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Prevalence of anemia and contributing factors among patients at MZH: A cross-sectional study

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Abstract

Background: Anemia is a global health issue, and its prevalence varies depending on multiple factors such as age, gender, and nutritional status. This research aimed to determine the prevalence of anemia and identify its related factors at Madinat Zayed Hospital.

Methodology: A retrospective cross-sectional study was conducted using data from the hospital's electronic medical records system, covering the period from January 2022 to March 2023. Data on hemoglobin, ferritin, vitamin B12, transferrin saturation, transferrin, and iron levels were collected. The total sample included 15,776 hemoglobin measurements, 1,119 ferritin, 226 vitamin B12, 1,801 transferrin saturation, 325 transferrin, and 1,472 iron measurements. Anemia was diagnosed based on WHO criteria (Hgb ≤121 g/L for females and ≤138 g/L for males) and classified as mild, moderate, or severe. SPSS (version 26.0) was used for the analysis of data. Prevalence was measured using descriptive statistics. At the same time, Chi-square tests were used to assess the association of anemia with gender, age, and biochemical markers.

Results: The overall prevalence of anemia was 86.3% (n = 13,621). Anemia severity was classified as moderate in 48.9% (n = 7,713) of cases, mild in 29.8% (n = 4,705), and severe in 6.6% (n = 1,036). Significant associations were found between anemia and gender, with females being more prone to moderate anemia (Chi-square = 3000.64, p = 0.000). Age was also a factor, as middle-aged patients (31-50 years) were more likely to have moderate anemia (Chi-square = 994.32, p = 0.000). However, no significant association was found between ferritin levels, iron levels, transferrin levels, vitamin B12 levels, and anemia severity.

Conclusion: Anemia remains highly prevalent at Madinat Zayed Hospital, with middle-aged females being particularly affected. While gender and age showed strong associations with anemia severity, ferritin, and transferrin saturation levels did not exhibit a significant correlation.

Keywords: Anemia; Iron; Ferritin; Anemia severity; Vitamin B12; Transferrin

1. Introduction

Anemia refers to a decrease in the number of red blood cells and/or the concentration of hemoglobin (Hb)(1). Anemia is one of the big public health issues worldwide, and it has serious effects on health, society, and the economy(2). In 2015, it impacted 24.8% of the global population, with the effects differing based on age, gender, altitude, and pregnancy status(3). Anemia can happen due to too much blood loss, inherited hemolytic diseases, or infections from parasites (4). Among the nutritional causes, deficiencies in iron, vitamin B12, folic acid, and ferritin are particularly common(5). There

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are several types of anemia, such as hemolytic anemia, sickle cell anemia, aplastic anemia, anemia of inflammation, and iron deficiency anemia. Out of these, iron deficiency is the leading cause of anemia, and it is responsible for about 42% of cases in children between 6 and 59 months globally(6). The prevalence of iron deficiency anemia in Saudi Arabia is reported to be between 30% and 56%(7). A study done in Riyadh City with schoolgirls found that the prevalence was 40.5% among female adolescents aged 16 to 18 years old(8). This type of anemia leads to decreased work capacity in adults and impacts mental growth in children and adolescents(9). People with IDA don't get enough iron, have issues with transporting or absorbing it, experience natural losses of iron, or suffer from ongoing blood loss due to illness(10). In adults, IDA can lead to various negative effects such as decreased work capacity or work, cognitive impairments, immune dysfunction, gastrointestinal issues, and problems with temperature regulation(11).

Iron deficiency is most common during puberty and as well as infancy(10). One common reason for iron deficiency anemia in pre-menopausal women is blood loss during menstruation. For every milliliter of blood lost, there's a loss of about 0.5 mg of iron(12). The lab tests that help confirm iron deficiency anemia (IDA) are serum ferritin, total iron binding capacity (TIBC), and transferrin saturation(13). A low serum ferritin level indicates iron deficiency, showing that the body's iron stores are depleted. Levels below 30 mg/L are considered the threshold for identifying mild cases; when anemia is present, ferritin levels tend to be lower, typically around 10-12 mg/L(13). Likewise, Vitamin B12 deficiency anemia is caused when the body does not have enough B12, which is needed for red blood cell production(14). Folic acid deficiency anemia, however, is caused by a lack of intake or absorption of a vitamin necessary for DNA synthesis and RBC formation, folate(14). These types of anemia are particularly dangerous to pregnant women, people with poor diets, or people with chronic conditions such as alcoholism, and must be diagnosed by testing for vitamin B12 and folic acid levels(14). A deficiency is indicated by low serum B12 levels, which can be confirmed by additional markers, such as elevated methylmalonic acid (MMA) and homocysteine levels, which usually rise when B12 is deficient(15). Similarly, serum folate is measured in order to diagnose folic acid deficiency anemia. A folate deficiency is indicated by low folate levels, and high homocysteine, which interferes with DNA synthesis and red blood cell formation(16). In patients, it is important to monitor hemoglobin, iron, ferritin, and vitamin levels to distinguish the type of anemia and to guide the appropriate treatment strategies. This study aims to determine the prevalence of anemia and its associated factors in Madinat Zayed Hospital, Saudi Arabia.

2. Methodology

2.1. Study Design, Area, and Period

This retrospective cross-sectional study conducted at Madinat Zayat Hospital aimed to determine the prevalence of anemia among patients and to identify factors associated with anemia. The data were extracted from the MZH hospital's electronic medical records system between January 2022 and March 2023. Madinat Zayed Hospital is located in the Al Dhafra Region of Abu Dhabi, United Arab Emirates. It is a modern healthcare facility equipped with state-of-the-art medical technologies. The hospital has a bed capacity of over 150 beds, providing a wide range of healthcare services, including emergency care, outpatient services, inpatient facilities, surgical units, and specialized clinics.

2.2. Population Characteristics

The study population included all pediatric as well as adult patients (age > 1 month) with hemoglobin measurements documented in the hospital's MRN during the study period.

2.3. Inclusion, and Exclusion Criteria

Patients with data available for hemoglobin (Hb), ferritin, vitamin B12, transferrin saturation, transferrin, and iron levels were eligible for inclusion in the study. All patients who agreed to participate were included in the study. Pregnant women, patients with bone marrow diseases, chronic kidney disease, and patients with inherited anemia disorders like sickle cell disease and thalassemia were excluded from the study.

2.4. Data Collection Procedure

We retrieved data from the electronic medical record system of Madinat Zayat Hospital, with 15,776 hemoglobin measurements. In addition, data were collected for other key biomarkers including 1,119 ferritin measurements, 226 vitamin B12 measurements, 1,801 transferrin saturation values, 325 transferrin levels, and 1,472 iron measurements

2.5. Diagnosis Of Anemia

For females, anemia was defined as having a hemoglobin (Hgb) value of 121 g/L or less, whereas for males, the Hgb value had to be 138 g/L or less. The severity of anemia was also classified as mild, which was defined as having a

hemoglobin level between 110 and 119 g/L in both males and females, moderate, which was defined as having a hemoglobin level between 80 and 109 g/L in both males and females, and severe, which was defined as having a hemoglobin level below 80 g/L in both males and females.

2.6. Ethical Approval

Madinat Zayed Hospital Ethics Committee gave ethical approval for this study. All patient data were anonymized to ensure confidentiality and privacy, and informed consent was obtained from all participants before inclusion in the study.

2.7. Data Analysis

SPSS (version 26.0) software was used to analyze the data and statistical tests were performed to see if there was an association between anemia and age, gender, ferritin, and vitamin B12 levels. Categorical associations were explored using the Chi-square test, p values of less than 0.05 were considered statistically significant. Quantitative variables were calculated using descriptive statistics (mean and standard deviation) and cross-tabulations were used to illustrate the relationships between anemia and the clinical parameters under study.

3. Results

3.1. Demographic Distribution of Patients Based On Laboratory Parameters

The study analyzed the age distribution and gender breakdown for participants across various hematological and biochemical parameters. The mean age for individuals with available hemoglobin (Hb) data was 45.20 ± 24.48 years, with a nearly even distribution of males (48.9%, n = 7709) and females (51.1%, n = 8067) among a total of 15,776 participants. For ferritin measurements, the mean age was 37.27 ± 14.99 years, with a majority of females (82.9%, n = 928) compared to males (17.1%, n = 191) out of 1119 participants. The mean age for individuals with vitamin B12 data was 39.19 ± 16.54 years, with females (58%, n = 131) outnumbering males (42%, n = 95) in a sample of 226. Transferrin saturation (SAT) was measured in participants with a mean age of 35.71 ± 19.49 years, where 79.6% (n = 1433) were female and 20.4% (n = 368) were male, out of 1801 participants. For transferrin levels, the mean age was 56.40 ± 18.98 years, with males making up 52.6% (n = 171) and females 47.4% (n = 154) of the 325 participants. Lastly, for iron measurements, the mean age was 38.22 ± 22.07 years, with a higher percentage of females (58.4%, n = 859) compared to males (41.6%, n = 613) out of 1472 participants.

Table 1 Age and Gender Distribution Of Patients

Parameters	Age (Mean ± S.D)	Male (%)	Female (%)	Total Participants
Hb (g/L)	45.20 ± 24.48	7709 (48.9%)	8067 (51.1%)	15776
Ferritin (mg/L)	37.27 ± 14.99	191 (17.1%)	928 (82.9%)	1119
Vit B12 (pmol/L)	39.19 ± 16.54	95 (42%)	131 (58%)	226
Transferrin SAT(%)	35.71 ± 19.49	368 (20.4%)	1433 (79.6%)	1801
Transferrin (mmol/L)	56.40 ± 18.98	171 (52.6%)	154 (47.4%)	325
Iron (mmol/L)	38.22 ± 22.07	613 (41.6%)	859 (58.4%)	1472

3.2. Hematological and Biochemical Profile of Patients

Table 2 presents the observed values for various parameters. The mean Hemoglobin (Hb) level was 105.45 ± 14.65 (L), ranging from 28 to 134 (L). The mean Ferritin level was 10.83 ± 4.47 (L), with a range of 0.30 to 29.90 (L). Vitamin B12 levels averaged 124.00 ± 20.17 (L), with values spanning from 41.10 to 198.6 (L). The mean Transferrin Saturation (SAT) was 0.091 ± 0.035, ranging from 0.00 to 0.15 (L). Transferrin levels had a mean of 21.08 ± 3.43 (L), with a range from 6.30 to 25.10 (L). Finally, the mean Iron level was 5.48 ± 2.25 (L), with values between 0.28 and 10.99 (L).

Table 2 Hematological and Biochemical Profile of Patients

Laboratory Parameters	Observed values (Mean± S.d)
Hb (g/L)	105.45±14.65
Ferritin (mg/L)	10.83±4.47
Vit B12 (pmol/L)	124.00±20.17
Transferrin SAT(%)	0.091±0.035
Transferrin (mmol/L)	21.08±3.43
Iron (mmol/L)	5.48±2.25

3.3. Prevalence of Anemia Among Patients at MZH

The overall prevalence of anemia among patients was 86.3%(13621) based on hemoglobin levels(Figure 1).

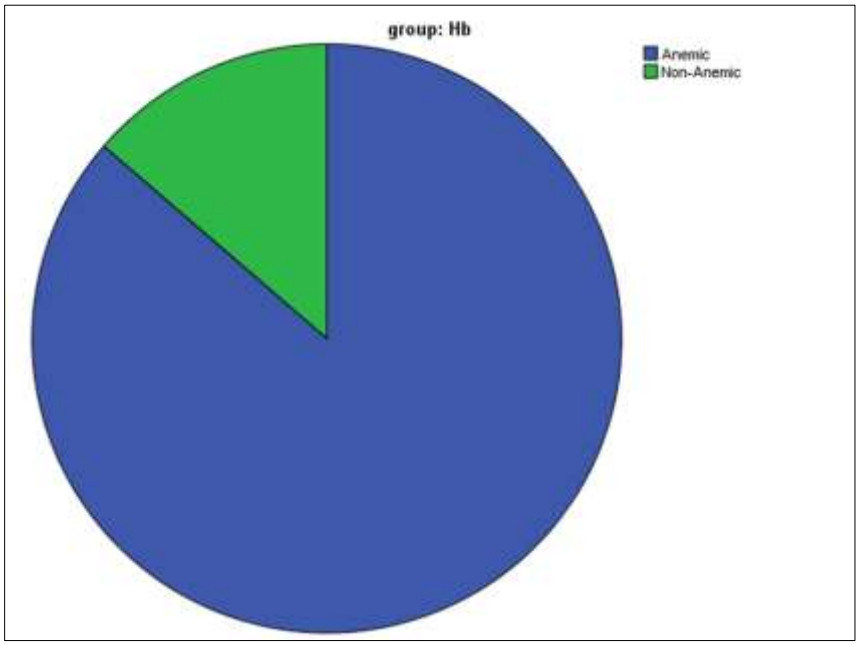

Figure 1 Pie Chart of Prevalence of Anemia

3.4. Severity of Anemia Among Patient At MZH

Table 3 illustrates the anemia severity among patients based on calculated Hemoglobin (Hb) levels. The results indicate that 48.9% of patients had moderate anemia, with Hb levels ranging from 80-109 g/L. Mild anemia was observed in 29.8% of patients, with levels between 110-119 g/L, while 6.6% had severe anemia, with Hb values below 80 g/L. Notably, 14.7% of patients showed no signs of anemia.

Table 3 Severity of anemia

Parameters	Anemia Severity	N/Frequency
Hemoglobin (g/L)	<80 g/L (severe)	1036 (6.6%)
	80-109 g/L (Moderate)	7713 (48.9%)
	110-119 g/L (Mild)	4705 (29.8%)
	non-anemic	2322(14.7%)
	N=15776	

3.5. Factors Associated with Anemia

Table 4 highlights the association between gender distribution, age, and anemia status. The results show a significant association, with females being more affected by mild to moderate anemia, while males predominantly had Hemoglobin (Hb) levels ≥138 g/L. The data confirms that females are more prone to developing anemia, supported by a Chi-square value of 3000.64 and a p-value of 0.000. This indicates that the severity of anemia is statistically associated with gender. Regarding the association between age and anemia severity, the results indicated that anemia severity is significantly associated with middle age, as patients aged 31 to 50 years were more likely to develop moderate anemia. In contrast, children under 12 months were less prone to anemia. This confirms that the severity of anemia increases with advancing age, with a Chi-square value of 994.32 and a p-value of 0.00, indicating a strong statistical association.

Table 4 Association of Anemia with Gender and Age

Gender	**Anemia Status (Hb Levels g/L)**				**N**	**Chi-square**	**p-value**
	<80 (Severe)	**80-109(Moderate)**	**110-119(Mild)**	**Non-Anemic-≥121 (Females) ≥ 138 (males)**			
Females	428	4487	3134	18	8067	3000.64	0.000
Males	608	3226	1571	2304	7709		
	Anemia Status (Hb Levels g/L)						
Age	<80(Severe)	80- 109 (Moderate)	110-119(Mild)	Non-Anemic	N	Chi-square	p-value
<12 months	60	917	383	41	1401	994.32	0.000
1-30 years	119	1313	1138	423	2993		
31-50 years	311	2533	1823	1050	5717		
51-70 years	221	1238	785	638	2882		
>71 years	325	1712	576	170	2783		

3.6. Association of Other Laboratory Parameters With Anemia

3.6.1. Association of Anemia with Ferritin Levels

Table 5 shows the association between anemia status and ferritin levels. Among 593 patients with ferritin levels of 1.11–10.5 mg/L, 285 had moderate anemia and 163 had mild anemia. Similarly, 458 patients with ferritin levels of 10.6–20.1 mg/L, 216 had moderate anemia and 139 had mild anemia. Additionally, 102 patients with ferritin levels of 1.11–10.5 mg/L had no anemia. The results indicate that anemia is not statistically associated with ferritin levels, as evidenced by a p-value of 0.979 and a Chi-square value of 4.214, showing no noteworthy association.

Table 5 Association of Anemia with Ferritin Levels

Anemia Status (Hb)	**Ferritin Levels(mg/L)**					**N**	**Chi-square**	**p-value**
	<0.30	**0.31-1.10**	**1.11-10.5**	**10.6-20.1**	**>20.10**			
Severe Anemia (<80g/L)	0	0	43	30	4	77	4.214	0.979
Moderate Anemia (80-109g/L)	1	1	285	216	35	538		
Mild Anemia (110-119g/L)	0	0	163	139	18	320		
Non-anemic ≥ (121 g/L)	0	0	102	73	9	184		

3.6.2. Association of Anemia With Transferrin SAT Levels

Table 6 presents the association between anemia status and Transferrin Saturation (SAT) levels. Among 654 patients with Transferrin SAT levels of 0.02–0.07(%), 311 patients had moderate anemia and 203 patients faced mild anemia. Similarly, 1,145 patients with Transferrin SAT levels of 0.08–0.15%, 523 had moderate anemia and 338 had mild anemia. Additionally, 105 patients with ferritin levels of 0.02_0.07 had no anemia. The results confirm that anemia is not statistically associated with Transferrin SAT levels, as indicated by a p-value of 0.500 and Chi-square value of 5.340, showing no significant association.

Table 6 Association of Anemia with Transferrin SAT Levels

Anemia Status (Hb)	Transferrin SAT (%)			N	Chi-square	p-value
	<0.01	0.02_0.07	0.08-0.15			
Severe Anemia (<80g/L)	0	35	76	111	5.349	0.500
Moderate Anemia (80-109g/L)	0	311	523	834		
Mild Anemia (110-119g/L)	1	203	338	542		
Non-anemic ≥(121 g/L)	1	105	208	314		

3.6.3. Association of Anemia with Vitamin B12 Levels

Table 7 highlights the association between anemia status and Vitamin B12 levels. Among 152 patients with Vitamin B12 levels of 121–160 pmol/L, 78 had moderate anemia and 44 had mild anemia. Additionally, 23 patients with Vitamin B12 levels of 121–160 pmol/L had no anemia. The results indicate that anemia status is not statistically associated with Vitamin B12 levels, as reflected by a p-value of 0.338 and a Chi-square value of 10.15, showing no noteworthy association.

Table 7 Association of Anemia with Vitamin B12 Levels

Anemia Status (Hb)	Vit B12 (pmol/L)				N	Chi-square	p-value
	41-80	81-120	121-160	161-198.6			
Severe Anemia (<80g/L)	0	6	7	0	13	10.15	0.338
Moderate Anemia (80-109g/L)	3	29	78	0	110		
Mild Anemia (110-119g/L)	4	13	44	1	62		
Non-anemic (≥121 g/L)	1	15	23	0	39		

3.6.4. Association of Anemia With Transferrin Levels

Table 8 shows the association between anemia status and Transferrin levels. Among 111 patients with Transferrin levels of 16.5–21.5 mmol/L, 53 had moderate anemia and 36 had mild anemia. Similarly, out of 178 patients with Transferrin levels above 21.6, 75 had moderate anemia and 54 had mild anemia. The results confirm that anemia status is not statistically associated with Transferrin levels, as indicated by a Chi-square value of 12.46 and a p-value of 0.188, showing no significant association.

Table 8 Association of Anemia with Transferrin Levels

Anemia Status (Hb)	Transferrin Levels (mmol/L)				N	Chi-square	p-value
	6.30-11.3	11.4-16.4	16.5-21.5	>21.6			
Severe Anemia (<80g/L)	0	3	6	12	21	12.46	0.188
Moderate Anemia (80-109g/L)	4	14	53	75	146		
Mild Anemia (110-119g/L)	0	5	36	54	95		
Non-anemic (≥121 g/L)	0	10	16	37	63		

3.6.5. Association of Anemia With Iron Levels

Table 9 presents the association between anemia severity and Iron levels. Among 383 patients with Iron levels of 2.89–4.49 mmol/L, 181 had moderate anemia and 109 had mild anemia. Similarly, 327 patients with Iron levels of 4.50–7.30, 175 had moderate anemia and 139 had mild anemia. 69 patients with Iron levels of 2.89–4.49 mmol/L had no anemia. The results indicate that anemia status is not statistically associated with Iron levels, as evidenced by a Chi-square value of 11.23 and a p-value of 0.51, showing no significant association.

Table 9 Association of Anemia with Iron Levels

Anemia Status (Hb)	**Iron Levels (mmol/L)**					**Total**	**Chi-square**	**p-value**
	0.28-2.88	**2.89-4.49**	**4.50-7.30**	**7.31-9.89**	**>9.90**			
Severe Anemia (<80g/L)	10	24	40	11	10	95	11.23	0.51
Moderate Anemia (80-109g/L)	63	181	327	81	47	699		
Mild Anemia (110-119g/L)	53	109	175	62	22	421		
Non-anemic (≥121 g/L)	27	69	113	34	14	257		

4. Discussion

This study aimed to investigate the prevalence of anemia and its associated factors among patients at Madinat Zayed Hospital. The patient's mean hemoglobin level was 105.45 g/L and the overall prevalence of anemia was high, with 86.3% of participants being affected. There was a marked gender difference, with females more susceptible to moderate anemia and males more frequently with normal hemoglobin. Moreover, moderate anemia was more common among middle-aged patients (31–50 years). No particular meaningful associations were found between anemia status and iron, ferritin, transferrin, or vitamin B12 levels.

Hemoglobin determination is one of the most convenient diagnostic methods for evaluating anemia in the population(17). In our study, 14.7% of patients were non-anemic, while 29.8% had minor anemia, 48.9% had moderate anemia, and 6.6% had severe anemia. This finding contradicts findings observed by another study in which results of hemoglobin levels indicated that 42% of the participants were non-anemic, 46.8% had slight anemia, 10% had moderate anemia, and 1.2% had severe anemia(18). Qureshi et al also reported that in their study mild degree anemia was the most prevalent, occurring in 46.34% of the participants in the North East America (19). Moderate-degree anemia was present in 43.44% of the participants. The least prevalent degree of anemia was severe anemia, which was present in 10.22% of the population.

The high prevalence of anemia (86.3%) reported in this study is consistent with that reported in several other regional and global studies. In a study conducted in Ethiopia anemia prevalence was found to be 64.8% which indicates that anemia is a universal health problem and its rate may spread over geographical regions and socio-economic factors. This investigation was consistent with the findings of studies conducted in Uganda (64.3%), Benin (61.8%), and Germany (60%)(20). Other previous studies conducted in Pakistan (71%), Bahrain (72.2%), and Tanzania (79.5%) also showed a high prevalence of anemia(21). Additionally, the prevalence was higher than that of other similar studies conducted in Tanzania (44%), Pakistan (55.5%), Italy (48%) and Germany (54.2%) (21).In a study conducted in Saudi Arabia, anemia prevalence rates, among adult females, have been as high as 40%, secondary to similar food and environmental factors(22). This inconsistency may be attributed to the age of the study subjects, socio-demographic, behavioral, and type of admission diagnosis, as well as variations in the study design, sampling methodologies, and sample size.

Studies consistently show that females are more prone to anemia than males, particularly in middle age, due to factors such as menstrual blood loss, pregnancy, and higher iron requirements(23). This is consistent with our finding that females had a higher prevalence of moderate anemia compared to males. Additionally, previous research has identified that older individuals are more likely to suffer from anemia due to age-related chronic diseases and reduced erythropoiesis, which supports the higher prevalence observed in middle-aged participants(24).

The present study did not observe a significant association between anemia status and ferritin levels, whereas a study from Kenya showed a strong correlation between cut-off ferritin levels and severe anemia(21). This discrepancy may be explained by differences in the demographic and clinical characteristics of the populations studied. In contrast, the current study also lacks significant associations between anemia severity and vitamin B12 levels, which is in contrast to research in Pakistan, where vitamin B12 deficiency was strongly associated with anemia, especially in elderly populations(21). It may be due to diet or healthcare differences in vitamin supplementation. Our study did not find an association between anemia status and iron levels. This contradicts a study in which significant associations were found between Iron and anemic status(25). Deficiency of iron was found to be associated with iron deficiency anemia.

This research has several limitations which should be acknowledged. The retrospective nature of the study precludes a determination of causality between anemia and its associated factors. There was a challenge getting to use secondary data of electronic medical records because there was incomplete or missing data which would have likely affected the quality of the findings. Furthermore, the study was conducted in just one hospital, and this may limit the generalizability of the study findings to other populations or districts. Finally, the analysis was focused on some specific biomarkers that may have narrowed down the exploration of other potentially relevant factors that affect anemia.

5. Conclusion

This study shows that anemia is a prevalent condition among patients at Madinat Zayat Hospital. The results indicate that females and middle-aged individuals have higher anemia prevalence and moderate anemia is the most common severity level. Although hemoglobin levels were clearly related to the severity of anemia, other laboratory markers, such as ferritin and transferrin saturation, did not show a statistically significant relationship with anemia status. These results point to the need for targeted interventions, particularly for women and middle-aged adults to manage and prevent anemia.

Overall, this study contributes valuable information about the prevalence of anemia and its associations with gender and age, particularly highlighting the vulnerability of middle-aged females. However, it also raises questions about the roles of biochemical markers and suggests the need for further research that includes broader factors and potentially a prospective design to enhance understanding and intervention strategies.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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