Journal of Society Medicine
Research & Review Articles on Diseases
Journal of Society Medicine. 2025; 4 (4)

Factors Related to Obstructive Sleep Apnea in Patients with Heart Failure and Atrial Fibrillation

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ARTICLE INFO

Article history:
Received
12 March 2025

Revised
11 April 2025

Accepted
30 April 2025

Manuscript ID:
JSOCMED-12032025-44-5

Checked for Plagiarism: Yes

Language Editor:
Rebecca

Editor-Chief:
Prof. Aznan Lelo, PhD

ABSTRACT

Introduction: Obstructive sleep apnea (OSA) causes cardiovascular disturbances due to intermittent hypoxia, oxidative stress, systemic inflammation, excessive negative intrathoracic pressure, sympathetic activation, and increased blood pressure. These factors can impair myocardial contractility, leading to the development of heart failure and atrial fibrillation (AF). Epidemiological studies have shown a significant independent association between OSA, heart failure, and AF. This study aims to identify factors associated with obstructive sleep apnea (OSA) in patients with heart failure accompanied by atrial fibrillation.

Method: This study was conducted on patients diagnosed with heart failure and atrial fibrillation hospitalized at the Integrated Heart Center of Adam Malik Hospital. Data collection began in August 2023 and continued until the required sample size was reached. This is an observational analytic study with a cross-sectional design.

Results: A total of 51 patients participated in this study. The majority of respondents were male (66.7%), with most being aged between 60-69 years. The study found that the degree of OSA in heart failure patients with AF was predominantly mild (30.8%), followed by moderate (25.0%) and severe (17.3%). The average AHI value was 16.78 with a standard deviation of 14.359. Multivariate analysis identified two significant variables: smoking history and functional capacity (NYHA Class) ($p > 0.05$).

Conclusion: A significant association was found between gender and smoking history with the occurrence of OSA in patients with heart failure and atrial fibrillation. The multivariate analysis also highlighted the significance of smoking history and functional capacity (NYHA Class) ($p > 0.05$).

Keywords OSA, Heart Failure, Atrial Fibrillation, AHI

How to cite: Masyab N, Lubis AC, Raynaldo AH. Factors Related to Obstructive Sleep Apnea in Patients with Heart Failure and Atrial Fibrillation. *Journal of Society Medicine*. 2025; 4 (4): 138-145. **DOI: https:// 10.71197/ jsocmed.v4i4.207**

INTRODUCTION

Heart failure (HF) and atrial fibrillation (AF) have emerged as significant cardiovascular diseases in recent decades. In the United States alone, heart failure affects more than 5 million people, with approximately 25 million individuals affected worldwide. Each year, 550,000 new heart failure cases are diagnosed, with a rising trend, particularly attributed to the aging population and the transition of low-income countries to developing nations. Advances in cardiovascular care and public health infrastructure are expected to increase the prevalence of heart failure over time [1,2]. In Indonesia, based on the 2018 Basic Health Research (RISKESDAS), the prevalence of heart failure diagnosed by doctors is 1.5%, affecting approximately 1,017,290 individuals. This growing prevalence, along with increased rates of re-hospitalization and mortality, highlights the increasing burden of heart disease [3].

Atrial fibrillation, a sustained arrhythmia, is commonly observed in patients with heart failure, with a prevalence of 25%. The coexistence of these two conditions exacerbates the severity of each other. The Framingham Heart Study reported that heart failure in patients with atrial fibrillation is associated with higher mortality rates (men: HR, 2.7 [95% CI, 1.9–3.7]; women: HR, 3.1 [95% CI, 2.2–4.2]). Conversely, atrial fibrillation also contributes to increased mortality in patients with heart failure (male HR, 1.6 [95% CI, 1.2–2.1]; female HR, 2.7 [95% CI, 2.0–3.6]) [4,5].

Obstructive sleep apnea (OSA), a common sleep-disordered breathing (SDB), affects 2-4% of middle-aged adults and is characterized by recurrent episodes of upper airway collapse, leading to chronic intermittent hypoxia (CIH) and fragmented sleep [6]. OSA is recognized as an independent risk factor for cardiovascular diseases, including hypertension, arrhythmias, heart failure, coronary artery disease, and stroke, with a prevalence ranging from 40-80% [6,9]. In patients with heart failure, SDB is associated with poor prognosis and progression of heart dysfunction. Nearly 50% of patients with heart failure, regardless of left ventricular ejection fraction, experience SDB, with a prevalence 10 times higher than that in the general population. Studies using polysomnography in patients with heart failure have found varying rates of OSA, ranging from 12% to 53%, which is significantly higher than that in the general population. Despite its high prevalence, SDB screening is rarely conducted, leading to frequent underdiagnosis of sleep apnea [10].

Atrial fibrillation was previously considered less common in the Asian population than in other regions. However, recent data have revealed higher prevalence rates. The REPORT-HF study (International Registry to Assess Medical Practice and Longitudinal Observation for the Treatment of Heart Failure) has highlighted that heart failure prognosis is worse in low- and middle-income countries, including Indonesia, where heart failure outcomes are poorer [2,11]. The prevalence of sleep apnea in patients with atrial fibrillation is higher than that in the general population (21%-74%). A sleep study from The Sleep Heart Health Study found that the prevalence of AF was 4.8% in patients with sleep apnea, compared to 0.9% in normal subjects. Furthermore, Mehra et al. reported that the risk of developing AF was four times higher in patients with severe OSA than in those without. OSA has also been linked to the onset of new AF after coronary artery bypass grafting (CABG) and is an independent predictor of postoperative AF [10,12].

Cardiovascular societies recommend OSA as a modifiable risk factor for both AF and heart failure. Most guidelines suggest OSA screening for certain populations and advocate CPAP therapy to reduce AF recurrence. CPAP therapy has been shown to improve the left ventricular ejection fraction and reduce the respiratory disturbance index (RDI) [12].

Despite the known relationship between OSA and heart failure with atrial fibrillation, the exact prevalence and contributing factors remain unclear. Previous studies have largely relied on patient history or questionnaires for diagnosing OSA without the use of objective measurements, such as the Apnea Hypopnea Index (AHI), which can be assessed through polysomnography. This study aimed to investigate the factors associated with and the prevalence of obstructive sleep apnea (OSA) in patients with heart failure and atrial fibrillation using type 3 polysomnography/home sleep apnea testing (HSAT).

METHOD

This analytical study used a cross-sectional approach to assess the prevalence and associated factors of obstructive sleep apnea (OSA) in patients with heart failure and atrial fibrillation. The study was conducted at the Cardiac Centre of H. Adam Malik Hospital in Medan, Indonesia, from August 2023 to November 2024, after receiving approval from the Health Research Ethics Committee of the Faculty of Medicine, University of North Sumatra.

The target population consisted of patients diagnosed with heart failure and atrial fibrillation, specifically those receiving treatment at the hospital's Cardiac Center during the study period. Consecutive sampling was used to select eligible participants who met the inclusion and exclusion criteria. The sample size calculation for the diagnostic test was based on the formula for sample size determination, which yielded a minimum sample size of 48 patients.

The inclusion criteria were patients with stable heart failure and atrial fibrillation, both persistent and paroxysmal, who were willing to participate in the study and sign the informed consent form. The exclusion criteria were as follows: congenital heart disease, severe or moderate valvular disease, and ongoing OSA treatment with CPAP.

The operational definitions included heart failure as a condition where the heart fails to distribute oxygen throughout the body, atrial fibrillation as uncoordinated atrial activation, and OSA as a disorder of repeated upper airway collapse causing intermittent hypoxia and fragmented sleep. The Apnea-Hypopnea Index (AHI) from home sleep apnea testing (HSAT) classified OSA severity.

The research began with ethical approval from the Health Research Ethics Committee, University of North Sumatra, followed by patient recruitment at H. Adam Malik Hospital's Cardiac Center. Enrolled patients met inclusion criteria and provided informed consent. Medical records were reviewed for baseline data, including anamnesis, physical examination, and diagnostic tests like ECG and echocardiography. Participants underwent anthropometric measurements and health history assessment, including comorbidities. Clinically stable patients underwent home sleep apnea testing using ResMed's ApneaLink Air device. Polysomnographic examination was conducted overnight for minimum 4 h, recording nasal airflow, respiratory movements, and oxygen saturation. AHI calculations classified OSA severity. Statistical analysis using SPSS version 20 included descriptive statistics, chi-square tests for categorical variables, and t-tests for continuous variables. Variables with $p<0.25$ underwent multivariate logistic regression to identify key factors associated with OSA in heart failure and atrial fibrillation patients.

Data collection involved several diagnostic tools, including electrocardiography (ECG), echocardiography, and polysomnography. The study examined factors such as age, sex, body mass index (BMI), neck circumference, hypertension, diabetes mellitus, smoking history, and functional capacity (NYHA Class) as potential risk factors for OSA in patients with heart failure and atrial fibrillation. Descriptive analysis and statistical tests, such as chi-square tests for categorical data and t-tests for continuous data, were used to analyze the data. Multivariate logistic regression analysis was applied to identify the most significant variables influencing OSA in this population. Data were processed and analyzed using SPSS version 20.

The study was conducted with ethical considerations in mind, and informed consent was obtained from all participants before data collection began. This study adheres to ethical standards and aims to contribute valuable insights into the relationship between OSA, heart failure, and atrial fibrillation and the impact of various risk factors on these conditions.

RESULTS

This research was an observational analytical study using a cross-sectional design conducted at the Cardiac Centre of H. Adam Malik Hospital, Medan, starting from August 2023. The target population for this study consisted of patients diagnosed with heart failure accompanied by atrial fibrillation, specifically those receiving treatment at the Cardiac Center of the hospital.

A total of 51 patients participated in this study, with 34 patients (66.7%) being male and the average age of the sample being 61 years old. Most patients had persistent atrial fibrillation (66.7%), and the most common left ventricular ejection fraction (LVEF) was <40% in 24 patients (47.1%), followed by LVEF of 50% in 16 patients (31.4%), and LVEF between 40-49% in 11 patients (21.6%).

The classification of OSA based on the Apnea-Hypopnea Index (AHI) showed that 30.8% of patients had mild OSA, 25.5% had no OSA, 25% had moderate OSA, and 17.3% had severe OSA. These findings are summarized in Table 1.

The analysis of the baseline characteristics of patients based on the presence or absence of OSA revealed that age, body mass index (BMI), and neck circumference did not significantly influence the occurrence of OSA in patients with heart failure and atrial fibrillation ($p > 0.05$). However, older age and higher BMI were associated with a higher tendency for OSA.

Table 1. Basic Demographic Characteristics of the Study Population

Demographic Data	n (51)
Gender, n (%)	
Male	34 (66.7)
Female	17 (33.3)
Age (years)	61 (31-82)
Body Mass Index (Kg/m²)	26.5 ± 5.56
Heart Failure, LVEF (%)	
LVEF ≥ 50%	16 (31.4)
LVEF 40-49%	11 (21.6)
LVEF < 40%	24 (47.1)
Atrial Fibrillation, n (%)	
Persistent AF	34 (66.7)
Paroxysmal AF	17 (33.3)
OSA, n (%)	
No OSA	13 (25.5)
Mild OSA	16 (30.8)
Moderate OSA	13 (25.0)
Severe OSA	9 (17.3)

The average AHI for the study population was 16.78 ± 14.359, with a significant p-value of <0.001 (Table 2).

Table 2. Mean and Standard Deviation of AHI

Variable	Mean ± SD	p-value
AHI (Degree of OSA)	16.78 ± 14.359	<0.001*

Noted: Independent t-test

Table 3. Characteristics of Risk Factors

Variable	OSA (+) (n = 38)	OSA (-) (n = 13)	p-value
Age			
< 60 years	16 (42.1%)	9 (23.7%)	0.463
> 60 years	22 (57.9%)	29 (76.3%)	
Gender			0.012*
Female	12 (31.6%)	9 (23.7%)	
Male	26 (68.4%)	29 (76.3%)	
BMI			0.152*
Under/Normal	25 (65.8%)	13 (34.2%)	
Over/Obese	13 (34.2%)	8 (61.5%)	
Neck Circumference			0.064*
< 41 cm	19 (50.0%)	19 (50.0%)	
≥ 41 cm	25 (65.8%)	13 (34.2%)	
Diabetes Mellitus			0.112*
Yes	15 (39.5%)	23 (60.5%)	
No	25 (65.8%)	13 (34.2%)	
Hypertension			0.043*
Yes	18 (47.4%)	20 (52.6%)	
No	25 (65.8%)	13 (34.2%)	
Smoking History			0.577*
Yes	18 (47.4%)	20 (52.6%)	
No	25 (65.8%)	13 (34.2%)	
Coronary Artery Disease			0.577*
Yes	18 (47.4%)	20 (52.6%)	
No	25 (65.8%)	13 (34.2%)	

Significant factors related to OSA included sex, smoking history, and functional capacity according to the New York Heart Association (NYHA) classification ($p < 0.05$). Patients with comorbidities such as diabetes mellitus, hypertension, and coronary artery disease (CAD) did not show significant differences between the two groups (with or without OSA). Among the study participants, 34 (66.7%) did not have diabetes mellitus; of these, 23 had OSA, while 11 did not. Regarding hypertension, 27 (52.9%) had hypertension, of which 19 had OSA and 8 did not. Additionally, 28 (54.9%) participants had a history of smoking, with 25 suffering from OSA and 3 not. CAD was present in 23 (45.1%) patients, of whom 18 had OSA and five did not. The findings are summarized in Table 3.

Multivariate analysis using logistic regression revealed that functional capacity according to the NYHA classification and smoking history were significantly associated with the occurrence of OSA in patients with heart failure and atrial fibrillation. All other variables showed p-values greater than 0.05, indicating no significant associations. The odds ratios for the significant factors are presented in Table 4.

Table 4. Risk Factor Analysis (Multivariate)

Variable	Odds Ratio (95% CI)	p-value
Age	0.431 (0.084 – 2.199)	0.312
BMI	1.659 (0.279 – 9.866)	0.578
Neck Circumference	0.245 (0.023 – 2.578)	0.241
Diabetes Mellitus	2.335 (0.388 – 14.03)	0.354
Gender	0.628 (0.041 – 9.593)	0.738
Smoking History	4.653 (1.064 – 20.34)	0.041
NYHA Class	6.693 (1.434 – 31.247)	0.016

Smoking history and functional capacity (NYHA class) were significant risk factors for OSA in patients with heart failure and atrial fibrillation. Other factors, such as age, BMI, neck circumference, diabetes, hypertension, and CAD, were not significantly associated in this study.

DISCUSSION

Obstructive sleep apnea (OSA) is a sleep disorder affecting 2-4% of middle-aged adults. In patients with heart failure, OSA worsens the prognosis and heart function. Nearly 50% of patients with heart failure have OSA, and the prevalence of OSA is higher in patients with atrial fibrillation (AF) than in those without AF. The prevalence of OSA in patients with AF ranges from 21% to 74%, which is ten times higher than that in the general population [6-9]. This study found a 74.5% OSA prevalence in patients with both heart failure and AF, aligning with Lailiyya et al.'s finding of 71% in patients with AF. This contrasts with Canadian and German studies showing only 37% and 36% prevalence in patients with heart failure [13,14], possibly due to the smaller sample size and different patient populations.

The Apnea-Hypopnea Index (AHI) classifies OSA severity by measuring the number of apneas and hypopneas per hour during sleep. The American Academy of Sleep Medicine defines mild (AHI 5-15), moderate (AHI >15-30), and severe OSA (AHI >30). This study found that 30.8% of patients had mild, 25% had moderate, and 17.3% had severe OSA, with a mean AHI of 16.78 ± 14.359.

OSA contributes to cardiovascular disease progression, affecting heart structure and function, and is linked to both fatal and nonfatal cardiovascular events. Over 40% of patients with heart failure and AF had moderate to severe OSA; however, its impact on clinical outcomes requires further research.

The study population was predominantly older, with 39.2% of patients aged ≥60 years, consistent with Lailiyya et al.'s finding of a 1.85-fold increased OSA risk in this age group [13]. OSA prevalence increases with age because of reduced pharyngeal muscle tone and increased upper airway fat deposition [14-16]. Males comprised 66.7% of OSA cases, aligning with Levy et al.'s findings, where males constituted over 60% of heart failure patients with OSA [3, 4]. Studies by Andrade et al. and Staerk et al. found that men have a higher OSA risk, with 86% showing a high risk [17-19]. The study found that 45.1% of patients were overweight (BMI >25), consistent with Chowdhury et al.'s findings [20]. While Gami et al. found that obesity was most prevalent in patients with AF and OSA, and Abumuammar et al. found no significant impact of BMI [21], this study suggests that BMI remains important for OSA development in patients with heart failure and AF. The study found that 72.5% of patients had neck circumference <41 cm, contradicting Haradwala and Sivaraman's findings that neck circumference ≥41 cm in men and ≥40 cm in women increased OSA risk. Cincinnati Veterans Affairs research showed that neck circumference correlates with OSA severity [22].

Diabetes mellitus was present in 33.3% of the study population, but this result contrasts with that of Andayeshgar et al., who reported that 56% of patients with OSA also had diabetes [23]. Aronsohn et al. found that worse OSA severity in patients with diabetes was associated with poor glycemic control, as measured by hemoglobin A1c levels. These findings suggest a potential interaction between OSA and diabetes, in which poorly controlled diabetes may exacerbate OSA severity independent of factors such as BMI, race, and age [24].

Hypertension was present in 52.9% of patients in this study, a result similar to that of a cohort study conducted in Brazil, which reported that approximately 50% of hypertensive patients had OSA [24]. However, this finding is not consistent with that of Lailiyya et al., who found that hypertension was the most significant risk factor for OSA in patients with AF, with 83.8% of patients with hypertension having OSA. Hypertension, particularly through the renin-angiotensin-aldosterone system (RAAS), contributes to OSA by causing fluid retention, which increases airway resistance and leads to upper airway collapse [25].

Finally, multivariate logistic regression analysis revealed that smoking history and functional capacity (NYHA class) were significant factors associated with OSA in patients with heart failure and atrial fibrillation. This contrasts with the findings of Shapira et al., who found that age and BMI were the most significant predictors of OSA, whereas hypertension did not have a significant effect [26-29]. Levy et al. also noted that patients with heart failure and OSA had lower functional capacity than those without OSA. These findings underscore the importance of addressing functional capacity and smoking history in the management of OSA in patients with heart failure and AF.

CONCLUSION

Based on the data analysis, this study concluded that male sex and smoking history are significantly associated with the occurrence of obstructive sleep apnea (OSA) in patients with heart failure and atrial fibrillation. The prevalence of OSA in this population was high, with a considerable proportion of patients experiencing moderate-to-severe OSA. The most common degree of OSA was mild, followed by moderate and severe degrees. Additionally, the study highlighted that most participants were men aged 60-69 years, with a reduced left ventricular ejection fraction (LVEF <40%), and a high prevalence of persistent atrial fibrillation and multimorbid conditions.

DECLARATIONS

Ethics approval and consent to participate. Permission for this study was obtained from the Ethics Committee of the Universitas Sumatera Utara and Haji Adam Malik General Hospital.

CONSENT FOR PUBLICATION

The Authors agree to publication in the Journal of Society Medicine.

FUNDING

None

COMPETING INTERESTS

The authors declare no conflicts of interest in this report.

AUTHORS' CONTRIBUTIONS

All authors significantly contributed to the work reported in the execution, acquisition of data, analysis, and interpretation, or in all these areas. Contributed to drafting, revising, or critically reviewing the article. Approved the final version to be published, agreed on the journal to be submitted, and agreed to be accountable for all aspects of the work.

ACKNOWLEDGMENTS
None

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