ORIGINAL RESEARCH

Prevalence and Associated Factors of Anemia Among Hospital Admitted Patients in Eastern Ethiopia

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Background: Anemia is one of the most common comorbidities frequently seen in admitted patients. However, there is a scarcity of evidence regarding anemia among hospital admitted patients in Ethiopia, particularly in the Harari Region. Therefore, this study aimed to assess the prevalence and associated factors of anemia among hospital admitted patients in Eastern Ethiopia.

Methods: A hospital-based cross-sectional study was conducted from October 25 to December 30, 2022. Four milliliters of venous blood were collected and complete blood count was done using the DxH 800 (Beckman Coulter, Inc, Miami, FL) hematology analyzer. The data were entered in Epi-data version 4 and exported to SPSS version 26 for statistical analysis. Bivariable and multivariable logistic regression models were fitted. The level of significance was declared at a p-value of < 0.05.

Results: Of the 381 hospital admitted patients, 64.8% (95% CI = 60.01, 69.65) of the participants were anemic. Admitted patients who drank standard alcohol daily (AOR = 3.78, 95% CI = 1.71, 8.30), underweight (AOR = 9.39, 95% CI = 2.90, 30.46), and undernourished patients (AOR = 2.59, 95% CI = 1.15, 5.84), patients admitted with chronic kidney disease (AOR = 11.16, 95% CI = 4.06, 30.64), chronic liver disease (AOR = 3.20, 95% CI = 1.21, 8.47), deep vein thrombosis (AOR = 6.22, 95% CI = 1.98, 19.52), infectious disease (AOR = 9.71, 95% CI = 2.77, 34.02), and chronic non-communicable disease (AOR = 7.01, 95% CI = 1.90, 25.99) were all significantly associated with anemia.

Conclusion: Anemia was common among hospital admitted patients and should prompt the focus on admission diagnoses that are likely to play leading roles in etiology. This information indicates a need for routine screening of anemia for all admitted patients to improve their health.

Keywords: anemia, prevalence, associated factors, admitted patients, Ethiopia

Introduction

The majority of hospital admitted patients are adults and geriatrics (≥15 years old) with chronic diseases and several comorbidities, which cause frequent hospitalizations.[1] Anemia is one of the more prevalent comorbidities.[2–6] It is a condition in which the number of red blood cells (RBC) or hemoglobin (Hgb) concentration within them is lower than normal.[7] Accordingly, it is diagnosed in non-pregnant women ≥ 15 years old Hgb < 12.0 g/dl; men ≥ 15 years old Hgb < 13.0g/dl.[8] Factors that contribute to the onset of anemia in admitted patients include nutritional deficiencies (iron, folate, and vitamin B12), acute or chronic blood loss, chronic diseases, hemoglobinopathies, infectious diseases (malaria, tuberculosis, the Human Immune Virus (HIV), and parasitic infections), and even other unknown causes.[9]

Compared to the general population, admitted patients have a higher prevalence of anemia.[10] It is thought to affect ranging from 30% to 90% of newly admitted patients over the duration of their illnesses.[2–6,11,12] Its prevalence is higher in female subjects, from 15 years of age to adulthood, and in older (> 80 years old) patients of both genders, affecting

42% of subjects.[13] The most typical cause of anemia worldwide is iron deficiency anemia (IDA).[14] However, multi-factorial anemia includes anemia of chronic diseases (ACD), chronic kidney disease (CKD), dietary deficiencies, hemorrhages, use of antithrombotic medications, inflammation of iron metabolism,[15,16] and anemia of chronic diseases (ACD), which have a higher prevalence of anemia.[13] Recent research has shown that ACD and IDA, both of which have low iron stores, have altered iron metabolism.[17] Hepcidin, a hormone produced by the liver during chronic inflammation, rises significantly when ferroportin activity is inhibited by hepcidin, which reduce iron absorption in the intestine while simultaneously causing iron sequestration in macrophages and enterocytes.[18]

Data from previous studies conducted in Ethiopia showed that the prevalence of anemia was higher in hospitalized patients.[19,20] Despite the high prevalence of anemia in admitted patients, very little research has been conducted in our setup. Therefore, the purpose of this study was to determine the prevalence of anemia and its contributing factors among hospital admitted patients in Eastern Ethiopia.

Materials and Methods
Study Design, Area, and Period
A hospital-based prospective cross-sectional study was conducted in Harar Town, one of the Federal Democratic Republic of Ethiopia's regional states in the country's east. Harari Region is one of Ethiopia's nine regional states, with Harar as its capital city. It is located 526 kilometers east of Addis Ababa, Ethiopia's capital. There are four public hospitals, two private hospitals, and five health centers in the region. Among these hospitals, the study was conducted at two public hospitals in the region (Hiwot Fana Comprehensive Specialized University Hospital (HFCSUH) and Jugol General Hospital) and one private hospital (Harar General Hospital). These hospitals provide curative, rehabilitative, and preventive health care services. The study was conducted at these three selected hospitals from October 25 to December 30, 2022.

Population, Inclusion, and Exclusion Criteria
The study population included all individuals over the age of 15 who were hospitalized at the selected hospitals and agreed to participate in the study. The admission diagnosis of the patients was obtained by reviewing the patient's card or chart. On the other hand, pregnant women and individuals who were unable to communicate were excluded from the study.

Sample Size Determination and Sampling Technique
The sample size of study participants was determined using a single population proportion formula by considering the 34% prevalence of anemia among hospital-admitted patients from a previous study conducted in Ethiopia.[19]
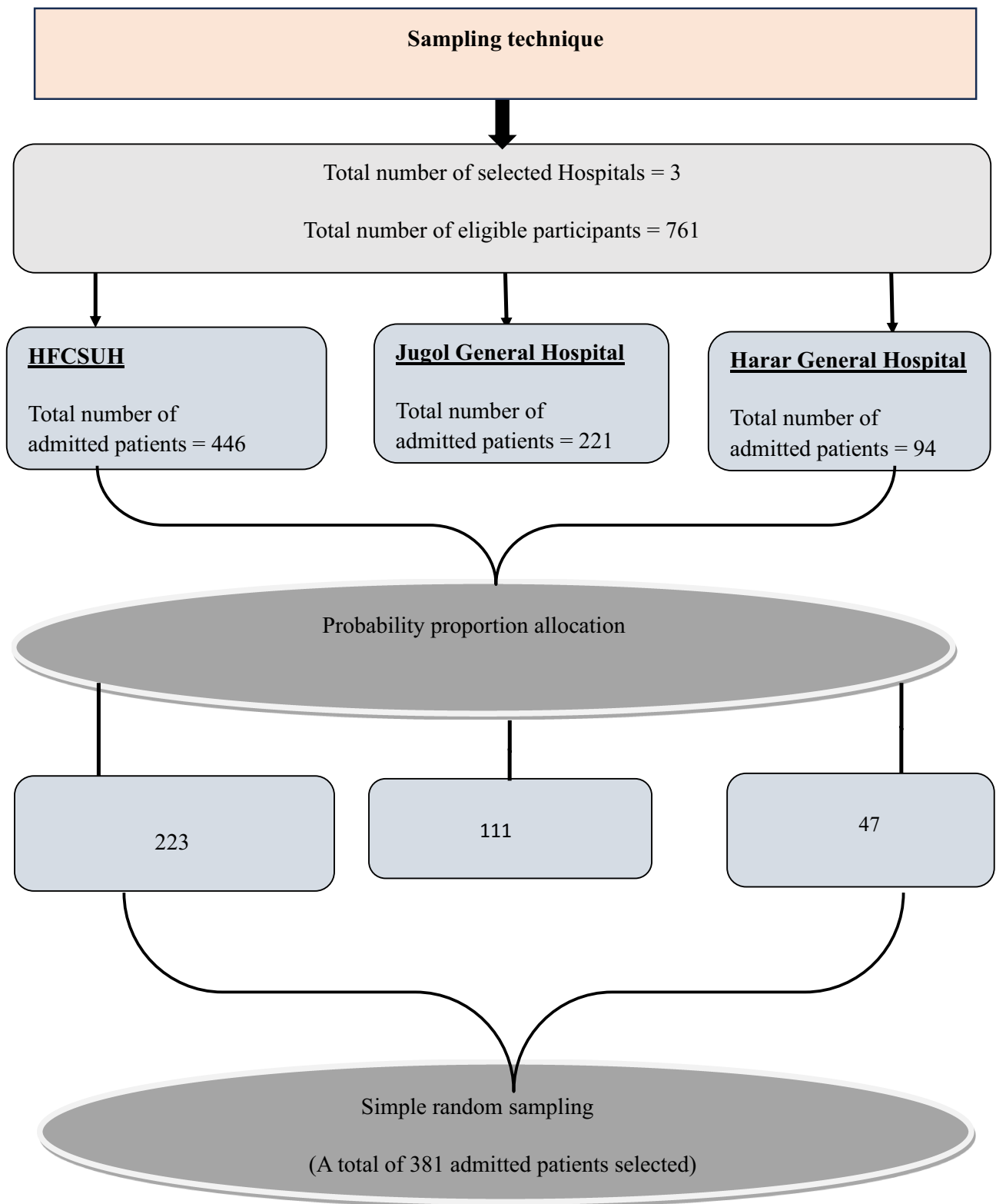
$$N = \frac{Z^2 P(1 - P)}{d^2}$$

where n represents the minimum sample size required; z is 1.96, which is the standard normal value at the level of confidence desired (for a 95% confidence interval); d is 0.05, the acceptable error willing to be committed; and p, which is 0.34, is the estimated proportion of anemia prevalence in hospital admitted patients.
Based on the above assumption, the sample size was calculated as follows:

$$\frac{1.96^2 0.34(1 - 0.34)}{0.05^2} = 345$$

After adding 10% non-respondent rates, a total of 381 study participants were recruited using a simple random sampling technique. Sampling frames were created and the number of patients to be included in the study was determined for each of the Hospitals by probability proportion allocation to size sampling, followed by simple random sampling (Figure 1).

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Sampling technique

Total number of selected Hospitals = 3

Total number of eligible participants = 761

HFCSUH

Total number of admitted patients = 446

Jugol General Hospital

Total number of admitted patients = 221

Harar General Hospital

Total number of admitted patients = 94

Probability proportion allocation

223

111

47

Simple random sampling

(A total of 381 admitted patients selected)

Figure 1 Schematic presentation of sampling procedure among hospital admitted patients in Eastern Ethiopia, 2022.

Data Collection and Measurement

A Structured questionnaire was prepared from different literature.[3,4,11,21,22] A total of nine data collectors (one senior clinical nurse, one senior medical resident, and one senior medical laboratory professional) from each of the selected hospitals collected socio-demographic characteristics, lifestyle, and history and clinical conditions (age at admission, cause of hospital admission, and laboratory tests) of each patient's data. The study participants' weight and height were measured using a digital weight scale with a connected height scale (Adult Scale ASTOR). Every day, the scale was reset to zero and calibrated. The heights of the participants were measured to the closest 0.1cm. The body mass index (BMI) of the subjects was calculated by dividing their weight (in kilograms) by their height (in meters squared), and they were classified as underweight (< 18.5 kg/m2), normal (18.5–24.9 kg/m2), overweight (25–29.9 kg/m2), and obese ($\geq$ 30 kg/m2).[23]

The middle upper arm circumference (MUAC) was used to measure nutritional status. With no clothing on the arm, the left arm circumference was measured in triplicate using a non-stretchable standard MUAC tape to the nearest 0.1 cm. Three measurements were obtained and the average was calculated. A standard scale was used to quantify the MUAC at the midpoint between the acromion and the shoulder. The mean of the two nearest recorded measures was utilized when the variation surpassed the average values of the three measures. Patients admitted with MUACs of < 22 cm were considered undernourished, whereas MUACs of $\geq$ 22 cm were regarded as normal.[24] One standard alcohol drink was defined as a drink with a net alcohol content of approximately 10g of ethanol (for example, one standard bottle of regular beer (285 mL), one single measure of spirits (30 mL), and one medium-sized glass of wine (120 mL)). Cigarette smoking was defined as admitted patients who had smoked at least one stick of cigarettes per day in the month (30 days) preceding data collection. Khat chewing was defined as admitted patients who had chewed khat in the month (30 days) before data collection.

Sample Collection and Laboratory Analysis

Four mL of venous blood was drawn using venipuncture according to World Health Organization (WHO) protocol[25] under aseptic conditions from each admitted patient. The blood samples were then put into an ethylene diamine tetraacetic acid (EDTA) tube and gently mixed by inverting the tube several times to avoid clotting. An automated hematology analyzer, UniCel DxH 800 Coulter (Beckman Coulter, Inc, Miami, FL) was used for the determination of Hgb, mean cell volume (MCV), mean cell hemoglobin (MCH), and mean cell hemoglobin concentration (MCHC).

Diagnosis of Anemia

Anemia was defined according to WHO criteria,[26] with a Hgb value of < 13g/dl for males and < 12g/dl for females. Anemia severity was also classified as mild (males: 11–12.9 g/dl; females: 11–11.9 g/dl), moderate (Hgb between 7 and 10.9 g/dl in both males and females), and severe (Hgb levels $\leq$ 7 g/dl in both males and females). Anemia was also classified into different morphology classifications based on MCV and MCHC values: microcytic hypochromic anemia (MCV < 80 fl and MCHC < 32%), macrocytic normochromic anemia (MCV >100 fl and MCHC between 32% and 36%), and normocytic normochromic anemia (MCV between 80 fl and 100 fl and MCHC between 32% and 36%).[27]

Data Processing and Analysis

Following data collection, the data were edited and cleaned, and each questionnaire was coded and validated for completeness. Epi-Data version 4.6 was used to enter data into the computer, and the statistical program Statistical Package for Social Sciences (SPSS) version 26 was used for analysis. Frequency, percentages, tables, and figures were used to describe categorical variables. The Kolmogorov -Smirnov test was used to ensure that continuous data had a normal distribution. Bivariable logistic regression analysis was employed, and the Crude Odds Ratio (COR) with 95% CI was computed to analyze the relationship between each independent variable and the outcome variable. Variables with p-values less than 0.25 were included for multivariable logistic regression analysis. Model goodness-of-fit was checked by the Hosmer and Lemeshow test, and the final model was well-fitted with the included independent variables (p-value = 0.81). The final model was performed to control the confounding variables and identify the associated factors by estimating the Adjusted Odds Ratio (AOR) with a 95% CI. Statistical significance was declared at a p-value of < 0.05.

Data Quality Control

A questionnaire was created in English and then translated into the local languages (Afan Oromo and Amharic) and then returned to English to maintain its consistency. One week before the actual data collection, 5% of the questionnaires were pre-tested among patients admitted at Dilchora General Hospital, which is about 52 kilometers away from the study region. The investigators attentively monitored the data collectors. The investigators evaluated the completeness of each questionnaire daily.

Ethical Consideration

The study protocol was approved by the Institutional Health Research Ethics Review Committee (IHRERC) of Haramaya University's College of Health and Medical Sciences, with reference number (IHRERC-175-2022). We conducted the investigations in accordance with the Helsinki Declaration's principles. The head of each hospital and participant above the age of 18 years provided informed, voluntary, written, and signed consent. In addition, written informed consent was obtained from the child's parent/legal guardian and oral assent was obtained from children under 18 years of age after explaining the benefits and risks of the study. Personal identifiers were not included during the data collection to ensure anonymity.

Results

Socio-Demographic Characteristics

A total of 381 admitted patients took part in the study. One hundred ninety-eight (52.0%) participants were female. The ages of the study participants ranged from 15 to 90 years old, with a mean age of 40.98 (SD = 17.3). The majority of 210 (55.1%) lived in rural areas. Regarding educational status, 82 (21.5%) admitted patients were in secondary school, and 70 (18.4%) were in college or above (Table 1).

Nutritional and Behavioral-Related Factors

One hundred fourteen (29.9%) of the 381 admitted patients were underweight (BMI < 18.5 kg/m2). In contrast, 59 (15.5%) of the patients who were admitted were obese (BMI ≥ 30 kg/m2). One hundred seventy admitted patients (44.6%) had an undernourished condition (MUAC 22 cm). According to the study, 245 (64.3%) of the participants were cigarette smokers, with 125 (32.8%) of them smoking ≥ 5 cigarette sticks each day. Additionally, 223 (58.5%) of the

Table 1 Sociodemographic Characteristics of Hospital Admitted Patients in Eastern Ethiopia, 2022

Variables	Category	Admitted Patients n (%)
Age in years	15–24	67 (17.6)
	25–34	120 (31.5)
	35–44	55 (14.4)
	45–54	48 (12.6)
	55–64	63 (16.5)
	Above 65	28 (7.3)
Sex	Female	198 (52.0)
	Male	183 (48.0)
Residence	Urban	171 (44.9)
	Rural	210 (55.1)
Educational Status	Unable to read and write	75 (19.7)
	Able to read and write	80 (21.0)
	Preparatory School	74 (19.4)
	Secondary School	82 (21.5)
	College or above	70 (18.4)

Table 2 Nutritional and Behavioral Related Factors of Hospital Admitted Patients in Eastern Ethiopia, 2022

Variables	Categories	N (%)
Body mass index	Underweight	114 (29.9)
	Normal weight	114 (29.9)
	Overweight	94 (24.7)
	Obese	59 (15.5)
MUAC	Malnourished	170 (44.6)
	Normal	211 (55.4)
Amount of standard Alcohol drink	No	158 (41.5)
	1– 4 days per a week	90 (23.6)
	Daily	133 (34.9)
Khat chewing habit	No	173 (45.4)
	< 300 g per day	119 (31.2)
	≥ 300 g per day	89 (23.4)
Cigarette smoking	No	136 (35.7)
	< 5 cigarette sticks per day	120 (31.5)
	≥ 5 cigarette sticks per day	125 (32.8)

**Abbreviation:** MUAC, Middle Upper Arm Circumference.

study participants were current alcohol users, with 133 (34.9%) of them consuming at least one standard alcoholic drink per day. Furthermore, 208 (54.6%) of the study participants were current khat chewers, with 119 (31.2%) of them chewing khat < 300 g per day (Table 2).

Admission Diagnosis of the Patients

Of 381 patients admitted to the selected hospitals, 90 (23.6%) were admitted with CKD, followed by chronic liver disease (CLD), 59 (15.5%), and chronic obstructive pulmonary disease (COPD) (13.9%) (Figure 2).

Prevalence of Anemia Among Admitted Patients

The mean hemoglobin level of the study participants was 10.85 g/dl ± 3.5 and ranged from 4.0 to 18.0 g/dl. The overall prevalence of anemia among admitted patients was 64.8% (CI: 60.01, 69.65). Out of this prevalence, the most common
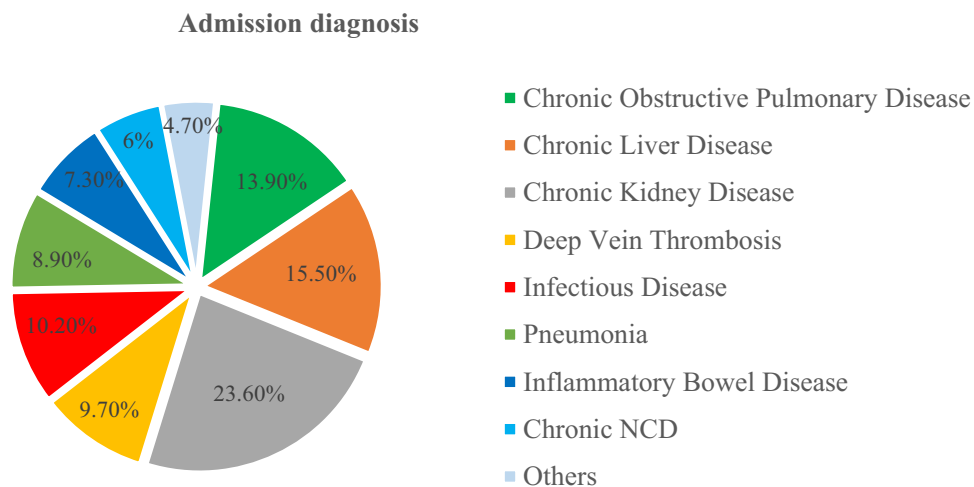
Figure 2 Admission diagnosis of hospital admitted patients in Eastern Ethiopia, 2022.
Abbreviation: NCD, Non-Communicable Disease.

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causes of anemia were CKD (31.2%), followed by CLD (14.6%) and infectious disease (13.4%). The least common cause of anemia in the current study was pneumonia, with a prevalence of 2.8% (Figure 3).
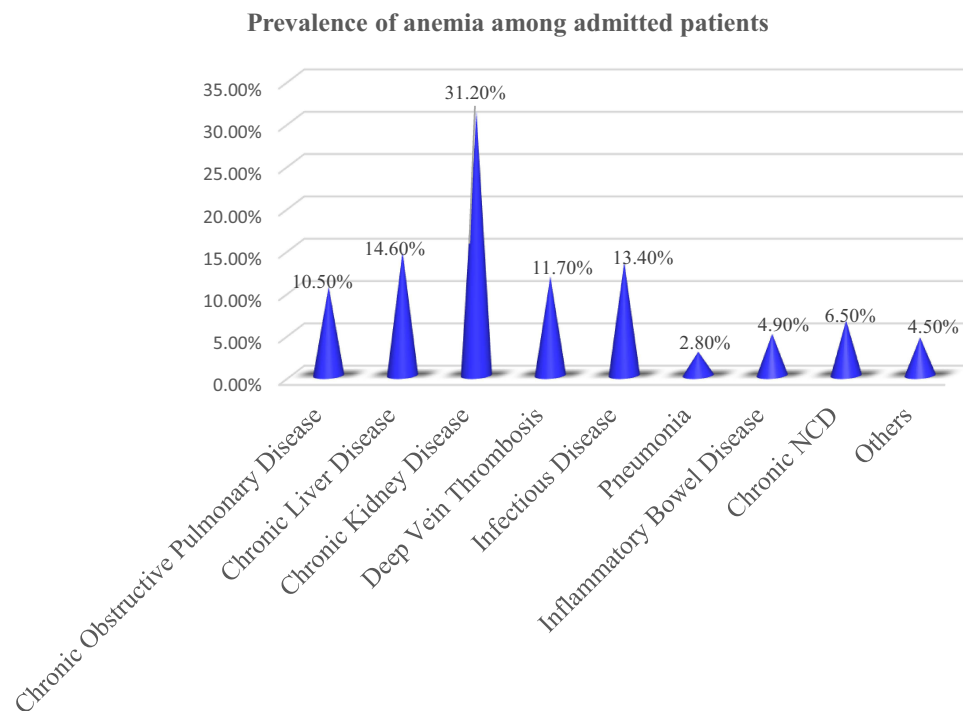
The Severity of Anemia Among Admitted Patients

Out of 247 (64.8%) anemic patients, 54 (14.2%) had mild anemia, 132 (34.6%) had moderate anemia, and 61 (16.0%) had severe anemia. In terms of anemia severity, the highest number of mild anemias was observed in participants admitted with CKD (31.5%), followed by CLD (18.4%). On the other hand, subjects admitted with chronic NCD (3.7%) showed the least mild anemia. In terms of moderate anemia, patients admitted with CKD had the highest percentage of cases (35.8%), followed by infectious diseases and deep vein thrombosis (15.2% of each). However, those admitted with inflammatory bowel disease (IBD) (1.5%) had the least amount of moderate anemia. In terms of severe anemia, patients admitted with CKD and CLD (23.0% of each) had the greatest percentages of severe anemia. However, admitted patients with pneumonia did not exhibit severe anemia (Figure 4).

Morphological Types of Anemia Among Admitted Patients

Based on MCV and MCHC, normocytic normochromic anemia constituted the majority of anemia (33.2%), followed by microcytic hypochromic anemia (27.9%). However, macrocytic normochromic anemia had the lowest percentage of anemia (7.8%) (Figure 5).

Factors Associated with Anemia

In the bi-variable logistic regression analysis, educational status, alcohol consumption, BMI, MUAC, and admission diagnosis were significantly associated at a p - value of < 0.25 and considered potential candidates for multivariable logistic regression analysis. In multivariable logistic regression, alcohol consumption, BMI, MUAC, and admission diagnosis were independently associated with greater odds for the presence of anemia at a p - value of < 0.05. Admitted patients who drank standard alcohol for 1– 4 days per week were 2.88 times more likely (AOR = 2.88, 95% CI = 1.45, 5.70) to develop anemia than those who did not drink standard alcohol. Moreover, admitted patients who drank standard
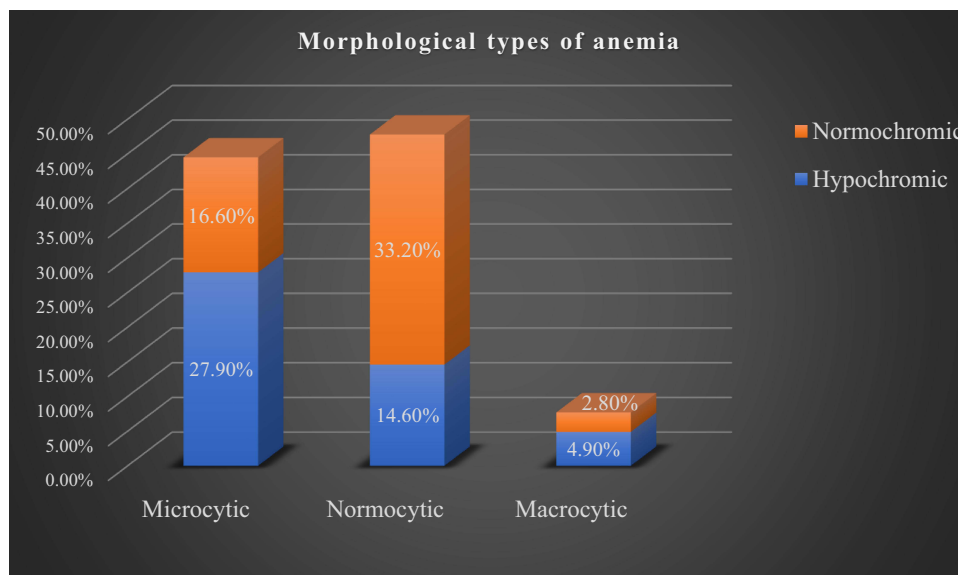

Prevalence of anemia among admitted patients

Figure 3 Prevalence of anemia among admission diagnosis of hospital admitted patients in Eastern Ethiopia, 2022.
Abbreviation: NCD, Non-Communicable Disease.

Severity of anemia among admission diagnosis
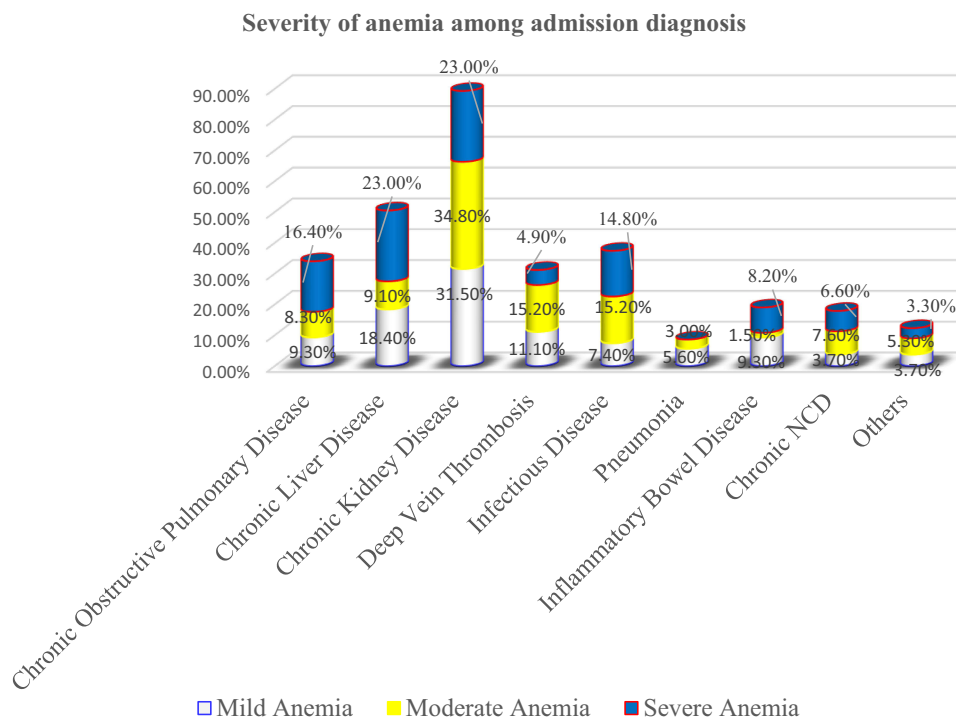
Figure 4 Severity of anemia among admission diagnosis of hospital admitted patients in Eastern Ethiopia, 2022.
Abbreviation: NCD, Non-Communicable Disease

Figure 5 Morphological types of anemia among hospital admitted patients in Eastern Ethiopia, 2022.

alcohol daily were 3.8 times more likely (AOR = 3.78, 95% CI = 1.71, 8.30) to develop anemia than those who did not drink standard alcohol.

Underweight admitted patients were 9.39 times more likely (AOR = 9.39, 95% CI = 2.90, 30.46) to develop anemia than patients who had normal weight. Additionally, obese admitted patients were 2.30 times more likely (AOR = 2.30, 95% CI = 1.00, 5.27) to develop anemia than normal-weight admitted patients. Undernourished admitted patients had 2.59 times higher odds (AOR = 2.59, 95% CI = 1.15, 5.84) of developing anemia than normal admitted patients. Patients admitted with CLD had 3.20 times higher odds (AOR = 3.20, 95% CI = 1.21, 8.47), CKD had 11.2 times higher odds

Table 3 Bivariable and Multivariable Logistic Regression Analysis for the Factors Associated with Anemia Among Hospital Admitted Patients in Eastern Ethiopia, 2022

Variables	Category	Anemia Status		95% CI	
		Yes N (%)	No N (%)	COR	AOR
Age in years	15–24	44 (65.7)	23 (34.3)	1.24 (0.49, 3.08)	1.33 (0.38, 4.71)
	25–34	80 (66.7)	40 (33.3)	1.29 (0.55, 3.02)	1.35 (0.42, 4.39)
	35–44	14 (25.5)	41 (74.5)	1.89 (0.72, 5.01)	1.71 (0.46, 6.29)
	45–54	28 (58.3)	20 (41.7)	0.91 (0.35, 2.35)	0.88 (0.25, 3.17)
	55–64	37 (58.7)	26 (41.3)	0.92 (0.37, 2.29)	0.95 (0.27, 3.34)
	Above 65	17 (60.7)	11 (39.3)	1	1
Sex	Female	131 (66.2)	67 (33.8)	0.89 (0.58, 1.35)	0.91 (0.51, 1.62)
	Male	116 (63.4)	67 (36.6)	1	1
Residence	Urban	113 (66.1)	58 (33.9)	1.11 (0.72, 1.69)	1.09 (0.62, 1.93)
	Rural	134 (63.8)	76 (36.2)	1	1
Educational Status	Unable to read and write	53 (70.7)	22 (29.3)	1.71 (0.86, 3.39)	1.36 (0.54, 3.43)
	Able to read and write	60 (75.0)	20 (25.0)	2.12 (1.06, 4.25)	2.13 (0.86, 5.31)
	Preparatory School	42 (56.8)	32 (43.2)	0.93 (0.48, 1.79)	0.47 (0.19, 1.15)
	Secondary School	51 (62.2)	31 (37.8)	1.16 (0.61, 2.23)	0.81 (0.34, 1.89)
	College or above	41 (58.6)	29 (41.4)	1	1
Amount of standard alcohol drink	No	72 (45.6)	86 (54.4)	1	1
	1– 4 days per a week	63 (70.0)	27 (30.0)	2.79 (1.61, 4.83)	2.88 (1.45, 5.70)*
	Daily	112 (84.2)	21 (15.8)	6.37 (3.63, 11.17)	3.78 (1.72, 8.30)*
BMI	Normal	52 (45.6)	62 (54.4)	1	1
	Underweight	108 (94.7)	6 (5.3)	21.46 (8.72, 52.84)	9.39 (2.90, 30.45)*
	Overweight	54 (57.4)	40 (42.6)	1.61 (0.93, 2.79)	1.61 (0.77, 3.41)
	Obese	33 (55.9)	26 (44.1)	1.51 (0.80, 2.85)	2.30 (1.00, 5.27)*
MUAC	Normal	106 (50.2)	105 (49.8)	1	1
	Undernourished	141 (82.9)	29 (17.1)	4.82 (2.97, 7.80)	2.59 (1.15, 5.83)*
Admission Diagnosis	COPD	26 (49.1)	27 (50.9)	1	1
	CLD	36 (61.0)	23 (39.0)	1.63 (0.77, 3.44)	3.20 (1.21, 8.47)*
	CKD	77 (85.6)	13 (14.4)	6.15 (2.77, 13.65)	11.15 (4.06, 30.60)*
	Deep vein thrombosis	29 (78.4)	8 (21.6)	3.76 (1.46, 9.74)	6.21 (1.98, 19.51)*
	Infectious disease	33 (84.6)	6 (15.4)	5.71 (2.05, 15.89)	9.70 (2.77, 34.02)*
	Pneumonia	7 (20.6)	27 (79.4)	0.27 (0.10, 0.70)	0.61 (0.18, 2.02)
	IBD	12 (42.9)	16 (57.1)	0.78 (0.31, 1.96)	1.29 (0.42, 4.04)
	Chronic NCD	16 (69.6)	7 (30.4)	2.37 (0.84, 6.71)	7.02 (1.90, 25.99)*
	Others	11 (61.1)	7 (38.9)	1.63 (0.55, 4.85)	3.76 (0.95, 14.87)

Note: *Statistically Significance at p value of < 0.05.
Abbreviations: BMI, Body Mass Index; MUAC, Middle Upper Arm Circumference; COPD, Chronic Obstructive Disease; CLD, Chronic Liver Disease; CKD, Chronic Kidney Disease; IBD; Inflammatory Bowel Disease; NCD, Non communicable Disease; COR, Crude Odds Ratio; AOR, Adjusted Odds Ratio.

(AOR = 11.16, 95% CI = 4.06, 30.64), deep vein thrombosis had 6.22 times higher odds (AOR = 6.22, 95% CI = 1.98, 19.52), infectious disease had 9.71 times higher odds (AOR = 9.71, 95% CI = 2.77, 34.02), and chronic NCD had 7.01 times higher odds (AOR = 7.01, 95% CI = 1.90, 25.99) to develop anemia as compared to patients admitted with COPD (Table 3).

Discussion

In this study, the overall prevalence of anemia among hospital admitted patients was 64.80%. Of these, 14.2% had mild anemia, 34.6% had moderate anemia, and 16.0% had severe anemia. This study was concordant with the studies conducted in Germany 60%,[28] Benin 61.8%,[4] and Uganda 64.3%.[5] However, Results from the present study revealed a lower prevalence of anemia than the previous studies conducted in Pakistan 71%,[3] Bahrain 72.2%,[2] and Tanzania 79.5%,[11] and a higher prevalence than other similar studies done in Italy 48%,[6] Germany 54.2%,[29] Pakistan 55.5%,[30] and Tanzania 44%.[12] This inconsistency

might be attributed to variations in the study design, sampling techniques and sample size, socio-demographic, behavioral characteristics, type of admission diagnosis, nutritional variation, and the age of the study subjects.

Normocytic normochromic (33.2%) blood picture was the most common morphological type of anemia, followed by microcytic hypochromic (27.9%) anemia. Whereas the least morphological type of anemia was macrocytic normochromic (2.8%) anemia found in this study. It is not surprising to see a normocytic normochromic blood picture of anemia in this study, as various previous studies conducted in India,[31] Pakistan,[32] Malaysia,[33] Saudi Arabia,[22] and Benin[4] also revealed this situation. Since the majority of participants in this study were admitted patients with CKD, chronic NCD, and ACD, which are expected to be normocytic and normochromic in morphology at the early stage of the disease.[33–35]

Admitted patients who drank standard alcohol for 1– 4 days per week and daily were 2.88 (AOR = 2.88, 95% CI =1.45, 5.70) and 3.78 (AOR = 3.78, 95% CI =1.71, 8.30) times more likely to develop anemia than those who did not drink standard alcohol, respectively. The result was in agreement with the studies conducted in Taiwan,[36] Finland,[37] and Japan,[38] as heavy drinkers were more likely to develop anemia than non-drinkers. Anemia in alcoholics has a complicated and multifaceted etiology, with causes ranging from poor nutrition to chronic inflammation, blood loss, liver failure, and inefficient erythropoiesis.[39,40]

Underweight admitted patients had 9.39 (AOR = 9.39, 95% CI = 2.90, 30.46) times higher odds of developing anemia than patients who had normal weight. The result was consistent with the studies conducted in Japan,[41] Israel,[42] and Tanzania.[43] The possible reasons for the underweight might be due to disease-specific factors such as loss of appetite, inflammation, swallowing difficulties, hypercatabolism, and treatment-related factors such as fasting episodes, treatment side effects, and psychological factors (anxiety, depression, and loneliness).[44,45]

Additionally, obese admitted patients had 2.30 (AOR = 2.30, 95% CI = 1.00, 5.27) times higher odds of developing anemia than patients who had normal weight. The result was in agreement with the studies conducted in the United States of America,[46] Pakistan,[47] Iran,[48] and Salzburg, Austria.[49] The principal mechanism that links obesity and anemia is low-grade systemic inflammation, which is observed in people with obesity.[50] In patients with obesity, serum hepcidin, and serum interleukin-6 are significantly higher, which results in reduced iron absorption and sequestration of iron within splenic and hepatic macrophages, which leads to a reduction in iron use in the obese.[51]

Undernourished admitted patients had 2.59 times higher odds (AOR = 2.59, 95% CI = 1.15, 5.84) of developing anemia than normal admitted patients. The result was in line with the studies conducted in the Netherlands,[44] and India.[52] Malnutrition is associated with poor tolerance to treatment, decreased quality of life, increased health care costs, social factors (such as poverty), and clinical conditions like malabsorption syndrome, intestinal obstruction, and gastric atony.[53]

Patients admitted with CLD were 3.20 (AOR = 3.20, 95% CI = 1.21, 8.47) times more likely to develop anemia than COPD patients. This finding was supported by researchs undertaken in the United States of America,[54] India,[55] and Bangladesh.[56] This could be due to the following factors: Hemorrhage, particularly in the gastrointestinal tract, is a prominent cause of anemia in people with chronic liver disease and cirrhosis.[56] Anemia owing to bleeding can arise as a consequence of chronic liver illness due to a deficiency of one or more blood clotting factors produced by the liver, thrombocytopenia, and/or impaired platelet activity.[57] Furthermore, iron insufficiency is common in late CLD patients because the liver secretes hepcidin, the major regulator of iron homeostasis.[58]

Admitted patients with CKD were 11.2 times (AOR = 11.16, 95% CI = 4.06, 30.64) more likely to develop anemia than COPD patients. Studies conducted in the United States,[59] Korea,[60] Indonesia,[61] Peshawar, Pakistan,[62] and Ghana[63] all corroborated this finding. This could be because people with CKD are more likely to develop anemia due to decreased erythropoietin production by failing kidneys. This might be since patients with CKD have a higher risk of developing anemia associated with decreased production of erythropoietin by failing kidneys.[64] Chronic kidney disease causes anemia by reducing erythropoietin production by the kidney's peritubular fibroblasts resulting in normocytic normochromic anemia, which was found in nearly half of CKD patients.[65]

Admitted deep vein thrombosis patients were 6.22 times (AOR = 6.22, 95% CI = 1.98, 19.52) more likely to develop anemia than COPD patients. This finding was reinforced by researchs undertaken across different corners of China,[66–68] France,[69] and Senegal.[70] The erythropoietin reaction to changes in Hgb levels is linearly logarithmic, which means that the lower the Hgb level, the higher the erythropoietin response.[71] Erythropoietin can promote hypercoagulability and raise the risk of thrombosis by increasing platelet and RBC levels as well as blood viscosity.[72]

Admitted patients with infectious illness were 9.7 times (AOR = 9.71, 95% CI = 2.77, 34.02) more likely to develop anemia than patients admitted with COPD. This finding was supported by researchs from Iran,[73] Cameroon,[74] and Ethiopia.[75] The primary factor in the development of malaria-related anemia is increased hemolysis of parasitized RBCs and increased destruction of non-parasitized RBCs.[76] This could be because hepcidin is elevated during infections, which also contributes to anemia.[77] Anemia prevalence in HIV-positive individuals increases with the progression of the disease and results in chronic acute phase response, elevated hepcidin, anemia of inflammation, and altered iron metabolism.[78,79] Anemia among pulmonary TB patients is thought to result from anemia of inflammation, as well as increased blood loss from hemoptysis (blood in sputum), decreased RBC production, and poor appetite and food intake, leading to poor nutrient status.[80]

Admitted patients with chronic NCDs were found to be 7.01 times (AOR = 7.01, 95% CI = 1.90, 25.99) more likely to be anemic than patients admitted with COPD. This result was in line with studies conducted in Malaysia,[81] India,[82] Pakistan,[83] and Ghana.[21] The pathogenesis of anemia in hematological malignant patients is largely speculative. In solid cancers, the most likely cause may be RBC fragmentation in small vessels of cancerous tissue, particularly in bone marrow, the lung, or other organs. Tumor cell cytokine production may also play a role in tumor necrosis factor (TNF)-mediated red cell damage[84] that activates the coagulation cascade and leads to RBC consumption via thrombotic microangiopathies.[82]

Conclusion
In this study, 64.80% of hospital admitted patients had anemia, indicating a need for routine screening for all admitted patients.

Abbreviations
ACD, Anemia of Chronic Disease; BMI, Body Mass Index; CKD, Chronic kidney disease; CLD, Chronic Liver Disease; COPD, Chronic Obstructive Pulmonary Disease; HIV, Human Immune Virus; Hgb, Hemoglobin; HFCSUH, Hiwot Fana Comprehensive Specialized University Hospital; IBD, Inflammatory Bowel Disease; IDA, Iron Deficiency Anemia; MCH, Mean Cell Hemoglobin; MCHC, Mean cell Hemoglobin concentration; MCV, Mean Cell Volume; MUAC, Middle-Upper Arm Circumference; NCD, Non-Communicable Disease; RBC, Red Blood Cell; WHO, World Health Organization.

Author Contributions
All authors contributed significantly to the work reported in the conceptualization, study design, execution, acquisition, analysis, and interpretation of data, as well as took part in drafting, revising, and critically assessing the paper. All authors have agreed to approve the final paper for publication in the current journal and to be held accountable for all elements of the work.

Disclosure
The authors declare that they have no competing interests.

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