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RESEARCH ARTICLE

PREVALENCE OF ANEMIA AND ASSOCIATED FACTORS IN OLDER ADULTS IN TERTIARY HOSPITALS IN SANA'A CITY, YEMEN

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Abstract

Background: Any level of anaemia is now acknowledged as a risk factor for any negative outcomes, including reduced quality of life, hospitalization, morbidity, and mortality, since it is a common condition in geriatrics and older adults and its frequency proportionately increases with age, leading to serious consequences. The purpose of this study is to evaluate the prevalence of anaemia and its contributing factors among elderly patients in Sana'a, Yemen.
Methods: A cross-sectional study with 250 older adult patients was conducted in a few tertiary institutions in Sana'a city between January 1st and March 31st, 2024. Clinical and sociodemographic information was gathered by direct interviews and examination of medical records. To measure blood parameters such HG, PCV, RBC counts, MCV, MCH, etc., each participant gave a venous blood sample.
Result: Anemia affected 30.2% of male patients (defined as <13 mg/dL) and 15.3% of female patients (defined as <11.5 mg/dL). A significant link was found between anemia and advanced age, with the 60–69 age group showing substantially higher odds of the condition (OR=5.6, p<0.0001); (for 60-69 years group OR=6.4, p<0.0001. Considering chronic diseases, there was significant association between anemia and DM (OR=2.9, p=0.0003), cancer (OR=7.8, p<0.0001), Encephalic Vascular Accident (OR=4.8, p<0.0001), osteoporosis (OR=3.7, p=0.002), and depression symptoms (OR=4.7, p<0.0001).
Conclusion: The epidemiological burden of anemia within the local geriatric cohort represents a significant public health concern. To mitigate prevalence and optimize clinical outcomes, targeted intervention strategies must integrate identified demographic and physiological risk factors.
Keywords: anemia, associated factor, elderly patients, prevalence, Sana'a city, Yemen.

INTRODUCTION

A reduction in haemoglobin concentration (Hgb), red blood cell count (RBC), packed cell volume or hematocrit (PCV or HCT), and the body's subsequent incapacity to meet the oxygen demands of its tissue, leading to hypoxia1[1], are the hallmarks of anaemia. The World Health Organization (WHO) defines anaemia in the elderly as having a Hgb concentration of less than 12 g/dL (120 g/L) for women and less than 13 g/dL (130 g/L) for men[2]. There are social and medical ramifications to ageing. It is linked to a rise in the prevalence of chronic illnesses, disabilities, and functional dependence as well as an increase in the need for social, medical, and caregiving services[3,4]. The underlying reason of geriatric anaemia is probably complicated, but hematopoietic stem cells may hold the key to a solution[5]. Globally, 1.62 billion people suffer from anaemia, including 164 million cases among the elderly[6]. Additionally, iron deficiency (ID), vitamin B12 and/or folic acid (folate), occult and gross gastrointestinal (GI) bleeding, malignancies, acute and chronic infections, kidney disease, and congestive heart failure (CHF) are all common causes of anaemia in the elderly[7-9].

Globally, anemia contributes significantly to the burden of disease, hindering public health, economic productivity, and socioeconomic development in both

developed and developing nations[10-13]. A 2008 systematic review by Gaskell *et al*., which analyzed 45 studies comprising 85,409 participants, found an overall anemia prevalence of 17% (range: 3–50%) among older adults. When stratified by care setting, prevalence rates varied widely: 47% (31–50%) in nursing homes, 40% (40–72%) among hospital admissions, and 12% (3–25%) in community-dwelling elderly populations, with most cases classified as mild. Furthermore, the review demonstrated that anemia prevalence escalated with advancing age and was marginally higher in men than in women[14]. Anaemia, usually mild, is one of the major risk factors for community-dwelling older adults. These observational data from community-based studies[15-19] consistently show that mild anaemia is associated with substantial unfavourable outcomes in older adults, such as a loss of physical capacity, decreased mobility, cognitive impairment, an increase in falls, an increase in hospitalisation, and mortality.

Patients suffering from malaria[20], cytomegalovirus[21,22], children with leukaemia[23,24], low hepcidin levels, celiac disease[25], kidney transplant recipients[26], pregnant women, malnourished children, HIV patients[27-30], and sickle cell anaemia[31] are all affected by anaemia, which is a severe public health crisis in Yemen.

The study's goals were to measure the amount of red blood cells, haemoglobin, packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin content, mean corpuscular haemoglobin concentration, level of red blood cell volume variability, and to identify risk factors linked to anaemia in older adult patients who visited hospitals in Sana'a City, Yemen.

SUBJECTS AND METHODS

Study design and sits: This cross sectional hospital based laboratory study was carried out in the tertiary hospitals (Al-Kuwait university hospital and Al-Thorah university hospital) among old adult patients from first October 2023 until January 2024.

Sample size: The following criteria were used to determine a sample size of 250: prevalence of anaemia among elderly patients=44.7%, margin of error=8.1%, and confidence level=99%[32].

Data collection: A pre-made questionnaire was used to gather individual data, including clinical information, demographic information, blood parameter laboratory findings, and related risk factors for anaemia in elderly adult patients.

Statistical analysis: The data was analysed using the Epi Info statistical programme version 6 (CDC, Atlanta, USA). When the data was regularly distributed, the quantitative data was expressed as mean values or standard deviation (SD). using percentages to express the qualitative data. Additionally, the $2X^2$ table was used to determine the related odds ratio, and the 95% CI, X^2, and p value were used to corroborate the link.

Ethical consideration: The study protocol was approved by the institutional ethical review committee prior to data collection. Before participation, all subjects or their guardians were informed of the study's objectives and potential benefits**,** and verbal informed consent was obtained. Participants and their families were explicitly advised that participation was entirely voluntary and that they could withdraw at any stage without penalty or explanation.

Fields and laboratory works: Initial clinical assessments were conducted by hospital physicians and documented using a pre-designed questionnaire that captured relevant risk factors. Subsequently, venous blood samples were collected to analyze hematological parameters using standard laboratory techniques.

RESULTS

Table 1 outlines the demographic profile, specifically the sex and age distribution, of adult patients aged over 40 years evaluated for anemia at a tertiary referral hospital in Sana'a, Yemen. Of the total sample, male patients predominated at 55.5%, while female patients accounted for 44.5%. The cohort exhibited a mean age of 52.9 years (±11.1 SD), with an overall age range spanning 40 to 95 years. Age stratification revealed that the highest concentration of patients fell within the 40–49 age bracket (42.4%), followed by the 50–59 cohort (28.0%), whereas the remaining older age groups demonstrated progressively lower frequencies.

Table 1: Sex and age distribution of adults over 40 years old patients tested for anemia.

Characters	N (%)
Sex	
Male	139 (55.5)
Female	111 (44.5)
Age groups (years)	
40 - 49	106 (42.4)
50- 59 years	70 (28)
60-69	44 (17.6)
>69	30 (12)
Total	250 (100)
Mean age	52.9 years
SD	11.1 years
Median	50 years
Mode	50 years
Min - Max	40 - 95 years

Table 2: HGB level of adults over 40 years old patients.

Characters	Total, N (%)
HGB (mg/dL)	
Less than 8	2 (0.8)
8- 11	28 (11.2)
11.1-12	24 (9.6)
12.1 -14	87 (34.8)
14.1- 16	69 (28)
>16.1	40 (16)
Total	250 (100)
Mean	13.7
SD	2.3
Median	13.8
Mode	13.8
Min - Max	6.6- 19.1

Table 2 presents the hemoglobin levels of adult patients attending hospitals in Sana'a, Yemen. The mean hemoglobin level of the overall cohort was 13.7

mg/dL (SD±2.3 mg/dL), with values ranging from 6.6 to 19.1 mg/dL. Anemia, defined as a hemoglobin level below 11.1 mg/dL, was present in 12.0% of all patients. Table 3 details the hemoglobin metrics specifically for adult male patients attending tertiary hospitals. In this subgroup, the mean hemoglobin level was 14.2 mg/dL (SD±2.5 mg/dL; range: 6.6–19.1 mg/dL). The prevalence of anemia (<13.0 mg/dL) among male patients was 30.2%. The majority of male patients (65.0%) presented with levels between 13.0 and 18.0 mg/dL, whereas only 4.3% exhibited levels exceeding 18.1 mg/dL. Table 3 presents the hemoglobin levels among female patients attending tertiary hospitals in Sana'a, Yemen. The mean hemoglobin level was 13.0±1.8 g/dL (range: 7.0–17.5 g/dL). Anemia, defined as a hemoglobin level below 11.5 g/dL, was prevalent in 24.3% of the cohort. The majority of patients (72.9%) presented with values between 11.5 and 16.5 g/dL, whereas only 2.7% exhibited levels exceeding 16.5 g/dL.

Table 3: HGB level of male and female adults over 40 years old patients.

Characters	Male, N (%)	Characters	Female N, (%)
HGB (mg/dL)		**HGB (mg/dL)**	
Less than 8	2 (1.4)	Less than 8	1 (0.9)
8- 11	16 (11.5)	8- 11.4	26 (23.4)
11.1-12.9	24 (17.3)	11.5-16.5	81 (72.9)
13 -18	91 (65)	>16.5	3 (2.7)
>18.1	6 (4.3)	Total	111 (100)
Total	139 (100)	Mean	13.0
Mean	14.2	SD	1.8
SD	2.5	Median	13.3
Median	14.6	Mode	13.8
Mode	15	Min - Max	7- 17.5
Min - Max	6.6- 19.1		

Table 4: PCV level of male and female adults over 40 years old patients.

Male		Female	
Characters	**N (%)**	**Characters**	**N (%)**
PCV		**PCV**	
Less than 40.0	40 (28.8)	Less than 36	20 (18)
40 - 50	52 (37.4)	36 - 46	84 (75.7)
>50.0	47 (33.8)	>46	7 (6.3)
Total	139 (100)	Total	111 (100)
Mean	43.3	Mean	40
SD	7.5	SD	5.3
Median	43.3	Median	40.9
Mode	49.2	Mode	38.1
Min - Max	21.5 – 56.7	Min - Max	22.5 – 52.6

Packed cell volume (PCV) distributions for the overall adult cohort are summarized in Table 4. Overall, 28.8% of patients fell below the standard reference range, 37.4% fell within the 40–50% range, and 33.8% exceeded 50%. Table 4 details the PCV stratification specifically for adult female patients. Within this group, 18.0% had subnormal PCV levels, 75.7% fell within the 36–46% range, and 6.3% exceeded 46%. Table 5 shows the red blood cell counts of adult females patients (cell $x10^6/\mu L$). The mean RBC count was 4.5 cells × $10^6/\mu l$ with a SD of 0.61 and ranged from 2.0 to 5.9 cells × $10^6/\mu l$. The result showed that 3.6% of our patients had a value lower than normal for adult female. Most of our patients were at 3.5–5.1 cells x $10^6/\mu l$ (90.1%). Table 6 shows the MCV level of adult patients. The mean MCV was 81.5 fl with SD equal to 10.2 fl, and the MCV ranged from 52 fl to 99.5 fl. Third of the patients had <80 fl of the MCV (30.4%) (macrocytic anemia). 23.2% of patients had 80-84 fl, 32% had 85-89 fl and only 14.4% of patients had >89 fl. Table 6 shows the MCH level of adult patients. The mean MCH of our patients was 26.8 p/cell, with an SD of 3.4 p/cell and ranged from 17.3 to 39.2 p/cell. Most patients had less than 27 p/cell (43.6%) indicating iron deficiency anemia while 19.2% had 27-28 p/cell and 2.8% had more than 31 p/cell indicating anemia due to low levels of folic acid or vitamin B12. Table 6 shows MCHC level of adult patients. The mean MCHC of our patients was 32.4 g/dl, with an SD of 2.3 g/dl and ranged from 28.6 to 42.6 g/dl. About 98.4% of patients had 30-35 g/dl while 1.6% had less than 30 g/dl and 0.4% had >35 g/dl. Table 7 shows anemia associated risk factors among older adults at a tertiary hospital in Sana'a city. Considering sex as associated factors, there was no association between anemia occurrence and sex. However, there was significant association between anemia and older ages in which odds ratio for 60-69 years group was 5.6, CI=2.8-11.3, X^2=27.6 and p<0.00 01. Also there was significant association between anemia and 60-69 years group in which OR was 6.4, CI=2.8-14.6, X^2=23.6 and p <0.0001. Considering chronic diseases, there was significant association between anemia and DM in which odds ratio for association was 2.9, CI=1.6–5.4, X^2=12 and p=0.0003. Also, there was significant association between anemia and cancer in which odds ratio for association was 7.8, CI=3.5–17.6, X^2=31 and p<0.00 01. Considering presence of encephalic vascular accident, there was significant association with anemia in which odds ratio

for association was 4.8, *CI*=2.2–10.1, X^2=19 and p<0.0001. Also, there was significant association between anemia and osteoporosis in which odds ratio for association was 3.7, CI=1.5–9.3, X^2=8.9 and p=0.002. Also, there was significant association between anemia and depression symptoms in which odds ratio for association was 4.7, *CI*=2.5–8.7, X^2=26 and p<0.0001.

Table 5: Red blood cell counts of male and female adults over 40 years old patients (10^6/µL).

Male		Female	
Characters	**N (%)**	**Characters**	**Before N (%)**
RBC (cell x 10^6/µL)		**RBC (cell x 10^6/µL)**	
Less than 4.5	35 (25.2)	Less than 3.5	4 (3.6)
4.5- 6.5	103 (74.1)	3.5- 5.1	100 (90.1)
>6.5	1 (0.72)	>5.1	7 (6.3)
Total	139 (100)	Total	111 (100)
Mean	4.9	Mean	4.5
SD	0.93	SD	0.61
Median	5	Median	5
Mode	6	Mode	5
Min - Max	2.2- 6.8	Min - Max	2.0- 5.9

Table 6: MCV, MCH, and MCHC level of adults over 40 years old patients.

Characters	**N (%)**	**Characters**	**N (%)**	**Characters**	**N (%)**
MCV /fl (Mean corpuscular volume/femtoleter		MCH (mean corpuscular hemoglobin/picograms per cell)		MCHC g/dl	
Less than 80	76 (30.4)	Less than 27	109 (43.6)	Less than 30	4 (1.6)
80-84	58 (23.2)	27-28	48 (19.2)	30-35	245 (98.4)
85-89	80 (32)	29-31	86 (34.4)	>35	1 (0.4)
>89	36 (14.4)	>31	7 (2.8)	Total	250 (100)
Total	250 (100)	Total	250 (100)	Mean	32.4
Mean	81.5	Mean	26.8	SD	2.3
SD	10.2	SD	3.4	Median	32.7
Median	83.6	Median	27.4	Mode	32.8
Mode	77	Mode	27.9	Min - Max	28.6 – 42.6
Min - Max	52 – 99.5	Min - Max	17.3 – 39.2		

DISCUSSION

According to this study, 30.2% of male patients and 15.3% of female patients had anaemia (<13 mg/dL) overall. Our data indicated a significant public health concern among these patients in accordance with WHO guidelines[33]. Compared to Pautas *et al*. in France, who found that 44.7% of elderly patients were anaemic[33], our prevalence is lower. The current study's findings regarding the prevalence of female anaemia are comparable to research done in the US (13.6%)[34], Austria (21.1%)[35], Egypt (17.5%)[36], and other countries. In contrast, it was 30.2% higher for our male compared to the United States (13.6%), Austria (21.1%), and Egypt (17.5%)[34-36]. The disparity between these rates may be explained by variations in the maximum age limitations applied, sample size, and lifestyles of study participants. Inadequate iron intake and consumption of animal products may also have long-term effects, according to our study.

Table 7: Anemia associated risk factors among older adults.

Characters	**Anemia n=72 N (%)**	**OR**	**CI**	**X^2**	***p***
Sex					
Male n=139	42 (30.2)	1.2	0.67-2	0.3	0.58
Female n= 111	30 (27.0)	0.85	0.4-1.4	0.3	0.58
Total n=250	72 (28.8)	0.11	0.05-0.25	37	<0.0001
Age groups (years)					
40 - 49 n=106	9 (8.4)	0.11	0.05-0.25	37	<0.0001
50- 59 n=70	16 (22.9)	0.65	0.34-1.2	1.6	0.19
60-69 n=44	27 (61.4)	5.6	2.8-11.3	27.6	<0.0001
>69 n=30	20 (66.7)	6.4	2.8-14.6	23	<0.0001
Chronic Diseases					
Presence of diabetes n=52	29 (55.8)	2.9	1.6-5.4	12.9	0.0003
Presence cancer n=43	23 (53.5)	7.8	3.5-17.6	31	<0.0001
Presence cardiovascular disease n=55	12 (21.8)	0.62	0.3-1.2	1.6	0.19
Presence Encephalic Vascular Accident n=35	21 (60)	4.8	2.2-10.1	19.3	<0.0001
Presence osteoporosis n=21	12 (57.1)	3.7	1.5-9.3	8.9	0.002
Infectious diseases n=44	4 (9)	0.28	0.06-0.5	10.1	0.0001
Presence of depression symptoms n=50	33 (66)	4.7	2.5-8.7	26	<0.0001

Additionally, the anaemia prevalence for both male and female patients in our study was significantly lower than reports from studies conducted in Tanzania (79.5%) by Chamba *et al.*[37], France (53%) by Petrosyan *et al.*[38], India (68.7%) by Pathania *et al.*[39], Turkey (54.9%) by Sahin *et al.*[40], and Ethiopia (54.5%) by Melku *et al.*[41]. In contrast to the study subjects in the other studies, who were institutionalized in long-term care facilities, the elderly in this study who sought medical attention in the outpatient department may have different comorbidities and study designs. Additionally, our results were less than those of Dunn *et al.*[42], 77% Mary Potter Hospices in New Zealand. Given that Dunn *et al*., included a greater percentage of patients with haematological malignancies and older patients admitted to the hospital for palliative care, this discrepancy may be explained by the distinct features of the study participants[42].

In the current analysis, males showed a slightly greater prevalence of anaemia than females (30% vs. 27%, AOR=1.2, 95% CI=0.67-2, p=0.58). This was comparable to earlier studies conducted in Russia, Egypt, and Ecuador[36,43,44]. After middle age, males' free and accessible testosterone concentration significantly decreases, which may account for the considerable difference in anaemia prevalence rates between men and women. The enhanced metabolic functions of the bone marrow are negatively impacted by this. Men are more likely to develop anaemia as they age because the rate of erythropoiesis decreases along with testosterone levels[45,46].

Anaemia was more common in older persons in the current study, and there was a strong correlation between anaemia and older ages (odds ratio for the 60-69 age group was 5.6, CI=2.8-11.3, X^2=27.6, and p <0.0001). Additionally, there was a significant correlation between anaemia and the 60-69 age group. The results of Guralnik *et al.* [47], support our findings.

Anaemia was more common in older persons in the current study, and there was a strong correlation between anaemia and older ages (odds ratio for the 60-69 age group was[5,6], CI=2.8-11.3, X^2=27.6, and p <0.0001). The results of Guralnik *et al.*[47], support our findings. The current survey found that 66.7% of older individuals were over 69, which is greater than the 20–26 % of older persons in the USA who are over 85. The relationship between anaemia prevalence and advanced age can be explained by a few causes. First, there is a greater need for erythropoietin (EPO). To keep up with the rising demand, healthy older persons seem to have higher EPO levels. In some situations, anaemia develops as a result of the reduced ability of the kidneys to produce hormones[48,49]. Moreover, proinflammatory cytokines are expressed more frequently as people age, which may exacerbate EPO insensi-tivity. Therefore, genetic variation in the expression of these cytokines can affect the development of anaemia in older persons through the reduction of erythroid colony formation by cytokines[42] and the activation of hepcidin production (inflammation related anaemia). In the hierarchical multiple regression model, the only predictor that was still significantly linked to anaemia in the first group was age. Even when the clinical factors group was included, age remained significant and had an independent effect even after the primary anemia-related disorders were taken into account.

In the current study, there was significant association between anemia and DM, cancer, encephalic vascular accident, osteoporosis and depression symptoms. Anaemia was still substantially correlated with the existence of diabetes, signs of depression, and malignancy. One of the primary causes of chronic renal insufficiency is diabetes. Due to decreased EPO secretion, diabetes accounts for a significant percentage of anaemia cases in older persons, even at subclinical levels[48,49]. Renal illness is linked to about 12.0% of anaemia cases in the United States[47]. Cancer is a significant risk factor for anaemia, especially when it affects the digestive tract since it can result in intermittent bleeding, which is usually undetectable and causes anemia[50]. The reduced reaction to EPO, primarily during chemotherapy[51], is another mecha-nism. In elderly persons, the relationship between anaemia and depression was examined. There were two plausible causation orientations for this association: anaemia can cause depression, but it can also result from depression. Due to vitamin deficiencies like folate and vitamin B12, which result in either an increase in homocysteine production or a decrease in S-adenosyl-methionine production, anae-mia can cause depression. Homocysteine buildup can impact central nervous system receptors[52], and S-adenosyl-methionine is a cofactor in the production of neurotransmitters such as serotonin.

Onder *et al.*[53], discovered a link between depression and a markedly elevated risk of anaemia in an Italian study (OR=1.93). Even after eliminating patients with pertinent comorbidities and vitamin B12 deficiency, this outcome remained[53]. Anaemia and marginal vitamin B6 insufficiency, as well as the co-occurrence of anaemia with low levels of vitamin B6 and folate[52], were found to be substantially correlated with depress-sive symptoms in a Taiwanese study.

Anaemia can also occur as a result of depression. Anaemia can develop in older persons due to poor nutrition caused by fatigue and disinterest in everyday tasks like cooking and shopping, which are common signs of depression. People who are sad frequently suffer from malnutrition[53].

CONCLUSION

Anaemia constitutes a significant public health concern among the local elderly population. To mitigate and manage this condition, routine clinical evaluations must incorporate standard anemia screening alongside targeted interventions that address established risk factors.

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AUTHOR'S CONTRIBUTION

Al-Robasi FASA: formal analysis, conceptualisation, writing original draft. **Hassan SMA:** data organisation, writing original draft. **Al-dossary OAI:** investigation. **Al-Ankoshy AAM:** formal analysis, data curation. **Almagrami AAS:** editing, critical review. **Al-Shamahy HA:** literature survey, formal analysis. **Al-Dabis EMS:** data curation, conceptualization. Final manuscript was checked and approved by all authors.

DATA AVILIABILITY

The data will be available to anyone upon request from the corresponding author.

CONFLICT OF INTEREST

Regarding this project, there is no conflict of interest.

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