Section: General Medicine

Original Research Article

PREVALENCE OF IRON DEFICIENCY IN PATIENTS WITH HEART FAILURE ADMITTED TO GOVERNMENT GENERAL HOSPITAL, KADAPA

K. B. Yadavendra Reddy[1], Bingi Prathap[2], Salipela Jaya Bharatha Reddy[3], Nallamothu Sandeep Kumar[3]

[1]*Professor & HOD, Department of General Medicine, Government Medical college, Kadapa, Andhra Pradesh, India*
[2]*Assistant Professor, Department of General Medicine, Government Medical college, Kadapa, Andhra Pradesh, India*
[3]*Post graduates, Department of General Medicine, Government Medical college, Kadapa, Andhra Pradesh, India*

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Corresponding Author:
Dr. K. B. Yadavendra Reddy,
Professor & HOD, Department of General Medicine, Government Medical college, Kadapa, Andhra Pradesh, India
Email: kbyr2016@gmail.com

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ABSTRACT

Background: Heart failure (HF) is a prevalent condition, affecting 1–2% of the general population, and is a leading contributor to mortality, morbidity, and reduced quality of life (QoL). According to the World Health Organization (WHO), anemia is defined as hemoglobin levels <13.0 g/dL in men and <12.0 g/dL in women. The objective is to determine the prevalence of iron deficiency among heart failure patients admitted to Government General Hospital, Kadapa. To assess and classify the severity of iron deficiency in these patients based on laboratory parameters (e.g., serum ferritin, transferrin saturation, hemoglobin levels).

Materials and Methods: This study was conducted as a single-center observational study at a tertiary care hospital in Andhra Pradesh, with the primary aim of determining the prevalence and characteristics of iron deficiency in heart failure patients. The study included adult patients (18 years or older) who were clinically diagnosed with heart failure based on established diagnostic criteria from recognized guidelines, including those for preserved ejection fraction.

Results: HTN patients: 80% (40/50) had ID. Non-HTN patients: 96% (48/50) had ID. Non-hypertensive patients were significantly more likely to have ID ($p = 0.014$). DM patients: 100% (30/30) had ID. Non-DM patients: 82.9% (58/70) had ID. All diabetic patients in this cohort had ID ($p = 0.016$). AF patients: 100% (30/30) had ID. Non-AF patients: 82.9% (58/70) had ID. All AF patients had ID ($p = 0.016$).

Conclusion: In conclusion, the high prevalence of iron deficiency in HF patients in Kadapa emphasizes the need for routine screening and management of ID in this patient population. The significant associations with age, occupation, residence, diabetes, and atrial fibrillation provide valuable insights for targeted interventions. Future research could focus on the long-term impact of ID treatment on HF outcomes in this specific population.

Keywords: Anemia, cardiac death, heart failure, iron deficiency

INTRODUCTION

Heart failure (HF) is a prevalent condition, affecting 1–2% of the general population, and is a leading contributor to mortality, morbidity, and reduced quality of life (QoL).[1] According to the World Health Organization (WHO), anemia is defined as hemoglobin levels <13.0 g/dL in men and <12.0 g/dL in women.[2] It is a frequent comorbidity in HF patients, and is associated with increased mortality in both acute and chronic HF.[3] The etiology of anemia is multifactorial, particularly in regions like India, where nutritional deficiencies, parasitic infections, and chronic diseases play significant roles.

Among the various causes of anemia in HF, iron deficiency (ID) has emerged as a key contributor, though other factors (e.g., gastrointestinal malignancies, chronic inflammation) must also be considered.[4] Iron is essential for numerous bodily functions, and its deficiency commonly arises during

pregnancy, lactation, menstruation, aging, and chronic illnesses. Since most HF patients are elderly, other age-related causes of anemia—such as occult bleeding or malignancies (present in ~10% of cases in endoscopic studies)—must be ruled out.

Malnutrition is another critical factor, driven by poor dietary intake, malabsorption due to gut edema, and chronic inflammation. Studies indicate that HF patients with low BMI (<25 kg/m²) and malnutrition face the worst survival outcomes, while cardiac cachexia (a severe catabolic state in advanced HF) exacerbates anemia and poor prognosis.[5,6] Low serum albumin, a marker of malnutrition, is strongly linked to increased mortality.[6]

Despite these varied contributors, iron deficiency remains the most common cause of anemia in HF. Western studies report ID prevalence rates of 21–43%, highlighting its clinical significance.[7] Given its treatable nature, ID represents a key therapeutic target in HF management.[8] This study aims to assess ID prevalence in Indian HF patients, providing data to guide future diagnostic and treatment protocols.

Study Objectives:

1. To determine the prevalence of iron deficiency among heart failure patients admitted to Government General Hospital, Kadapa.
2. To assess and classify the severity of iron deficiency in these patients based on laboratory parameters (e.g., serum ferritin, transferrin saturation, hemoglobin levels).
3. To compare the prevalence of iron deficiency between different types of heart failure. (EF%)
4. To evaluate the association between iron deficiency and severity of heart failure (NYHA functional class).

MATERIALS AND METHODS

This study was conducted as a single-center observational study at a tertiary care hospital in Andhra Pradesh, with the primary aim of determining the prevalence and characteristics of iron deficiency in heart failure patients. The study included adult patients (18 years or older) who were clinically diagnosed with heart failure based on established diagnostic criteria from recognized guidelines, including those for preserved ejection fraction.

Exclusion criteria involved patients with non-cardiac conditions that could independently cause iron deficiency (such as hemorrhoids or malignancies), those with conditions that might complicate fluid overload assessment (like end-stage renal failure), individuals with specific cardiac conditions that follow different disease pathways (such as congenital heart disease, valvular heart disease), and treatment for anemia and iron deficiency(blood transfusions, erythropoietin therapy, iron supplements). All enrolled participants underwent detailed clinical evaluation including comprehensive medical history (with dietary assessment), physical examination, blood tests, and standardized echocardiographic evaluation. Patients were classified according to left ventricular ejection fraction: preserved (EF ≥50%), mildly reduced (EF 41-49%), and reduced ejection fraction (EF ≤40%). In addition to routine blood tests, iron status was thoroughly assessed through measurement of serum iron, ferritin, total iron-binding capacity, and transferrin saturation.

Anemia is defined according to World Health Organization criteria as hemoglobin levels below 13 g/dL for men and 12 g/dL for women. While the conventional diagnostic threshold for absolute iron deficiency is serum ferritin below 30 µg/L, this cutoff may not be appropriate in heart failure patients due to inflammation-induced elevations in ferritin levels. Therefore, the study adopted modified diagnostic criteria: absolute iron deficiency was identified as serum ferritin <100 µg/L, while functional iron deficiency was characterized by normal ferritin levels (100-300 µg/L) accompanied by low transferrin saturation (<20%). These adjusted parameters account for the unique pathophysiology of iron metabolism in heart failure patients.

Statistical analysis: The statistical analysis was performed using standard methods for data presentation and comparison. Categorical variables were reported as frequencies with percentages, while continuous variables following normal distribution were expressed as mean ± standard deviation. For comparative analysis, the chi-square test was employed for categorical data and Student's t-test for normally distributed continuous variables, with p-values calculated accordingly to determine statistical significance. All analyses were conducted using appropriate statistical software with a predetermined significance level of $p<0.05$.

RESULTS

Table 1: Prevalence of Iron Deficiency in the study population

Iron deficiency	No.	Percentage (%)
With ID (tsat<20%)	88	88
Without ID (tsat>20%)	12	12
Total	100	100

88% of heart failure (HF) patients admitted to the hospital had iron deficiency (TSAT < 20%).

Table 2: Socio-demographical characteristics of the study population.

Variables	Category	Iron Deficiency		X2 value	p-value
		Yes	No		
Age (in years)	<50	23	3	8.350	0.015 (Sig.)
	50-70	32	9		
	>70	33	0		
Gender	Males	30	5	0.266	0.606 (NS)
	Females	58	7		
Occupation	Driver	10	0	51.306	0.000 (Sig.)
	Farmer	30	1		
	Housewife	10	3		
	Labourer	28	2		
	Office employee	10	0		
	Unemployed	0	6		
Residence	Rural	68	6	4.082	0.043 (Sig.)
	Urban	20	6		
NYHA	CLASS I	8	3	5.032	0.169 (NS)
	CLASS II	20	4		
	CLASS III	40	2		
	CLASS IV	20	3		

Iron deficiency is most prevalent in patients >70 years (100% of this group had ID). Younger patients (<50) also show high ID rates (88.5%). No significant difference in ID prevalence between males (85.7%) and females (89.2%). Drivers, farmers, and labourers have very high ID rates (>93%). Rural patients have higher ID prevalence (91.9%) vs. urban (76.9%). Though not statistically significant, Class III patients have the highest ID prevalence (95.2%).

Table 3: Co-morbidities in the study population

Variables	Category	Iron Deficiency		X2 value	p-value
		Yes	No		
HTN	YES	40	10	6.061	0.014 (Sig.)
	NO	48	2		
DM	YES	30	0	5.844	0.016 (Sig.)
	NO	58	12		
AF	YES	30	0	5.844	0.016 (Sig.)
	NO	58	12		

HTN patients: 80% (40/50) had ID. Non-HTN patients: 96% (48/50) had ID. Non-hypertensive patients were significantly more likely to have ID (p = 0.014). DM patients: 100% (30/30) had ID. Non-DM patients: 82.9% (58/70) had ID. All diabetic patients in this cohort had ID (p = 0.016). AF patients: 100% (30/30) had ID. Non-AF patients: 82.9% (58/70) had ID. All AF patients had ID (p = 0.016).

Table 4: Risk factors in the study population

Variables	Category	Iron Deficiency		X2 value	p-value
		Yes	No		
Smoking	YES	50	7	0.10	0.921 (NS)
	NO	38	5		
Alcohol	YES	28	8	5.566	0.018 (Sig.)
	NO	60	4		
Betelnut chewing	YES	28	4	5.844	0.916 (NS)
	NO	60	8		

Smokers: 87.7% (50/57) had ID. Non-smokers: 88.4% (38/43) had ID. No significant difference in ID prevalence between smokers and non-smokers (p = 0.921). Alcohol users: 77.8% (28/36) had ID. Non-users: 93.8% (60/64) had ID. Non-drinkers had significantly higher ID rates than drinkers (p = 0.018). Betel nut users: 87.5% (28/32) had ID. Non-users: 88.2% (60/68) had ID. No significant difference in ID prevalence between users and non-users (p = 0.916).

Table 5: Other parameters analysed in the study population

Variables	Iron Deficiency		t-test value	p-value
	Yes (mean±SD)	No (mean±SD)		
Age	63.034±15.324	59.5±10.587	0.772	0.442(NS)
HR	85.84±16.991	78.75±9.29	2.190	0.039(Sig.)
MAP	98.88±16.838	101.166±5.474	0.464	0.644(NS)
Hb	10.619±1.96	14.02±0.572	5.961	0.000(Sig.)
Ferritin	145±71.84	354.8±16.367	9.860	0.000(Sig.)
EF (%)	40±11.23	45.58±8.55	9.655	0.101(NS)

No significant age difference between ID and non-ID groups. ID patients had higher resting heart rates. Blood pressure was similar in both groups. ID does not significantly affect vascular resistance in this cohort. ID patients had severely lower Hb (mean difference: -3.4 g/dL). ID group had much lower ferritin (mean difference: -209.8 ng/mL). Ferritin <100 ng/mL (with TSAT <20%) is diagnostic for ID in HF. A 5.58% lower EF in ID patients, but not statistically significant.

Table 6: Characteristics of Anaemia in the study population

Variables	Category	Iron Deficiency		X2 value	p-value
		Yes	No		
Anaemia	YES (Hb<12)	68	0	28.977	0.000 (Sig.)
	NO (Hb<12)	20	12		
EF (%)	>51	20	5	3.025	0.220 (NS)
	41- 50	16	3		
	≤ 40	52	4		

There is a strong statistically significant association between anaemia (Hb < 12) and iron deficiency. All patients with anaemia (68 out of 68) in this sample had iron deficiency, suggesting that iron deficiency is highly prevalent in anaemic patients in this study population. There is no statistically significant association between EF (%) categories and iron deficiency. Although more patients with low EF (≤40%) had iron deficiency (52 vs. 4), the difference across groups was not statistically significant (p = 0.220).

Table 7: Characteristics of ID in the study population

ID	Number (n)	Percentage (%)
Absolute ID (SF<100)	35	35
Functional ID (SF 100-300)	53	53
No ID (SF >300)	12	12
Total	100	100

88% of patients (n=88) had some form of iron deficiency (either Absolute or Functional). Only 12% (n=12) had no iron deficiency (SF > 300). Iron deficiency is highly prevalent (88%) in this population, with Functional ID being dominant.

DISCUSSION

The findings of this study reveal a strikingly high prevalence of iron deficiency (ID) among heart failure (HF) patients admitted to Government General Hospital, Kadapa, with 88% of the cohort exhibiting ID (either absolute or functional). This prevalence is substantially higher than the rates reported in Western populations, where ID prevalence ranges between 21% and 43%.[7] The dominance of functional ID (53%) over absolute ID (35%) in our cohort aligns with the pathophysiology of HF, where chronic inflammation disrupts iron metabolism, leading to impaired iron utilization despite adequate stores.[7,9]

The high prevalence of ID in our study may be attributed to several factors unique to the Indian population. Nutritional deficiencies, parasitic infections, and socioeconomic disparities likely contribute to the elevated burden of ID, as suggested by Yeo et al,[9] who identified Indian ethnicity as an independent predictor of ID in Asian cohorts. Additionally, the predominance of rural residents (91.9% ID prevalence) in our study underscores the role of limited healthcare access and dietary inadequacies in exacerbating ID.[4]

Our results also highlight significant associations between ID and comorbidities such as diabetes mellitus (DM) and atrial fibrillation (AF), with 100% of DM and AF patients exhibiting ID. These findings contrast with Western studies, where the association between DM and ID is less pronounced.[3] This discrepancy may reflect the interplay of malnutrition and chronic inflammation in Indian HF patients, further emphasizing the need for tailored management strategies.

The strong correlation between anemia (Hb <12 g/dL) and ID (100% of anemic patients had ID) reinforces the central role of ID in anemia among HF patients. This aligns with global data but highlights a more severe burden in our population.[2,7] Notably, while ID was prevalent across all ejection fraction (EF) categories, no significant association was found between ID and EF, consistent with the findings of Jankowska et al,[7] who reported similar ID rates in HF with preserved and reduced EF.

The higher ID prevalence among elderly patients (>70 years) and specific occupational groups (e.g., farmers, laborers) suggests demographic and lifestyle influences on iron status. These findings echo the work of Sun et al,[4] who linked occupational hazards and aging to increased ID risk. Conversely, the lower ID prevalence among alcohol users (77.8%) compared to non-users (93.8%) warrants further investigation, as alcohol may influence iron absorption or dietary habits.[3]

Our ID prevalence of 88% far exceeds the 37-61% reported in Western cohorts,[7,9] underscoring regional disparities. The study by Yeo et al,[9] in

multi-ethnic Asian populations reported ID rates of 55% in HF patients, with Indian subgroups showing higher susceptibility, supporting our findings. Similarly, the high anemia prevalence (68%) in our study contrasts with Western data (30-50%),[3] reflecting the compounded impact of ID and malnutrition in our setting.

This study investigated the prevalence and characteristics of iron deficiency (ID) in patients with heart failure (HF) admitted to Government General Hospital, Kadapa. The findings reveal a notably high prevalence of ID within this cohort, with 88% of admitted HF patients demonstrating iron deficiency (TSAT < 20%). This figure is consistent with, and in some cases even higher than, prevalences reported in other international and national studies. For instance, a meta-analysis by Grote Beverborg et al. found that ID affects up to 50% of HF patients globally, with functional ID being particularly common.[10] Another study in India by Kumar et al. reported a prevalence of ID in HF patients to be around 60-70%.[11] The higher prevalence in our study might be attributed to regional dietary habits, socio-economic factors, or specific patient demographics.

Our analysis of socio-demographic characteristics showed significant associations between ID and age, occupation, and residence. Patients over 70 years of age exhibited a 100% prevalence of ID, and those under 50 years also showed high rates at 88.5%. This bimodal distribution, or at least a high prevalence across age groups, warrants further investigation as many studies typically report increasing ID with age in HF populations.[12] The significant prevalence among drivers, farmers, and labourers (>93%) and rural residents (91.9%) suggests potential links to nutritional deficiencies, physical exertion, or limited access to healthcare in these groups. This aligns with observations in other developing regions where rural populations and those in physically demanding occupations often have higher rates of micronutrient deficiencies.[13]

Regarding comorbidities, the study found a significant association between ID and both diabetes mellitus (DM) and atrial fibrillation (AF), with 100% of patients with these conditions also presenting with ID. While non-hypertensive patients were significantly more likely to have ID compared to hypertensive patients, this finding requires careful interpretation. It is possible that patients with HTN are under more regular medical supervision, leading to earlier detection and management of other conditions, or that the mechanisms linking HTN to ID are different. The strong association of ID with DM and AF is well-documented in existing literature, as these conditions often share common inflammatory pathways and metabolic derangements that can impact iron metabolism.[14,15]

Interestingly, our study found no significant difference in ID prevalence based on smoking or betel nut chewing habits. However, non-drinkers of alcohol had significantly higher rates of ID compared to alcohol users. This contrasts with some studies that suggest alcohol consumption can contribute to nutritional deficiencies, including iron.[16] The reason for this inverse association in our cohort needs further exploration, perhaps considering the quantity and type of alcohol consumed, or confounding dietary factors among non-drinkers.

Physiological parameters revealed that ID patients had significantly lower hemoglobin (Hb) and ferritin levels, which are direct indicators of iron status. The mean Hb difference of -3.4 g/dL and ferritin difference of -209.8 ng/mL between ID and non-ID groups are clinically significant and strongly support the diagnosis of ID in this population. The finding of higher resting heart rates in ID patients is also noteworthy, as anemia and iron deficiency can lead to increased cardiac workload to compensate for reduced oxygen delivery, thus impacting heart rate.[17] While a 5.58% lower ejection fraction (EF) was observed in ID patients, it was not statistically significant. This indicates that while ID may contribute to cardiac dysfunction, it might not be the sole or primary determinant of EF reduction in this specific HF cohort, or that the sample size for this particular association was limited.

A strong statistically significant association was observed between anemia (Hb < 12) and iron deficiency, with all anaemic patients in the study also presenting with ID. This highlights that in this population, iron deficiency is a near-universal underlying cause of anemia in HF patients. This underscores the importance of assessing iron status in all HF patients with anemia. Finally, the study characterized the types of ID, with 88% of patients having either absolute (SF<100) or functional ID (SF 100-300), and functional ID being the dominant form (53%). This is consistent with current understanding that functional iron deficiency, where iron stores are adequate but iron utilization is impaired due to inflammation, is highly prevalent in chronic diseases like HF.[18]

CONCLUSION

In conclusion, the high prevalence of iron deficiency in HF patients in Kadapa emphasizes the need for routine screening and management of ID in this patient population. The significant associations with age, occupation, residence, diabetes, and atrial fibrillation provide valuable insights for targeted interventions. Future research could focus on the long-term impact of ID treatment on HF outcomes in this specific population.

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