect 366 million people worldwide by 2030, with India experiencing the largest increase. It was 171 million in 2000. India already has 61.3 million diabetic patients, and by 2030, that number is predicted to increase to 101.2 million. With 31.7 million diabetes patients, India led the globe in 2000; China came in second with 20.8 million diabetics. Complications will probably grow in tandem with this larger diabetes burden [7].

Due to the existence of anemia, the HbA1c values are erroneously low, which results in poor control of hyperglycemia and may worsen the severity of diabetes complications. Diabetes patients' clinical presentation, underlying pathophysiology, and disease development can vary greatly from person to person. In certain cases, unusual symptom presentation might further complicate the diagnosis of type 2 diabetes. Many people with type 2 diabetes (T2DM) have no symptoms at diagnosis, while some have severe hyperglycemia or even diabetic ketoacidosis. Adults with latent autoimmune diabetes4 and young people with maturity-onset diabetes [8] may present as type 2 diabetes. The time and frequency of testing for T2DM or prediabetes in asymptomatic individuals depend on whether risk factors are present or absent[9].

Anemia is a worldwide public health issue that affects people of all ages and genders in both industrialized and developing nations. Approximately 24% of the world's population, or 1.62 billion individuals, suffer from anemia. The condition is most common in poorer nations, affects preschoolers to the greatest extent, and has the least impact on adult males. A common finding in patients with diabetic nephropathy, anemia is one of the common preventable conditions that is often overlooked. Diabetes-related chronic hyperglycemia can lead to a hypoxic environment at the renal interstitium, which impairs the production of erythropoietin from peritubular fibroblast cells and ultimately causes anemia.

Anemia in diabetic patients may aggravate and worsen the complications of type 2 diabetes, such as neuropathy and nephropathy. Anemia is also an independent risk factor for complications like diabetic retinopathy. Other mechanisms causing anemia may exist prior to the involvement of the kidneys in patients with diabetes mellitus and may contribute to the pathogenesis and progression of cardiovascular disease in diabetes mellitus patients. It may be possible to slow the development of vascular issues in these individuals by putting more of an emphasis on screening for anemia, other diabetes-related comorbidities, and hemoglobin level correction [10,12].

Chronic kidney disease is most commonly caused by diabetes mellitus, and previous research has demonstrated that anemia is a recognized consequence of the condition. In individuals with type 2 diabetes mellitus who have normal kidney function, that is, before extensive renal failure occurs, anemia has not, however, received much attention[11]. In addition to examining the forms of anemia that these individuals experience, the study intends to ascertain the prevalence of anemia in patients with type 2 diabetes mellitus and normal blood creatinine levels. People who have both diabetes and anemia have been found to have a greater death rate than people who only have diabetes. Therefore, treating anemia in diabetics as soon as possible may help lower the morbidity and death rates related to diabetes complications [12].

**METHODS**

The study was conducted in the Department of General Medicine, Jaipur National University Institute of Medical Science & Research Centre, Jaipur, Rajasthan in North western India. The subjects for the study included 210 adult patients with age more than 25 years and having diabetes attending in the medicine outdoor patient department (OPD) or admitted in the ward as in the medicine indoor patient department (IPD) and were selected for this study. The study was approved by the Institutional Ethics Committee,

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Jaipur National University Institute of Medical Science & Research Centre, Jaipur, Rajasthan (approval number: JNUIMSRC/IEC/2023/120 Dated 28 November 2023). All participants were explained about the purpose of the study. Sample Calculation: The sample size was calculated using the Rao Soft sample size calculator at 95% CI, 5% margin of error and 50% response distribution. The total sample size was 210 patients with Type 2 diabetes mellitus diagnosed at least one year back. (N=210). All participants signed the informed consent in this research. At the beginning we take their general information. After obtaining informed written consent, all patients were subjected to detailed history, through clinical examination and investigation.

The **laboratory investigations** were based on the World Health Organization criteria for anemia classification: males with hemoglobin levels below 13 g/dl and non-pregnant females with levels below 12 g/dl. Clinical grading was determined by random blood sugar levels and HbA1c ranges. For HbA1c, the following classifications were used: non-diabetic (4.5-5.7%), good control (6.0-7.0%), pre-diabetic (5.8-6.5%), fair control (7.0-8.0%), diabetic (>6.5%), and poor control (>8.0%). Hemoglobin levels were categorized as mild (12–15 g/dl for females, 13–17 g/dl for males), moderate (8–10.9 g/dl), and severe (<8 g/dl).

**Inclusion Criteria**

Patients diagnosed with Type 2 diabetes mellitus for at least 12 months, having at least one HbA1c reading≥ 6.5, Without insulin use in the first year after diagnosis, without a history of ketosis or ketonuria, Diagnosed with an age ≥ 25 years.

**Exclusion Criteria**

Newly detected Type 2 DM patients within 12 months of diagnosis, Less than 25 years of age, Patients diagnosed with Type 1 Diabetes mellitus, Gestational Diabetes mellitus, Patient not willing to provide consent.

Ethical clearance for the study was obtained from the Joint Institutional Ethics Committee of the hospital (Registration number JNUIMSRC/IEC/2023/120) on November 23, 2023. Informed consent was also obtained from all participants.

**SOCIOECONOMIC STATUS SCALE USE** The modified Kuppuswamy Socioeconomic Status (SES) scale is widely used in India to assess the socioeconomic status of individuals or families. It categorizes families into five classes based on a total score ranging from 3 to 29. However, the scale needs regular adjustments to account for changes in income levels influenced by fluctuating consumer price index (CPI) values. Hence, this paper seeks to revise and present an "Updated Modified Kuppuswamy SES" for the year 2023, addressing the need for current and accurate socioeconomic classification [18].

**STATISTICAL ANALYSIS** : The Data were analyzed Using IBM SPSS Statistics Version 27. Frequency (Percentages) descriptive statistics, such as mean and standard deviation, were calculated for explanatory variables, and statistical tests, including the t-test and the Chi-square test, were utilized to investigate the differences between the two groups. Furthermore, we conducted a determine the strength of the association between hemoglobin level and other continuous variables P values.

## RESULTS

**TABLE 1: DISTRIBUTION OF AGE GROUP FEMALE AND MALE.**

| AGE GROUPS | SEX | | TOTAL |
|---|---|---|---|
| | MALE | FEMALE | |
| 25-34 Years | 10 | 11 | 21 |
| | 47.61% | 52.38% | 100.0% |
| 35-44 Years | 21 | 19 | 40 |
| | 52.5% | 47.5% | 100.0% |
| 45-54 Years | 25 | 28 | 53 |
| | 46.15% | 53.84% | 100.0% |
| 55-64 Years | 23 | 24 | 47 |
| | 48.93% | 51.06% | 100.0% |
| 65-74 Years | 18 | 22 | 40 |
| | 45.0% | 55.0% | 100.0% |
| 75-84 Years | 05 | 04 | 09 |
| | 55.55% | 44.44% | 100.0% |
| TOTAL | 102 | 108 | 210 |
| | 48.57% | 51.42% | 100.0% |

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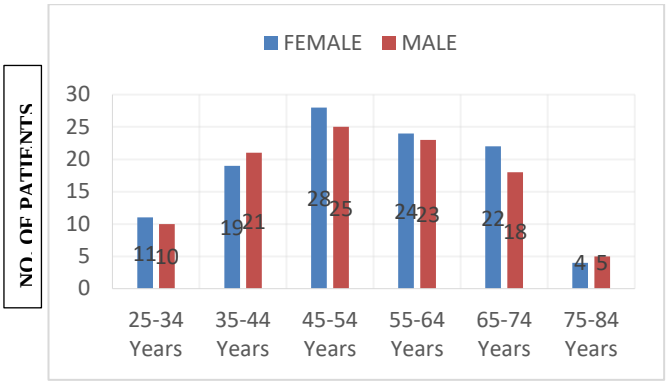
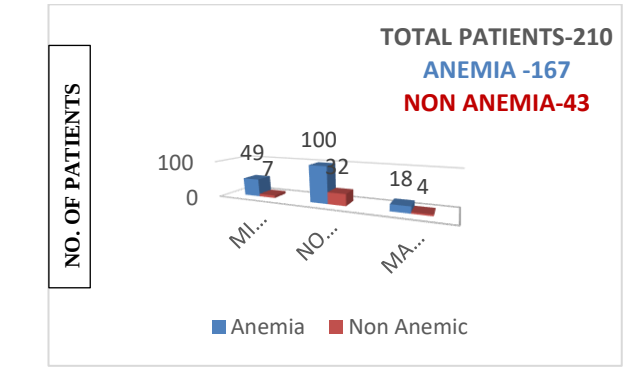
**GRAPH 1: DISTRIBUTION OF AGE OF T2DM CASE.**




The study analyzed 210 patients with type 2 diabetes and anemia, selected through random convenient sampling. The sample was divided into six age groups and analyzed based on simple demographic factors. The highest number of type 2 diabetes cases occurred in the 45-54 age group, with 52 patients (24 males and 28 females) **(Table 1) (Graph 1)**.

| MCV | Anemia | | Total |
|---|---|---|---|
| | Anemia | Non-Anemic | |
| MICROCYTIC | 49 | 7 | 56 |
| | 87.5% | 12.5% | 100% |
| NORMOCYTIC | 100 | 32 | 132 |
| | 75.75% | 24.24% | 100% |
| MACROCYTIC | 18 | 4 | 22 |
| | 81.81% | 18.18% | 100% |
| TOTAL | 167 | 43 | 210 |
| | 79.52% | 20.47% | 100% |

**TABLE 2: DISTRIBUTION OF ANAEMIA ACCORDING TO MCV IN T2DM.**

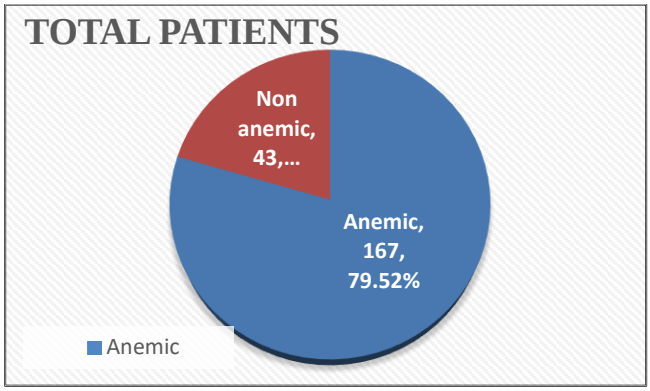



**GRAPH 2: MCV RESULT PATIENTS ANEMIA AND NON-ANEMIA**

A total of 167 anemic cases were analyzed, among that 83 male and 84 female patients; anemia was classified as microcytic, macrocytic, and normocytic based on MCV data interpretation. In anemic cases, the majority of the patients 49 cases comprising 25 males and 24 females, i.e., (29.34%) were found to have microcytic anemia, followed by 100 cases comprising 51 males and 49 females, i.e., (59.88%) with normocytic anemia. Macrocytic anemia was present in 18 cases, comprising 7 males and 11 females, accounting for (10.77%) of the total cases. Further, the above information is presented in **Table 2.**

| HBA1C | Anemia | | Total |
|---|---|---|---|
| | Anemic | Non-anemic | |
| Diabetic:-> 6.5% | 167 | 43 | 210 |
| | 79.52% | 20.47% | 100% |
| Chi-square: 6.069, P value: < 0.001 | | | |

**TABLE 3: DISTRIBUTION OF ANEMIA ACCORDING TO MCV IN T2DM**




**GRAPH 3: DISTRIBUTION OF ANAEMIA ACCORDING TO MCV IN T2DM**

The study observed 167 cases of anemia in people with Type 2 Diabetes Mellitus. The research found a significant correlation between anemia and HbA1c levels, which measure glycemic control. A good HbA1c level for non-diabetic individuals falls between 4.5% to 5.7%. Among the diabetic, frail patients, 79.52% had HbA1c levels greater than 6.5%, indicating uncontrolled diabetes. This shows that the prevalence of anemia increases with HbA1c levels, particularly in diabetic patients with undiagnosed anemia. There were 43 out of 210 subjects (20.47%) in the non-

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anemic control group with HbA1c levels >6.5%.

**TABLE 4: COMPARISON OF CLINICAL PROFILES BETWEEN DIABETIC PATIENTS WITH AND WITHOUT ANEMIA.**

| Variables | Diabetic with anemia (n=167) | Diabetic with non-anemia (n=43) | P- value |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| Mean age (years) | 52.60 ± 13.83 | 54.88 ± 15.54 | 0.002 |
| Hemoglobin (g/dL) | 9.86 ± 1.91 | 13.82 ± 2.67 | 0.001 |
| Mean Corpuscular Volume (FL) | 78.50 ± 5.82 | 91.03 ± 8.10 | 0.000 |
| Mean Corpuscular Hemoglobin (pg.) | 25.19 ±2.38 | 29.04 ±3.10 | 0.001 |
| Postprandial Blood Sugar (mg/dL) | 297.07 ± 99.75 | 241.86 ± 91.30 | 0.024 |
| HbA1c (%) | 9.55 ± 3.36 | 8.41 ± 2.45 | 0.001 |
| **Chi square = 6.54** | | | |

The study found that the mean age of patients with anemia was 52.60 ± 13.83 years, while the mean age of patients without anemia was 54.88 ± 15.54 years. The average age difference between the two groups was statistically significant ($P < 0.05$). This suggests that the risk of anemia increases with age. Out of 210 patients, 79.52% were observed to be anemic. Among the diabetic patients, 51.42% were females and 48.57% were males. Specifically, out of the 210 patients, 167 were anemic, resulting in a 79.52% prevalence rate. Anemia was detected in 51.42% of diabetic females and 48.57% of diabetic males. There was a significant relationship between anemia and gender in diabetic patients. Anemia prevalence is higher in diabetic females than in diabetic males ($P < 0.05$). Additionally, diabetic patients with anemia have a significantly higher prevalence of anemia compared to those without anemia ($P < 0.05$). The mean hemoglobin level of diabetic patients with anemia was 9.86 ± 1.91, and for diabetic patients without anemia, it was 13.82 ± 2.67. The mean corpuscular volume (MCV) for patients with diabetes and anemia was 78.50 ± 5.82, whereas for individuals with diabetes without anemia, it was in the range of 91.03 ± 8.10. The mean PBS for patients with diabetes and anemia was 230.07 ± 99.75, while for those with diabetes but no anemia, it was 241.86 ± 109.30. Additionally, the standard deviation of PBS for patients with diabetes and anemia was 9.55 ± 3.36, and for those with diabetes but no anemia, it was 8.41 ± 2.45.

**TABLE 5: ASSOCIATION OF TYPE OF ANEMIA WITH SOCIOECONOMIC STATUS.**

| AGE GROUP WITH SOCIOECONOMIC | TYPES OF ANEMIA | | | P VALUE |
|---|---|---|---|---|
| | MICROCYTIC | NORMOCYTIC | MACROCYTIC | |
| Upper (I) | 0 | 0 | 0 | 0.014 |
| Upper Middle (II) | 8 | 16 | 5 | |
| Lower Middle (III) | 13 | 40 | 8 | |
| Upper Lower (IV) | 24 | 64 | 5 | |
| Lower (V) | 8 | 12 | 7 | |
| Total | 53 | 132 | 25 | |

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The socioeconomic class was categorized based on the types of anemia. Out of 210 patients, 64 in the upper lower socioeconomic class (IV) had a greater number of normocytic anemias, which was found to have statistical significance (P=0.014).

**DISCUSSIONS**

The study was conducted in the medicine department with 210 patients, 102 are male and 108 are female counting for 48.57 % and 51.42 % respectively with male: female ratio of 1:1.05 T2DM fulfilling the inclusion and exclusion criteria. it was observed that the prevalence of anemia was greater in diabetic patients compared to non-diabetic patients. Another study conducted by Gunvanti B. Rathod *et.al.*, found a similar result, concluding that the prevalence of anemia was greater in diabetic patients [13]. It was inferred that females are most likely to develop anemia in diabetes mellitus as compared to males. Salma M. Al Dallal *et.al.*, reached the same conclusion; out of the 210 cases of T2DM based on MCV, 100 are normocytic, 49 are microcytic, and 18 are macrocytic [14]. When anemia was studied among these groups based on MCV, it was found that 100 out of 132 of the normocytic group were anemic. Similarly, 49 out of 56 of the microcytic group were anemic, and 18 out of 22 of the macrocytic group were anemic. Our study also found that the most common type of anemia in the diabetic group was normocytic anemia (100/ 210), which was diabetic with the non-anemia group (32/ 210). This higher prevalence of normocytic anemia could be because anemia in the studied population without non-anemic diabetes is also 24.24%, and it was found in non-anemic diabetes. The predominant type of anemia in the population was normocytic anemia in diabetes patients. The research found a significant correlation between anemia and HbA1c levels, which measure glycemic control. A good HbA1c level for non-diabetic individuals falls between 4.5% to 5.7%. Among the diabetic anemic patients, 167 out of 210 subjects (79.52%) had HBA1c levels > 6.5%, resulting in uncontrolled diabetes. A Nigerian study revealed that anemia is more prevalent among patients with poorly controlled diabetes compared to those with well-managed diabetes. Furthermore, Awofisoye, *et al*. diabetic autonomic neuropathy, which often arises in the early stages of poorly managed diabetes, can interfere with erythropoietin production. This disruption may lead to an early decline in erythropoietin levels in patients with poor glycemic control [15]. There were 43 subjects out of 210 subjects (20.47%) of diabetics in the non-anemic control group with HBA1c levels of >6.5%. Our study found that the mean age of patients with anemia was 52.60 ± 13.83 years, while the mean age of patients without anemia was 54.88 ± 15.54 years. The difference in average age between the two groups was statistically significant ($P < 0.05$). This suggests that the risk of anemia increases with age, which is anemia was more common in the upper lower social economics class than in the upper middle and upper class. Anupam Raj Gaurab *et.al.*, found a similar result [16]. There was a statistically significant relationship between anemia and gender in diabetic patients. The prevalence of anemia is significantly higher in diabetic females than in diabetic males ($P < 0.05$). Additionally, diabetic patients with anemia had a significantly higher prevalence of anemia than those without anemia ($P < 0.05$). The mean Hemoglobin of patients with diabetes with anemia was found to be 9.86 ± 1.91, and for people with diabetes with non-anemia, it was found to be 13.82 ± 2.67. The MCV for patients with anemia was 78.50 ± 5.82, and for people with diabetes with non-anemia, it was found to be 91.03 ± 8.10, which is similar to a study done by Vitalis F. Feteh *et.al.*,[17]. The PBS for patients having diabetes with anemia was found to be 230.07 ± 99.75 and for people with diabetes with non-anemia found to be 241.86 ± 109.30. The PBS for patients having diabetes with anemia was found to be 9.55 ± 3.36, and for people with diabetes with non-anemia, it was found to be 8.41 ± 2.45. The study observed 167 cases of anemia among people with Type 2 Diabetes Mellitus (T2DM). The research found a significant correlation between anemia and HbA1c levels, which measure glycemic control. Among the diabetic anemic patients, 167 out of 210 patients (79.52%) had HBA1c levels > 6.5%, resulting in uncontrolled diabetes. This shows that the prevalence of anemia increases with HBA1c levels, particularly in diabetic patients with undiagnosed anemia. There were 43 subjects out of 210 subjects (20.47%) of diabetics in the non-anemic control group with HBA1c levels of >6.5%. Many people with DM suffer from renal problems, which makes DM the leading cause of end-stage renal illness. Anemia is a significant indicator of renal disease and may contribute to the onset of diabetes-related issues. Diabetes-related chronic hyperglycemia may create a hypoxic state inside of a retinal interstitial, impairing peritubular fiber's ability to make erythropoietin and contributing to anemia. Type 2 diabetes affects more than 95% of persons with the disease. Non-insulin-dependent or adult-onset type 2 diabetes was previously referred to as such. This kind of diabetes was previously exclusively observed in adults, but it is now

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increasingly common in youngsters as well.

## CONCLUSION

This study revealed that the prevalence of anemia was notably higher in patients, particularly among females compared to males. The predominant form of anemia observed was normocytic, accounting for 100% of cases, followed by microcytic anemia, which was present in 49% of patients, and macrocytic anemia, which was the least common at 18%. Additionally, the research highlighted an increase in anemia prevalence with age, particularly in patients with Type 2 Diabetes Mellitus (T2DM). Socioeconomic factors also played a significant role, with anemia being more common in the upper-lower socioeconomic class (98 patients) than in the upper-middle (28 patients) or lower-middle (61 patients) classes. These results suggest that both demographic factors like gender and age, as well as socioeconomic status, contribute significantly to the higher prevalence of anemia, underscoring the need for targeted interventions in specific patient populations.

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**CONFLICT OF INTEREST**: None

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