

Evaluation of Sleep Disordered Breathing in Different Cases of Heart Diseases

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Abstract:

Background: The frequency of sleep disordered breathing (SDB) is higher in people with cardiovascular disease, which may be related to the pathophysiology of the disease. **Objectives:** This work aimed to evaluate the frequency and characteristics of SDB among patients with various cardiovascular diseases. **Methods:** This cross-sectional observational study that was conducted on 105 different cardiac patients divided into (AF, CAD, HFpEF and HFrEF) who underwent Overnight polysomnography (PSG) at Sleep Study Unit, Chest Department, at Benha University Hospital. **Results:** High frequency of SDB in different cardiac groups. Obstructive sleep apnea (OSA) and obesity hypoventilation syndrome (OHS) were more frequent in all groups, but group D (HFrEF) had the highest frequency (96.7% and 50%, respectively), but simple primary snoring and upper airway resistance syndrome were less frequent across all groups. While central sleep apnea (CSA) and mixed apnea were mostly absent across all groups, with no significant differences observed ($P = 0.392$). **Conclusion:** high frequency of SDB in patients with different cases of heart diseases which have increased risk of disease progression if SDB remains untreated.

Keywords: Sleep Disordered Breathing; Obstructive Sleep Apnea; Central Sleep Apnea; Obesity Hypoventilation Syndrome

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Introduction

SDB is characterized by repetitive episodes of either shallow breathing or complete cessation of airflow (apnea) during sleep, which consequently leads to intermittent episodes of oxygen desaturation (hypoxemia) and marked fluctuations in intrathoracic pressure. These pathophysiological disturbances contribute to increased sympathetic nervous system activity, endothelial dysfunction, systemic inflammation, and metabolic dysregulation. Collectively, such alterations markedly elevate the risk of developing a wide spectrum of serious cardiovascular complications ⁽¹⁾. Among the most clinically relevant outcomes associated with SDB are sudden cardiac death, the development and recurrence of atrial fibrillation (AF), ischemic stroke, coronary artery disease (CAD), and progression to heart failure (HF) ⁽¹⁾.

The most frequently encountered and clinically significant subtype of SDB is OSA, which occurs due to recurrent upper airway collapse during sleep despite preserved respiratory effort ⁽²⁾. In contrast, CSA is less common but is also of considerable importance in patients with advanced cardiac dysfunction.

Notably, both SDB and nocturnal hypoxemia have been reported to be highly prevalent among patients with chronic stable heart failure, especially those with reduced left ventricular ejection fractions. Multiple clinical studies have consistently demonstrated that the presence of SDB in this population is not merely an epiphenomenon but rather acts as an independent predictor of adverse outcomes, including increased all-cause mortality and higher rates of hospitalization due to worsening HF ⁽³⁾. This strong association underscores the importance of early identification and appropriate management of SDB in patients with heart failure, as

targeted interventions may have the potential to improve both quality of life and long-term survival.

Aim of the work:

The aim of this work is to evaluate the frequency and characteristics of SDB among patients with various cardiovascular diseases, including stable CAD, chronic AF, heart failure with preserved ejection fraction (HFpEF), and heart failure with reduced ejection fraction (HFrEF).

Patients and methods

Study selection:

This is cross sectional observational study that was conducted on 105 different cardiac patients at the Sleep Study Unit, Chest department at Benha University Hospital in cooperation with the cardiology department during the period from December 2022 to December 2024. The cardiac patients were divided into 4 groups: **Group (A):** 30 stable CAD patients (a range of clinical presentations or syndromes that arise due to structural and/or functional alterations related to chronic diseases of the coronary arteries and/or microcirculation. These alterations can lead to transient, reversible, myocardial demand vs. blood supply mismatch resulting in hypoperfusion (ischemia), usually (but not always) provoked by exertion, emotion or other stress, and may manifest as angina, other chest discomfort, or dyspnea, or be asymptomatic)(4) , **Group (B):** 30 chronic AF patients (AF for which no further attempts at restoration of sinus rhythm are planned, after a shared decision between the patient and physician)(5), **Group (C):** 15 HFpEF patients (signs and symptoms of HF, an EF $\geq$ 50%, elevated levels of natriuretic peptides (NP; NT-proBNP $\geq$ 125 pg/mL), and at least one of the following: relevant structural heart disease (left ventricular hypertrophy or left atrial enlargement)

and/or diastolic dysfunction(6), **Group (D):** 30 HFrEF patients (symptoms and/or signs of HF & LVEF $\leq 40\%$ caused by a structural and/or functional cardiac abnormality and corroborated by elevated natriuretic peptide levels and/or objective evidence of pulmonary or systemic congestion⁽⁷⁾.

Study description

All subjects were subjected to the following: -

Full medical history, including smoking history, chest symptoms, history of comorbidities, and symptoms of sleep apnea (either daytime or nighttime symptoms).

Full clinical examination (general and local).

Full lab including {CBC (complete blood count), RFT (renal function test), LFT (liver function test), (LDL)

Other labs include:

Thyroid function tests

NT-pro BNP (N. Terminal pro. brain natriuretic peptide): in patients suspected HFpEF.

Oxygen saturation by pulse oximetry, ECG, Echocardiography.

Sleep study include:

Pretest questionnaires:

Epworth sleepiness scale (ESS) which was translated to Arabic language according to Anwar et al ⁽⁸⁾.

STOP BANG score ⁽⁹⁾

Measurement of neck circumference, Abdominal circumference, and BMI.

Measurement of oxygen saturation by pulse oximetry.

Overnight Polysomnography for all subjects (SOMNO Screen Plus; SOMNO

Medics GmbH, Randersacker, Germany).

The polysomnography consists of pulse oximetry, electroencephalogram, electrooculogram, ECG, electromyogram, thoracic and abdominal belts, body position sensor, assessment of respiratory flow and pressure by nasal thermistor and nasal cannula and bipolar channel limb

movements (tibialis anterior). Electrodes and sensors were directly attached to patients by sleep physiologist. Data acquisition was obtained immediately after signal detection by preprocessed computer (DOMINO Software, ver. 2.6.0; SOMNO Medics GmbH).

Exclusion criteria:

1. Patients who had acute congestive heart failure.
2. Patients who had acute coronary syndrome.
3. Patients who have had recent stroke or psychiatric disorders.
4. Patients with thyroid dysfunction and ENT cause SDB.
5. Patients with past history of chronic chest diseases.

Approval code: MD12-1-2023

Statistical analysis:

The collected data was revised, coded, and tabulated using Statistical package for Social Science (**IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.**).

Results

In the current study, among the studied patients, the mean age range was between (60-63 ys) with male predominance in all groups (90% in group A, 86.7% in group B, 73.3% in group C, and 93.3% in group D), with no statistically significant difference noticed between different groups regarding age and sex, respectively, highlighting its limited influence as a discriminating factor in this study, in terms of symptoms, significant differences were observed between the groups ($p1 = 0.009$). Group C had the lowest percentage of daytime and nighttime symptoms but had the highest percentage of snoring. No significant difference was found regarding snoring history between the studied groups as shown in (**Table 1**).

The prevalence of diastolic dysfunction varied significantly between groups. Grade I was most prevalent in Group C at 80.0%, followed by Group B at 73.3%, while Grade II was predominant in Group D at 70.0%. The differences were statistically significant ($p < 0.001$) as showed in **(Figure 1)**. Furthermore, LVEF (left ventricular ejection fraction) showed significant variations across groups, with Group D exhibiting the lowest mean LVEF% at 42.07%. Pairwise comparisons indicated significant differences between Group D and the other groups ($p < 0.001$) as shown in **(Figure 2)**.

In terms of pretest scores as shown in **(Table 2)** Stop-BANG score shows significant differences among the groups ($P < 0.001$), with Group B having the highest mean score of 4.77 ± 1.17 , followed by Group C at 4.20 ± 0.56 . Pairwise comparisons indicate significant differences in the Stop-BANG scores between group B vs. group A and D ($P_2 < 0.001$, $P_4 = 0.001$ respectively), highlighting potential variations in sleep disturbance severity among these heart disease groups. In this study, in terms of AHI (apnea hypopnea index) categories, severe AHI levels (≥ 30) are most prevalent in Group A at 70.0%, followed by Group B at 43.3%. The AHI and RDI (respiratory disturbance index) values are highest in Group A and lowest in Group C. Significant differences in AHI and RDI are observed among the groups ($P_1 = 0.019$ and $P_1 = 0.014$, respectively) as shown in **(Table 2)**. As regarding Apnea types in this study, group D has the highest incidence of obstructive apnea events at 96.7%, significantly higher than the group C ($P_1 = 0.012$). While group A showed the highest number and index of obstructive apnea events than all

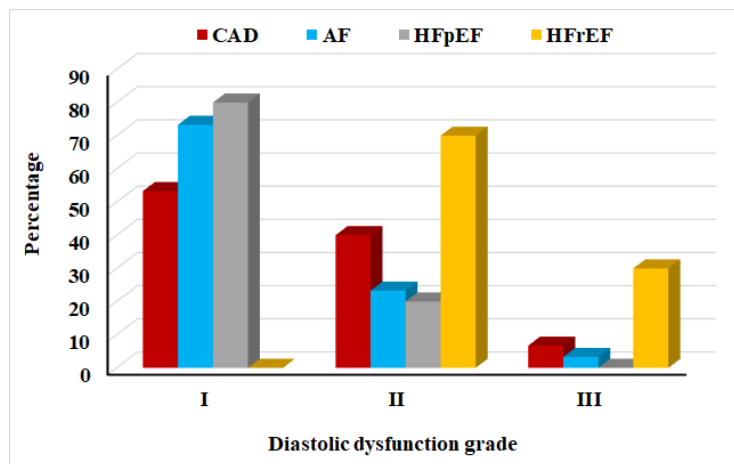
other B, C & D groups ($P_2 = 0.001$, 0.012, 0.014 respectively). No significant differences between studied groups regarding central apnea presence, number ($P_1 > 0.05$ for each). Mixed apnea is mostly absent across all groups, with no significant differences observed ($P_1 = 0.392$) as shown in **(Table 3)**.

This study explored that there was significant difference regarding frequency of OHS among the studied groups ($P_1 = 0.017$), with group D showing the highest frequency (50%), followed by group B (33.3%), group A (23.3%) and lastly group C (6.7%) as showed in **(table 4)**. In this study there was a correlation between AHI and echocardiographic parameters: in group A, AHI showed significant positive correlations with WMSI (wall motion score index) and MVRG (mitral valve regurge grade) and a significant negative correlation with LVEF. In group B, AHI showed significant positive correlations with DDG (diastolic dysfunction grade), WMSI, and MVRG and a significant negative correlation with LVEF. In group C, AHI showed significant positive correlations with DDG and MVRG. In group D, AHI showed significant positive correlations with DDG and WMSI and significant negative correlation with LVEF as shown in **(Table 5)**. In contrast other polysomnographic parameters including RDI exhibited significant differences in the cardiac patient groups. In this study it showed that RDI showed significant negative correlation with LVEF in all groups as shown in **(figure 3)**.

Table (1): Demographic data and clinical features of different groups of heart diseases.

		Group A (CAD) n = 30		Group B (AF) n = 30		Group C (HFpEF) n = 15		Group D (HFrEF) n = 30		Test	P
		No.	%	No.	%	No.	%	No.	%		
Sex	Male	27	90.0	26	86.7	11	73.3	28	93.3	$\chi^2=$	MC
	Female	3	10.0	4	13.3	4	26.7	2	6.7	3.599	0.348
Age	Mean $\pm$ SD.	63.77 $\pm$ 3.96		63.63 $\pm$ 4.66		60.40 $\pm$ 4.34		62.0 $\pm$ 5.20		H=	0.094
	Median	64.0		65.0		60.0		63.0		6.402	
Pairwise		P2 ^{FE} 0.032*, ^{FE} p3=0.032*, ^{FE} p4=1.000, FEp5=0.101									
Smoking	No	7	23.3	7	23.3	15	100.0	2	6.7	$\chi^2=$	<0.00
	Yes	23	76.7	23	76.7	0	0.0	28	93.3	44.444*	1*
Pairwise		P2 <0.001* p3<0.001*, ^{FE} p4=0.145, p5<0.001*									
Symptoms											
Day time symptoms	No	30	100.0	30	100.0	12	80.0	29	96.7		
	Yes	0	0.0	0	0.0	3	20.0	1	3.3		
Pairwise		P2 ^{FE} 0.032*, ^{FE} p3=0.032*, ^{FE} p4=1.000, FEp5=0.101									
Nighttime symptoms	No	30	100.0	30	100.0	12	80.0	29	96.7	$\chi^2=$	MC
	Yes									7.865*	0.009*
Pairwise		P2 ^{FE} 0.032*, ^{FE} p3=0.032*, ^{FE} p4=1.000, ^{FE} p5=0.101									
Snoring History											
No		29	96.7	28	93.3	12	80.0	28	93.3	$\chi^2=$	MC
										4.127	0.301
Yes		1	3.3	2	6.7	3	20.0	2	6.7		
Pairwise		p3<0.001*, p4<0.001*, p5=0.580									

SD.: Standard deviation, Min.: Minimum, Max.: Maximum, H: Kruskal Wallis test, χ^2 : Chi Square test, MC: Monte Carlo, p1: Comparing different groups of heart diseases, p2: Comparing CAD and each other studied groups, p3: Comparing AF and HFpEF, p4: Comparing AF and HFrEF, p5: Comparing HFpEF and HFrEF, *: Significant when p value <0.05.

**Figure (1):** Comparison between different groups of heart diseases regarding ECHO parameters (DDG) (Column chart).

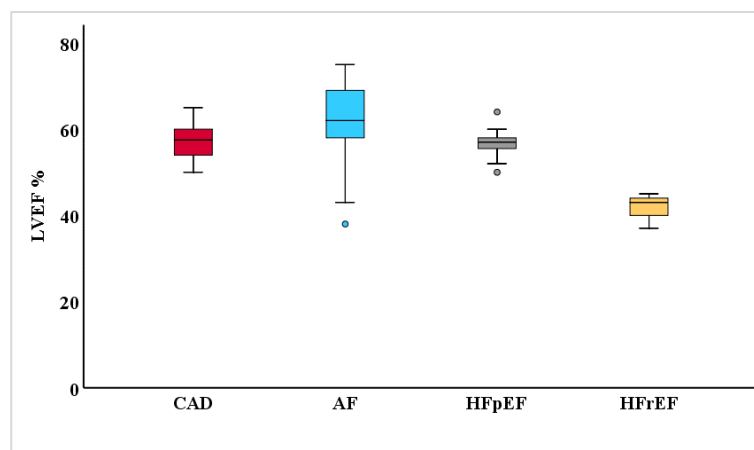


Figure (2): Comparison between different groups of heart diseases regarding ECHO parameters (LVEF %) (Box plot chart).

Table (2): Pretest scores & PSG parameters among different groups of heart diseases.

Table (2). Pretest scores & PSG parameters among different groups of heart diseases.										
	Group A (CAD) n = 30		Group B (AF) n = 30		Group C (HFpEF) n = 15		Group D (HFrEF) n = 30		Test	p1
	No.	%	No.	%	No.	%	No.	%		
Pretest scores										
Stop-BANG score.										
Mean ± SD.	3.77 ± 0.82		4.77 ± 1.17		4.20 ± 0.56		3.80 ± 0.48		H=	<0.001*
Median	4.0		5.0		4.0		4.0		17.831*	
p2			<0.001*		0.241		0.689			
Pairwise			p3=0. 0.058, p4=0.001*, p5=0.116							
Epworth										
Sleepiness scale										
Mean ± SD.	18.87 ± 5.11		20.33 ± 3.09		21.07 ± 2.60		20.70 ± 3.30		H=	0.438
Median	20.50		21.50		21.0		22.0		2.714	
Polysomnography parameters										
	Group A (CAD) n = 30		Group B (AF) n = 30		Group C (HFpEF) n = 15		Group D (HFrEF) n = 30		Test	p1
	No.	%	No.	%	No.	%	No.	%		
AHI categories										
Mild (<15)	3	10.0	9	30.0	6	40.0	9	30.0	χ ² =	0.158
Moderate (15-<30)	6	20.0	8	26.7	4	26.7	9	30.0	9.288	
Severe (≥30)	21	70.0	13	43.3	5	33.3	12	40.0		
AHI										
Mean ± SD.	43.72 ± 24.22		31.79 ± 24.45		20.89 ± 11.43		36.04 ± 29.62		H=	0.019*
Median	39.05		25.90		16.10		22.2		9.974*	
p2			0.031*		0.003*		0.069			
Pairwise			p3=0.226, p4=0.733, p5=0.137							
RDI										
Mean ± SD.	44.10 ± 24.02		32.56 ± 23.94		20.90 ± 11.38		36.79 ± 29.36		H=	0.014*
Median	40.05		25.90		16.30		22.8		10.577*	
p2			0.047*		0.002*		0.080			
Pairwise			p3=0.126, p4=0.814, p5=0.085							

SD.: Standard deviation, Min.: Minimum, Max.: Maximum, H: Kruskal Wallis test, χ²: Chi Square test, MC: Monte Carlo, p1: Comparing different groups of heart diseases, p2: Comparing CAD and each other studied groups, p3: Comparing AF and HFpEF, p4: Comparing AF and HFrEF, p5: Comparing HFpEF and HFrEF, *: Significant when p value <0.05.

Table (4): Comparison between different groups of heart diseases regarding apnea types.

	Group A (CAD) n = 30		Group B (AF) n = 30		Group C (HFpEF) n = 15		Group D (HFrEF) n = 30		Test	p1
	No.	%	No.	%	No.	%	No.	%		
Central apnea										
Absent	14	46.7	17	56.7	9	60.0	12	40.0	$\chi^2=2.457$	0.483
Present	16	53.3	13	43.3	6	40.4	18	60.0		
Number										
Mean $\pm$ SD.	2.13 $\pm$ 1.59		10.08 $\pm$ 20.77		8.50 $\pm$ 8.64		11.44 $\pm$ 19.06		H=	0.162
Median	1.0		2.0		7.50		2.0		5.139	
Obstructive apnea										
Absent	3	10.0	7	23.3	5	33.3	1	3.3	$\chi^2=9.057^*$	MC 0.020*
Present	27	90.0	23	76.7	10	66.7	29	96.7		
p2										
Pairwise										
Number										
Mean $\pm$ SD.	14.22 $\pm$ 14.01		4.22 $\pm$ 2.66		5.70 $\pm$ 6.82		9.0 $\pm$ 12.35		H=	0.005*
Median	9.0		3.0		3.0		4.0		12.836*	
p2										
Pairwise										
Pairwise										
Mixed apnea										
Absent	29	96.7	26	86.7	15	100.0	27	90.0	$\chi^2=3.040$	MC 0.392
Present	1	3.3	4	13.3	0	0.0	3	10.0		
Number										
Mean $\pm$ SD.	1.0 $\pm$ 0.0		1.0 $\pm$ 0.0		-		1.0 $\pm$ 0.0		-	-
Median	1.0		1.0				1.0			

SD.: Standard deviation, Min.: Minimum, Max.: Maximum, H: Kruskal Wallis test, F: One Way ANOVA. χ^2 : Chi Square test, FE: Fisher Exact, MC: Monte Carlo, p1: Comparing different groups of heart diseases, p1: Comparing different groups of heart diseases, p2: Comparing CAD and each other studied groups, p3: Comparing AF and HFpEF, p4: Comparing AF and HFrEF, p5: Comparing HFpEF and HFrEF, *: Significant when p value <0.05.

Table (5): Obesity hypoventilation syndrome type (OHS) in different cardiac groups.

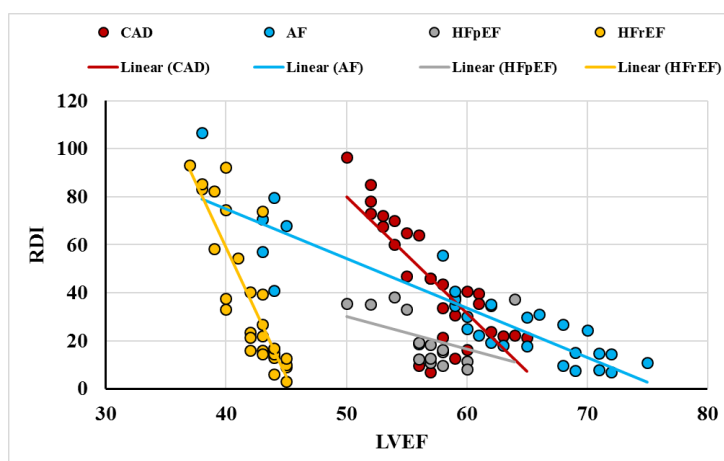
Group A (CAD) n = 30			Group B (AF) n = 30		Group C (HFpEF) n = 15		Group D (HFrEF) n = 30		test	P1
OHS	N	%	N	%	N	%	N	%		
No	23	76.7	20	66.7	14	93.3	15	50.0	$\chi^2=10.032$	0.017*
Yes	7	23.3	10	33.3	1	6.7	15	50.0		
P2	-		0.390		0.236		0.032*			
-	-		-		P3=0.070		P4=0.295			
-	-		-		P5=0.007*					

χ^2 : Chi Square test, FE: Fisher Exact, MC: Monte Carlo. p1: Comparing different groups of heart diseases, p2: Comparing CAD and each other studied groups, p3: Comparing AF and HFpEF, p4: Comparing AF and HFrEF, p5: Comparing HFpEF and HFrEF, *: Significant when p value <0.05.

Table (6): Correlation between AHI and Echocardiographic parameters among different groups of heart diseases.

	AHI							
	Group A (CAD) n = 30		Group B (AF) n = 30		Group C (HFpEF) n = 15		Group D (HFrEF) n = 30	
	rs	p	rs	p	rs	p	rs	p
DDG	0.348	0.059	0.674	<0.001*	0.579	0.024*	0.677	<0.001*
WWSI	0.494	0.005*	0.682	<0.001*	-	-	0.555	0.001*
MVRG	0.511	0.004*	0.749	<0.001*	0.787	<0.001*	0.311	0.094
LVEF	-0.753	<0.001*	-0.876	<0.001*	-0.512	0.051	-0.895	<0.001*

rs: Spearman's rho. *: Significant when p value <0.05.

**Figure (3):** Correlation between RDI and LVEF among different groups of heart diseases.

Discussion

SDB incorporates a spectrum of respiratory disturbances during sleep and has emerged as a significant public health reaching-concern with far implications for human health. SDB comprises conditions such as OSA, CSA, and hypoventilation syndromes distinguished by recurrent incidents of either whole or partial airflow obstruction and irregular breathing patterns during sleep. This multidimensional disorder has garnered significant attention due to its increasing prevalence, especially among individuals with obesity, and its demonstrated association with a heightened risk of CVDs⁽¹⁰⁾. Among the studied patients, the mean age range was between (60-63) with male predominance in all groups as shown in (Table 1). This was in accordance with Abu- Naglah A et al⁽¹¹⁾ had found that patients with chronic heart failure mostly male in all SDB groups; (72.7%) in OSA, (64.3%) in CSA, and (61.5%) in non-SDB, with mean age (58.2±3.7) years with no statistically significant differences noticed

regarding age and sex (p-value=0.509 and 0.713), respectively⁽¹¹⁾. In terms of symptoms, Group C had the lowest percentage of daytime and nighttime symptoms but had the highest percentage of snoring as shown in (Table 1). In accordance with this observation Gupta N et al⁽¹²⁾ observed a Significant history of Snoring was present in 64% of HFpEF cases compared to control subjects. In this study, in terms of AHI categories, severe AHI levels (≥ 30) are most prevalent in group A at 70.0%, followed by group B at 43.3%. The AHI and RDI (respiratory disturbance index) values are highest in Group A and lowest in group C as shown in (Table 2). There is some evidence suggesting that the prevalence and the severity of SA are modified along the CAD evolution. Mooe et al.⁽¹³⁾ reported that clinically significant sleep apnea (AHI >10) was documented in 37% of investigated 142 patients with stable angina pectoris and angiographically confirmed CAD⁽¹³⁾. As regarding Apnea types in this study, group D has the highest incidence of obstructive apnea

events at 96.7%, While group A showed the highest number of obstructive apnea events than B, C & D groups. No significant differences between studied groups regarding central apnea presence and number ($P > 0.05$ for each). Mixed apnea is mostly absent across all groups, with no significant differences observed ($P = 0.392$) as shown in (Table 4). This was in accordance with Kishan et al. ⁽¹⁴⁾ showed that the frequency of SDB was slightly greater in HF patients (81.5%), with OSA predominating (59.2%) as opposed to CSA (22.33%). The HFrEF group's SDB prevalence was 84.4%, whereas the HFpEF group's SDB prevalence was noticeably higher (79.3%) ⁽¹⁴⁾. Also, Abu-Naglah et al ⁽¹¹⁾ had showed that Patients with CHF are prone to SDB. Up to 80% of CHF patients may have either central or obstructive sleep apnea. The prevalence of SDB was 78.3%; this was split between those with OSA (55%) and CSA (23.3%) and those without SDB (21.7%). In the HFrEF, HFmrEF, and HFpEF groups, the prevalence of SDB was, respectively, 85%, 85%, and 65%. The three groups had a prevalence of OSA of 50%, 55%, and 60%, respectively, and a prevalence of CSA of 35%, 30%, and 5%, respectively. This study showed that there was significant difference regarding frequency of OHS among the studied groups ($P = 0.017$), with group D showing the highest frequency (50%), followed by group B (33.3%), group A (23.3%) and lastly group C (6.7%) as shown in (table 5). Morbid obesity is a well-known risk factor for heart failure, even in the absence of other cardiovascular risk factors such as ischemic heart disease, hypertension, and diabetes. The incidence of obesity was reported to be 41.4% of patients discharged with a diagnosis of heart failure with preserved ejection fraction. Additionally, various neurohormonal and metabolic abnormalities associated with obesity, such as hyperinsulinemia and hyperleptinemia, as well as activation of the renin-aldosterone-angiotensin system and the sympathetic nervous system, are thought to be responsible for cardiac remodeling, left ventricular hypertrophy and dysfunction, and altered left ventricular morphology. It is postulated that the inflammatory state and oxidative stress that develop with morbid obesity can lead to an increase in left ventricular mass including left ventricular internal diastolic chamber size and left ventricular wall thickness (Al Otair et al.,) ⁽¹⁵⁾.

This study's objective was to evaluate the connection among polysomnographic parameters beyond AHI and the identification of its relation to cardiovascular disease severity. AHI showed significant positive correlations with WMSI, DDG and MVRG and a significant negative correlation with LVEF in all groups as shown in (Table 6). This was in accordance with Gupta N et al ⁽¹²⁾ had noted that patients with HFpEF with increasing severity of diastolic dysfunction, there was an associated increase in AHI severity, decline in sleep efficiency, along with occurrence of CSA in severe diastolic dysfunction patients. Also, Abu-Naglah et al ⁽¹¹⁾ had found that a statistically significant ($p\text{-value} < 0.001$) decline of mean LVEF% in CSA (HFrEF) patients (36.6 ± 7.1) % when compared with OSA(HFrEF) patients (47.3 ± 10) % and patients without SDB (49.9 ± 8.3) %. Also, Bitter et al. ⁽¹⁶⁾ reported that with increasing impairment of diastolic function, the proportion of SDB and particularly CSA increased as more severe SDB was associated with a higher degree of diastolic dysfunction. HF and CSA patients are characterized by a high sympathetic activation during both day and night. This sympathetic activation is linked to the frequency of apneas. Additionally, the frequency and severity of hypoxia through chemoreflex activation contributes to the degree of sympathetic activation. These mechanisms suggest that CSA can have a causative role in worsening the clinical condition of patients with HF, emphasizing the existence of a bidirectional relationship between two conditions. This study explored other polysomnographic parameters, including RDI, which exhibited significant differences in the cardiac patient groups. This study showed that that RDI showed significant negative correlation with LVEF in all groups as shown in (figure 3). This was in accordance with Frangopoulos, F. et al. ⁽¹⁷⁾ discovered that the probability of heart failure was nominally statistically significant and correlated with a respiratory event index (REI) of ≥ 15 . REI was linked to HF ($p = 0.043$), particularly when lying down (0.036). 14.25 respiratory occurrences per recording hour was the cutoff value. Only REI showed a correlation with heart failure, particularly when the patient was in supine position. This strongly suggests that mechanical encumbrance may be the key factor influencing the interaction between HF and

OSA. One of the main characteristics of the clinical presentation of heart failure is trepopnea, and the supine posture is believed to worsen obstructive respiratory episodes⁽¹⁷⁾.

Conclusions

This study concluded a high frequency of SDB in patients with different cases of heart diseases (CAD, AF, HFpEF, and HFrEF).

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Author contributions

All authors were involved in the study design, analysis, interpretation of the data and revising its content. All authors agree to be accountable for all aspects of the work.

Declaration of interest

The authors have no financial involvement or relevant affiliations with any organization or entity that has a financial interest in our financial conflict with the subject matter or materials discussed in the manuscript. This encompasses employment, consultancy, honoraria, stock ownership or options, expert testimony, grants, or patents received or pending, or royalties.

Ethical approval

The Research Ethics Committee at the Faculty of Medicine, Benha University has approved the study.

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