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Article

Prevalence of Anemia and Its Associated Factors Among Chronic Heart Failure Patients at Arsi University Asella Referral and Teaching Hospital, Southeast Ethiopia

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Abstract

Introduction: Anemia is common in heart failure patients. It has been associated with an increased risk of hospitalization, morbidities, and considerable mortality in heart failure patients, making its correction an important element in improving the quality of life and clinical outcomes of patients. The magnitude of anemia and its associated factors among heart failure patients were not explored in the study setting. This study aimed to assess the prevalence of anemia and its associated factors among chronic heart failure patients at Asella referral and teaching hospital in southeast Ethiopia. **Methods:** This cross-sectional study included 264 heart failure patients who visited the cardiac follow-up clinic at Asella referral and teaching hospital, Southeast Ethiopia. A systematic random sampling method was used to select the study participants. Logistic regression analysis was used to assess factors associated with anemia in chronic heart failure patients. Statistical significance was declared at a p-value < 0.05. **Results:** The overall anemia prevalence was 27.3% (95% CI: 21.98, 32.6) among chronic heart failure patients. Age ≥ 60 years (AOR = 3.17, 95% CI: 1.02-9.87), female sex (AOR = 2.56, 95% CI: 1.31-5.01), utilization of angiotensin converting enzyme inhibitors (ACEIs) (AOR = 3.81, 95% CI: 1.81-7.94), history of previous hospitalization (AOR = 2.23, 95% CI: 1.31-5.01), and higher New York Heart Association (NYHA) functional class (class III (AOR = 2.81, 95% CI: 1.21-6.55), class IV (AOR = 6.38, 95% CI: 1.29-13.57)) were significantly associated with anemia among heart failure patients. **Conclusion:** This study revealed that the prevalence of anemia among chronic heart failure patients was high. Improved screening protocols and tailored interventions addressing older patients, females, patients taking ACEIs, and patients with advanced heart failure are essential for enhancing early detection and management of anemia in chronic heart failure patients to reduce associated morbidity and mortality.

Keywords: prevalence of anemia; heart failure; anemia; asella; southeast ethiopia

1. Introduction

Anemia, which is a decrease in the number of red blood cells or the hemoglobin concentration in the blood, is defined based on the world health organization (WHO) criteria as a hemoglobin (Hgb) level < 12 g/dl for non-pregnant women and < 13 g/dl for men, but the normal Hgb concentration varies with age, sex, and physiologic status such as pregnancy (1). Anemia is common in heart failure patients. It has been associated with an increased risk of hospitalization, morbidities, and considerable mortality in heart failure patients, making its correction an important element in improving the quality of life and clinical outcomes of patients (2-8). According to the European

Society of Cardiology (ESC) Heart Failure Pilot Survey on heart failure patients, anemia was independently associated with heart failure hospitalizations and was strongly related to all-cause mortality (9).

According to studies conducted in different areas of the world, the prevalence of anemia among heart failure patients ranges from 12.8% to 64.3% (10-20). The prevalence of anemia in heart failure patients was 29.5% and 49.5% in studies done in Somalia and Cameroon, respectively (21, 22). In a study conducted in northwest Ethiopia at the University of Gondar Hospital on heart failure patients, the prevalence of anemia was 41.9%(4).

Although the exact causes of anemia in heart failure are unclear, most likely multifactorial etiologies such as renal dysfunction, impaired erythropoietin generation and response, neuro-hormonal cytokine activation, pro-inflammatory cytokine production, deficiencies in iron metabolism or absorption, and impaired bone marrow function are proposed causes of anemia in heart failure(23-25).

Advanced age, higher NYHA functional class, renal failure, use of angiotensin converting enzyme inhibitors(ACEIs), female sex, presence of diabetes mellitus, presence of hypertension, history of previous admission, valvular disease, pulmonary hypertension, and presence of hyponatremia were significantly associated with anemia in heart failure patients(4, 11-16, 26, 27).

The aim of this study was to determine the magnitude of anemia and associated factors among chronic heart failure patients at Arsi University Asella referral and teaching hospital, Southeast Ethiopia.

2. Materials and Methods

2.1. Study Setting

An institution based cross-sectional study was conducted between March 1, 2023, and December 30, 2023, at Arsi University Asella referral and teaching hospital, which is located in Arsi zone, about 175 km southeast of the capital city of Ethiopia, Addis Ababa. The hospital serves for 3.5 million people. The cardiac follow-up clinic provides health care services for outpatients with cardiac disorders. The clinic was run by cardiologist, internists, internal medicine residents, and nurses. An average of 15 cardiac patients visit each day, and about 240 cardiac patients are seen per month.

2.2. Study Population and Study Subjects

2.2.1. Study Population

Adult patients who were followed at cardiac follow up clinic at Arsi University Asella referral and teaching hospital.

2.2.2. Study Subjects

Adult chronic heart failure patients who were followed at cardiac follow up clinic at Arsi University Asella referral and teaching hospital during the study period.

2.2.3. Inclusion and Exclusion Criteria

Inclusion criteria

Chronic heart failure patients ≥ 18 years of age who were followed at cardiac follow up clinic at Arsi University Asella referral and teaching hospital.

Exclusion criteria

Chronic heart failure patients with acute decompensation, pregnant patients, patients with incomplete medical records, or patients who did not give consent were excluded from the study.

2.2.4. Study Variables

Dependent variable: anemia among chronic heart failure patients. Independent variables: 1) Sociodemographic variables: age, sex, residence, and monthly income; 2) Clinical related variables: blood pressure (BP) status, body mass index (BMI), hemoglobin (Hgb) level, mean corpuscular volume (MCV) value, serum sodium level, presence of chronic kidney disease (CKD), left ventricular ejection fraction (LVEF), history of previous hospitalization in the past 6 months, history of diabetes mellitus (DM), and NYHA functional class, etiology of heart failure(HF); 3) Treatment related variables: use of ACEIs, use of beta (B) blocker, use of aspirin, use of anticoagulant, and use of diuretics.

2.2.5. Sample Size and Sampling Procedure

The sample size was calculated using a single population proportion formula with the assumption of 95% confidence level, 5% margin of error, and taking 41.9% for prevalence of anemia among heart failure patients in a study in northwest Ethiopia(4). A systematic random sampling method was used to recruit 270 study subjects.

2.2.6. Data Collection Instruments and Procedures

Data were collected through face-to-face interviews using a structured questionnaire and a review of medical records. Patients were interviewed to obtain sociodemographic data. The relevant medical history, laboratory, and treatment related parameters were obtained from patients' records. Complete blood count (CBC) were sent for study subjects (for those patients who did not have an updated CBC in the past three months). The questionnaire was prepared in English, translated into the local languages (Amharic and Afan Oromo) for data collection, and then retranslated back to English while maintaining its consistency. Two data collectors (medical practitioners) and one supervisor (internal medicine resident) participated in the data collection process. The questionnaire was pretested on 15 participants in a similar setup before the actual data collection commenced to check for reliability and consistency of the questionnaire. The quality of the data was ensured through the training and supervision of the data collectors.

2.3. Data Analysis

The collected data were entered into Epi Data 4.6 and imported into SPSS version 26.0 for analysis. Patient characteristics were reported as counts (percentages) for categorical variables and means with standard deviations for continuous variables. Bivariate and multivariate logistic regression models were constructed to identify factors associated with anemia in heart failure patients. The crude odds ratio (COR) and adjusted odds ratio (AOR) were reported. A P-value < 0.05 was considered to indicate a significant association. The Hosmer - Lemeshow goodness test was performed to evaluate model fitness, and the value was 0.189. The results were presented in text, tables, and figures.

2.4. Ethical Considerations

The research protocol complied with the Declaration of Helsinki, and ethical approval was obtained from the College of Health Science Arsi University Ethical Review Committee (Approval No. A/CHS/RC/49/2023). Study subjects were recruited only after written informed consent was obtained. All the data obtained were treated confidentially.

2.5. Operational Definition

Anemia: is a condition in which hemoglobin (Hgb) concentration and/or red blood cell (RBC) numbers are lower than normal and insufficient to meet an individual's physiological needs. The

WHO utilizes Hgb < 13 g/dl for males and < 12 g/dl for non-pregnant females to determine anemia (1).

Mild anemia: hemoglobin >9.9 g/dl to <13 g/dl for male and <12 g/dl for female(1).

Moderate anemia: hemoglobin 7-9.9 g/dl (1).

Severe anemia: hemoglobin <7 g/dl (1).

Acute decompensated heart failure (ADHF): rapid onset of new or worsening signs and symptoms of heart failure requiring hospitalization (28).

Chronic heart failure: Heart failure is considered chronic when symptoms and signs remain unchanged for at least one month (29).

3. Results

3.1. Sociodemographic Characteristics of the Study Participants

A total of 264 study participants were included in the study, with a 97.8% response rate. 139 (52.7%) participants were above 60 years of age. The mean age of the participants was 54.87 ± 18.59 years. A total of 154 (58.3%) were females. Geographic residence patterns revealed that a significant majority of patients, 172 (65.2%), resided in rural areas. 128 (48.5%) study participants had a monthly income of less than 5000 Ethiopian birrs (ETBs) (Table 1).

Table 1. Sociodemographic characteristics of study participants on prevalence of anemia and its associated factors among chronic heart failure patients at cardiac follow up clinic Asella referral and teaching hospital, Southeast Ethiopia.

Characteristics	Category	Frequency	Percentage
Sex	Male	110	41.7
	Female	154	58.3
Age	18-29 years	32	12.1
	30-59 years	93	35.2
	≥60 years	139	52.7
Residence	Urban	92	34.8
	Rural	172	65.2
Average monthly income (ETBs)	< 5000 ETBs	128	48.5
	5000-10,000 ETBs	97	36.7
	> 10,000 ETBs	39	14.8

ETBs: Ethiopian birrs.

3.2. Clinical Related Characteristics of the Study Participants

The findings of this study showed that about 52 (19.7%) patients were hypertensive. In the laboratory estimation of hemoglobin (Hgb) and mean corpuscular volume (MCV), the majority of patients, 192 (72.7%) had normal Hgb levels with a mean value of 13.94 ± 2.21 g/dl. A total of 182 (68.9%) patients had normal MCV values, with a mean value of 84.61 ± 7.73 femtoliters (fl). In this study, 64 (24.2%) patients had previous history of hospitalization. 110 (41.7%) participants had symptoms of New York Heart Association (NYHA) functional class I, whereas 93(35.2%) had NYHA class II symptoms (Table 2). Among the study participants, 130 (49.2%) had ischemic heart disease (IHD) and 56 (21.2%) had chronic rheumatic valvular heart disease (CRVHD) (Figure 1).

Table 2. Clinical related characteristics of study participants on prevalence of anemia and its associated factors among chronic heart failure patients at cardiac follow up clinic, Asella referral and teaching hospital,Southeast Ethiopia.

Characteristics	Category	Frequency	Percentage
Blood pressure status	Hypotension	5	1.9

BMI (kg/m ²)	Normal	207	78.4
	Hypertensive	52	19.7
	Underweight (<18.5 kg/m ²)	24	9.1
	Normal weight (18.5-24.9 kg/m ²)	209	79.2
	Overweight (25-29.9 kg/m ²)	22	8.3
Hgb level (g/dl)	Obese (30-34.9 kg/m ²)	9	3.4
	low(anemic) < 12/13 g/dl	72	27.3
	Normal ≥ 12/13 g/dl	192	72.7
MCV values(fl)	<80 fl	73	27.7
	80-100 fl	182	68.9
	>100 fl	9	3.4
Sodium level(mEq/L)	Low <135 mEq/L	44	16.7
	Normal:135-145 mEq/L	213	80.7
	High >145 mEq/L	7	2.7
Presence of CKD	No	259	98.1
	Yes	5	1.9
LVEF	≥50%	110	41.7
	41-49%	71	26.9
	≤40%	83	31.4
History of previous hospitalization in last 6 months	No	200	75.8
	Yes	64	24.2
History of DM	No	259	98.1
	Yes	5	1.9
NYHA functional class	class I	110	41.7
	class II	93	35.2
	class III	51	19.3
	class IV	10	3.8

BMI: Body mass index, Hgb: Hemoglobin, MCV: Mean corpuscular volume, fl:femtoliters, CKD: Chronic kidney disease, LVEF: Left ventricular ejection fraction, DM: Diabetes mellitus, NYHA: New York Heart Association, Kg/m²: kilograms per square meter, g/dl: grams per deciliter, mEq/L: milliequivalents per liter.

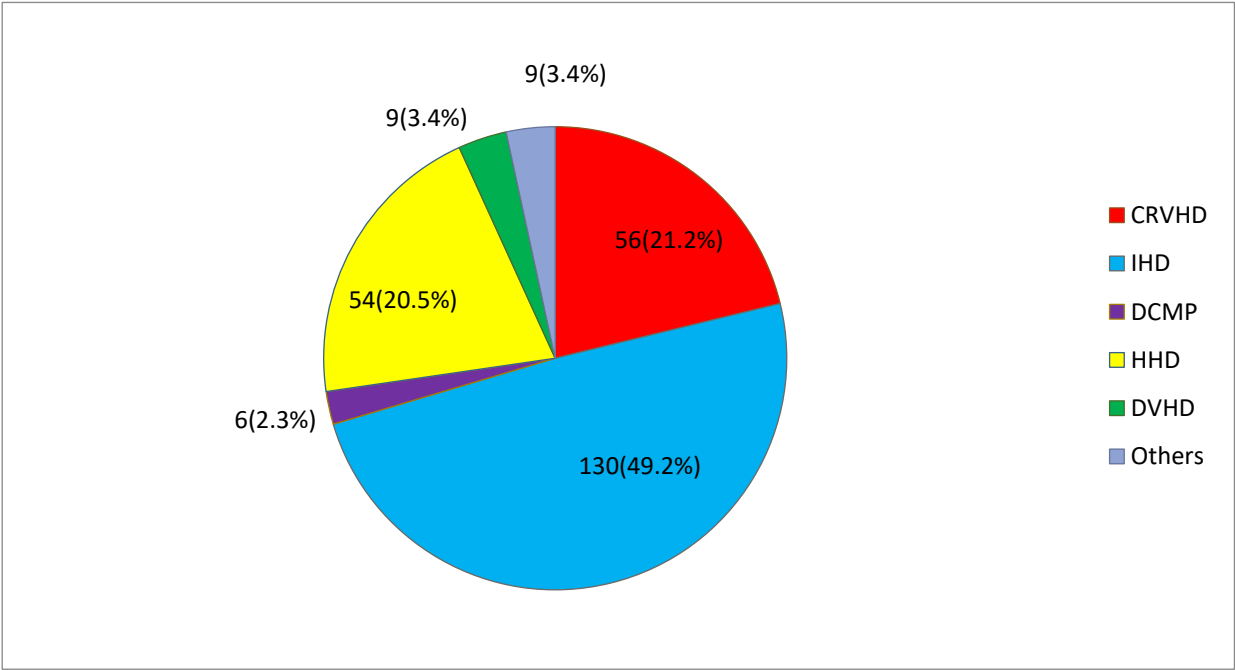


Figure 1. Etiology of heart failure among study participants at Asella referral and teaching hospital cardiac follow up clinic, Southeast Ethiopia. CRVHD: chronic rheumatic valvular heart disease, IHD: ischemic heart disease, DCMF: dilated cardiomyopathy, HHD: hypertensive heart disease, DVHD: degenerative valvular heart disease

3.3. Treatment Related Characteristics of the Study Participants

In terms of treatment modalities, 144 (54.5%) study participants were found to be on ACEIs. A total of 131(49.6%) patients were taking enalapril. Furthermore, 154 (58.3%) patients were taking beta blockers; the predominant prescribed medication was metoprolol succinate. The study also revealed that 118 (44.7%) patients (44.7%) received aspirin. A total of 175 (66.3%) patients were taking diuretics (Table 3).

Table 3. Treatment related characteristics of study participants on prevalence of anemia and its associated factors among chronic heart failure patients at cardiac follow up clinic, Asella referral and teaching hospital, Southeast Ethiopia.

Characteristics	Category		Frequency	Percentage
Use of ACEIs	No		120	45.5
	Yes	Enalapril	131	49.6
		Lisinopril	13	4.9
		Total	144	54.5
Use of beta-blocker	No		110	41.7
	Yes	Metoprolol	141	53.4
		Carvedilol	6	2.3
		Propranolol	7	2.6
		Total	154	58.3
Use of aspirin	No		146	55.3
	Yes		118	44.7
Use of anticoagulant	No		217	82.2
	Yes		47	17.8
Use of diuretic	No		89	33.7
	Yes		175	66.3

ACEIs: Angiotensin converting enzyme inhibitors.

3.4. Prevalence of Anemia Among Heart Failure Patients

In this study, the overall prevalence of anemia among heart failure patients was 72/264 (27.3%) with 95% CI (21.98, 32.6) (Figure 2). Among the total anemic patients, 52 (72.2%) patients had mild anemia, 13(18.1%) had moderate anemia and 7(9.7%) had severe anemia.

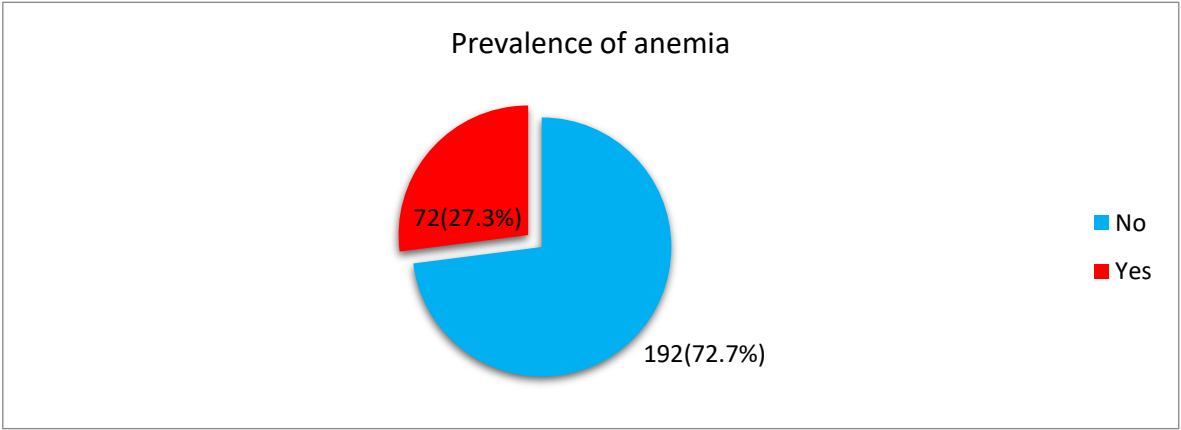


Figure 2. Prevalence of anemia among chronic heart failure patients at cardiac follow up clinic, Asella referral and teaching hospital, Southeast Ethiopia.

3.5. Factors Associated with Anemia Among Chronic Heart Failure Patients

The study utilized both bivariate and multivariable analysis to identify factors associated with anemia among chronic heart failure patients. In the bivariate analysis, factors with a p-value less than 0.25 were considered, encompassing participant age, sex, residence, utilization of ACEIs, use of beta blockers, use of aspirin, use of anticoagulant, left ventricular ejection fraction (LVEF), history of previous hospitalization, and NYHA functional class. In the multivariable logistic regression analysis: older age, female sex, use of ACEIs, history of previous hospitalization, and higher NYHA functional class were significantly associated with anemia among chronic heart failure patients with p-value of < 0.05.

Patients more than or equal to 60 years of age were found to have a 3.2 times higher likelihood of experiencing anemia than their younger counterparts (18-29 years old) (AOR = 3.17, 95% CI: 1.02-9.87). The odds of anemia were 2.56 times greater among female patients than male patients (AOR = 2.56, 95% CI: 1.31-5.01). Additionally, patients who were taking angiotensin converting enzyme inhibitors(ACEIs) were 3.8 times more likely to develop anemia than those who did not use ACE inhibitors (AOR = 3.81, 95% CI: 1.81-7.94). Furthermore, patients with a previous history of hospitalization faced 2.23 times higher odds of anemia than patients without a previous hospitalization history (AOR = 2.23, 95% CI: 1.31-5.01). Moreover, patients classified as NYHA functional class III had a 2.8 times higher likelihood of developing anemia (AOR = 2.81, 95% CI: 1.21-6.55) and NYHA class IV exhibited an even greater risk, with a 6.4 times higher chance of developing anemia compared to those in NYHA functional class I (AOR = 6.38, 95% CI: 1.29-13.57) (Table 4).

Table 4. Bivariate and multivariate analysis of factors associated with anemia among chronic heart failure patients at cardiac follow up clinic, Asella referral and teaching hospital, south-east Ethiopia.

Variable	Category	Presence of anemia		COR (CI=95%)	AOR (CI=95%)	P-value
		No	Yes			
Participant age	18-29 years	27	5	1	1	0.179
	30-59 years	70	23	1.77(0.612-5.)	2.26(0.68-7.45)	
	≥ 60 years	95	44	2.13(1.19-3.83)	3.16(1.02-9.87)	
Participant sex	Male	89	21	1	1	0.006*
	Female	103	51	2.09(1.17-3.76)	2.56(1.31-5.01)	
Participant residence	Urban	70	22	1	1	0.078
	Rural	122	50	1.30(0.73-2.33)	1.88(0.93-3.81)	
Use of ACEIs	No	99	21	1	1	0.000*
	Yes	93	47	2.58(1.44-4.62)	3.81(1.83-7.94)	
Use of beta blocker	No	85	25	1	1	0.265
	Yes	107	47	1.49(0.85-2.62)	1.56(0.72-3.39)	
Use of aspirin	No	112	34	1.56(0.91-2.69)	1.06(0.44-2.51)	0.899
	Yes	80	38	1	1	
Use of anticoagulant	No	155	62	1.48(0.69-3.15)	1.99(0.81-4.92)	0.135
	Yes	37	10	1	1	
LVEF	≥50%	98	34	0.51(0.27-0.96)	1.06(0.39-2.82)	0.912
	41-49%	56	12	0.31(0.14-0.69)	0.44(0.17-1.10)	
	≤40%	38	26	1	1	
Previous history of hospitalization	No	153	47	1	1	0.032*
	Yes	39	25	4.39(2.40-8.02)	2.24(1.07-4.68)	
NYHA functional classification	Class I	90	20	1	1	0.179
	Class II	67	26	1.64(0.85-3.17)	1.66(0.79-3.48)	
	Class III	31	20	2.52(1.20-5.282)	2.81(1.21-6.55)	

Class IV	4	6	6.36(1.64-24.56)	6.38(1.29-13.57)	0.023*
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*Significant variables, ACEIs: Angiotensin converting enzyme inhibitors; LVEF: Left Ventricular ejection fraction, NYHA: New York Heart Association, COR: Crude odds ratio, AOR: Adjusted odds ratio, CI: Confidence interval.

4. Discussion

A total of 264 chronic heart failure patients were included in the study. This study revealed that the prevalence of anemia among heart failure patients was 27.3% with 95% CI (21.98, 32.6). This finding was consistent with previous study conducted in Mogadishu, where anemia was prevalent in 29.5% of heart failure patients(21). However, the present anemia prevalence is lower than that reported in other studies, including those conducted in Cameroon (49.5%)(22), Gondar university referral hospital (41.9%)(4), South Korea (39.1%)(13), two European Society of Cardiology heart failure registries (33%)(14), Swedish heart failure registry (34%)(15), a united kingdom (UK) meta-analysis (42.8% in heart failure with reduced ejection fraction and 41.6% in preserved ejection fraction)(16), and a systematic review and meta-analysis (37.2%)(2). Furthermore, the anemia prevalence was higher than that reported in a Canadian population-based cohort study (17%) (12), a study conducted in Germany outpatient cardiology unit (18.9%) (18) and USA (12.08%) (17). The disparities in prevalence could stem from diverse factors, including demographics, socioeconomic status, environmental conditions, study design, sample size, and different hemoglobin cutoff values for the diagnosis of anemia across different regions.

The identified factors associated with anemia among chronic heart failure patients were older age, female sex, use of ACEIs, history of previous hospitalization, and higher NYHA functional class. Patients more than or equal to 60 years of age were 3.2 times more likely to experience anemia than their younger counterparts (AOR = 3.17, 95% CI: 1.02-9.87). This study was consistent with findings reported by a meta-analysis done in UK in heart failure patients with preserved ejection fraction and with reduced ejection fraction(15, 16) and study conducted at Gondar university hospital(4). This might be due to age-related physiological changes, such as a decline in bone marrow function, altered erythropoietin production, and a higher prevalence of chronic diseases, all of which contribute to a greater susceptibility to anemia.

The odds of anemia were 2.56 times greater among female patients than male patients (AOR = 2.56, 95% CI: 1.31-5.01). This finding was in line with a study conducted in Asia(11) and a population-based cohort study done in Canada(12). This could be due to the fact that females are more prone to iron deficiency due to menstruation and reproductive factors, leading to a higher risk of anemia. Hormonal influences such as, estrogen, can impact iron metabolism. Additionally, variations in dietary habits, nutritional requirements, and socioeconomic factors may contribute to sex-based differences in anemia prevalence.

Patients who used ACEIs were 3.8 times more likely to develop anemia than those who did not use ACEIs (AOR = 3.81, 95% CI: 1.81-7.94). This finding was supported by a study conducted in Asia(11). The increased likelihood of anemia among patients using ACEIs may be scientifically justified by the known side effects of these medications. ACEIs can lead to a decrease in erythropoietin production and interfere with the renin-angiotensin system, potentially affecting iron metabolism and causing anemia. Additionally, ACE inhibitors can induce renal dysfunction, impacting erythropoiesis.

The odds of anemia were 2.2 times higher in chronic heart failure patients with history of previous hospitalization than in patients who did not have previous hospitalization. This finding was consistent with the study done in South Korea(13). This could be due to patients with previous hospitalizations might have comorbidities and advanced heart failure, which can contribute to the occurrence of anemia. Furthermore, this study revealed that patients in NYHA functional class III had a 2.8 fold higher likelihood of anemia (AOR = 2.81, 95% CI: 1.21-6.55), whereas those in class IV faced an even greater risk, with a 6.4 fold higher chance (AOR = 6.38, 95% CI: 1.29-13.57) than did those compared to those in class I. These findings were supported by previous studies conducted in

Asian(11) and at Gondar university referral hospital(4). This may be scientifically justified by the progressive severity of heart failure and its impact on various physiological pathways. As heart failure advances, compromised cardiac output and inadequate tissue perfusion can contribute to reduced oxygen delivery, potentially leading to anemia.

Limitations of the Study

Since this was a cross-sectional study, the prevalence and associated factors of anemia among chronic heart failure patients might not be a true reflection of what happens all the time. The study was conducted at a single center, which may limit the generalizability of the findings to other healthcare settings with different patient populations and practices.

5. Conclusions

The overall prevalence of anemia among chronic heart failure patients was high. Advanced age, female sex, utilization of ACEIs, history of previous hospitalization, and higher NYHA class were independently associated with anemia among chronic heart failure patients. Improved screening protocols and tailored interventions addressing older patients, females, patients taking ACEIs, and patients with advanced heart failure are essential for enhancing early detection and management of anemia in chronic heart failure patients to reduce associated morbidity and mortality.

Authors’ Contributions: A.H. contributed to the conception, design, data collection, analysis, writing, and review of the manuscript. D.Z. ,G.D. , G.H. , and S.A contributed to conception, design, analysis, writing, and review of the manuscript. All the authors read and approved the final manuscript and approved its submission for publication.

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Ethics Approval and Consent to Participate: Ethical approval was obtained from the College of Health Science Arsi University Ethical Review Committee (Approval No. A/CHS/RC/49/2023). Study subjects were recruited only after informed written consent was obtained.

Consent for Publication: Written informed consent for publication was obtained from the study subjects.

Availability of Data and Materials: All the data generated and analyzed are included in this research article.

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Competing Interests: The authors declare that they have no competing interests.

Abbreviations

ACEI,Angiotensin converting enzyme inhibitors; ARTH, Asella referral and teaching hospital; BMI,Body Mass Index; BP,Blood Pressure; CBC, Complete Blood Count; CI, Confidence Interval; DCM,Dilated Cardiomyopathy; EF,Ejection Fraction; LVEF,Left Ventricular Ejection Fraction; EGFR,Estimated Glomerular Filtration Rate; EPO, Erythropoietin; ESC,European Society of Cardiology; GURH,Gonder university referral hospital; HF,Heart Failure; Hgb, Hemoglobin; HR,Hazard Ratio; IHD,Ischemic heart disease; NYHA: New York Heart Association; OPD,Out patient department; OR,Odd Ratio; VHD,Valvular heart disease; WHO, World Health Organization.

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