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ORIGINAL ARTICLE

Assessment of functional capacity and sleep quality of patients with chronic heart failure

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KEYWORDS
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Abstract *Background:* Adequate sleep improves physical and mental alertness. However, there is a dearth of empirical data on functional capacity (FC) and sleep quality (SpQ) in patients with chronic heart failure (CHF).
Objective: This study investigated the relationship between FC and SpQ of patients with CHF and apparently healthy controls (HCs).
Methods: This case-control study recruited 50 patients with CHF whose left ventricular ejection fraction (LVEF) was <40%, attending cardiac clinics of selected government hospitals in Osun State. Furthermore, 50 age- and sex-matched healthy individuals were recruited as controls. Socio-demographic characteristics and cardiovascular parameters were assessed. The FC (VO_2 max) and SpQ were assessed using the 6-minute walk test (6-MWT) and Pittsburgh Sleep

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Quality Index (PSQI), respectively. Data were analysed using descriptive and inferential statistics. Alpha level was set at $p < 0.05$.
Results: Patients had a significantly lower FC and poorer SpQ than HCs, 4.6 ± 0.5 versus 11.3 ± 1.6 mL/kg/min ($t = -3.452$; $p = 0.001$) and 8.74 ± 1.6 versus 3.8 ± 1.3 ($t = -5.371$; $p = 0.001$), respectively. HCs were about five times more likely to walk longer distance [odds ratio (OR), 4.8; confidence interval (CI), 2.0—11.1] and had a better heart rate (OR, 2.8; CI, 1.4—5.3) than patients. SpQ had a significant negative correlation with FC of patients ($r = -0.362$; $p = 0.001$) but a significant positive correlation with HCs ($r = 0.481$; $p = 0.041$). Furthermore, there were significant correlations between FC and body mass index in both groups (CHF: $r = 0.247$, $p = 0.022$; HCs: $r = 0.321$, $p = 0.040$).
Conclusion: Patients with heart failure demonstrated lower functional capacity and poorer sleep quality.

Introduction

The prevalence of chronic heart failure (CHF) is on the rise due to ageing population and improved medical and healthcare services worldwide [1,2]. Surprisingly, the mortality rate from CHF is still high despite recent advances in treatment and care [3]. In sub-Saharan Africa, the epidemiological transition from communicable diseases to chronic non-communicable diseases has contributed to high prevalence of cardiovascular disease, including CHF [4]. Although the actual prevalence of CHF is unknown in Nigeria, reports from hospital admissions and mortality rates have shown that prevalence of CHF is on the increase according to Adedoyin and Adesoye [5] and Ojji et al [6] reporting prevalence rates of 3.5% and 4.3%, respectively.

Chronic heart failure is characterized by progressive fatigue, pedal and abdominal oedema, and exertion dyspnoea during minimal exercise and then later on progresses to dyspnoea at rest [7,8]. Furthermore, patients with CHF usually experience a characteristic breathing pattern called Cheyne—Stokes respiration [9]. It is a series of increasingly deep breaths followed by a brief cessation of breathing, thus causing sleep-disordered breathing (SDB), including obstructive sleep apnoea (OSA) or central sleep apnoea (CSA), which often leads to poor sleep quality (SpQ) [10,11]. Sharma et al [12] also confirmed that poor SpQ further complicates CHF by contributing to hypertension, myocardial infarction, stroke, and nocturnal arrhythmias that could be very deleterious in patients with CHF.

Sleep complaints are common in patients with CHF and may include fragmentation of sleep and excessive daytime sleepiness [11]. Sleep disorder may affect functional performance causing fatigue and confusion and leading to a vicious cycle of poor health status and worsening prognosis. It may also predict mortality [13]. Due to progressive deconditioning and persistent poor SpQ commonly seen in patients with CHF, regular assessment of SpQ and functional capacity have become imperative in order to identify patients at risk and provide a better guide to therapeutic procedures for effective rehabilitation. It is now evident that the treatment of sleep disorder requires a multidisciplinary approach in order to enhance prognosis [14,15].

Functional capacity is the ability of the body to utilize oxygen and a known measure of cardiorespiratory fitness, as well as a strong predictor of survival in CHF. Oxygen deprivation during sleep may have negative consequences on the cardiovascular health of patients with CHF. Although studies have shown that improvement in functional capacity has direct and multiplier effects on cardiovascular health in patients with CHF [16,17], the relationship between sleep quality and functional capacity remains unclear. More importantly, few studies have examined the relationship between SpQ and functional capacity in Nigerian patients with CHF and compared with apparently healthy controls. *A priori*, we hypothesized that patients with CHF have a different SpQ compared to healthy subjects, which is related to low functional capacity independent of severity of the cardiac condition. This study investigated the relationship between SpQ and functional capacity of Nigerian patients with CHF and apparently healthy controls.

Methods

Participants and setting

This is a case-control study that employed purposive sampling technique to recruit 50 patients (16 male and 34 female) with chronic heart failure (CHF) who were receiving treatment at the cardiac care units of selected government hospitals in Osun State. Furthermore, 50 apparently healthy individuals (20 males and 30 females) were recruited as controls. The sample size for this study was based on comparative research studies comparing two equal groups as advanced by Eng [18]. The sample size formula goes thus: $N = [4\sigma^2(z_{crit} + z_{pwr})^2]/D^2$, where N is the total sample size (the sum of the sizes of both comparison groups), σ is the assumed standard deviation (SD) of each group (assumed to be equal for both groups), the z_{crit} value is the desired significance criterion, z-value (z-value for 95% confidence level, 1.96), while the z_{pwr} value is the desired statistical power, 80% (0.842). D is the minimum expected difference (effect size) between the two means of primary

outcome (sleep quality). According to Lewith et al [19] in a previous study, an effect size of 3 points and an SD of 1.2 on PSQI were considered to be clinically significant in patients with sleep disturbance. Thus, the equation above yielded a sample size of $N = 50.2$. Therefore, a total of 50 participants (rounding N to the nearest whole number) were to be recruited. However, the sample size was doubled to 100, comprising 50 patients with CHF and 50 age- and sex-matched apparently healthy individuals as controls. This was done with the view to improving the validity of the results.

Inclusion and exclusion criteria

Eligibility for inclusion were clinical diagnosis of stable CHF in stage II or III [New York Heart Association (NYHA) functional classification]. The left ventricular ejection fraction (LVEF) was less than 40% obtained from the echographic assessment. Participants whose ages were 40 years and older and attending cardiac care units of selected government hospitals in Osun State, namely Ife Hospital Unit, Ile-Ife, and Wesley Guild Hospital, Ilesha, of the Obafemi Awolowo University Teaching Hospitals Complex and Ladoke Akintola University of Technology Teaching Hospital, Osogbo. In addition, age- and sex-matched apparently healthy controls were recruited among hospital staff and patients' relatives. They were excluded from the study if they had presented with self-reported unstable angina during the previous months, musculoskeletal problems that significantly limit walking and comorbidities such as type 2 diabetes neuropathy, neurological condition, depressive symptoms, and cognitive disorders. Ethical approval for the study was sought and obtained from the Health Research and Ethics Committee of the Institute of Public Health (IPH/OAU/12/428), Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

Procedures

Permission to recruit participants into the study was sought from the unit heads in charge of cardiac care clinics in the selected government hospitals with an explanation of the purpose of the study. The purpose and procedures of the study were explained to the participants and written informed consent was obtained. Anthropometric characteristics including weight, height, and body mass index (BMI) were assessed while cardiovascular parameters including heart rate, systolic and diastolic blood pressure were measured in sitting position using an electronic sphygmomanometer (Omron Intelli Sense M6 Comfort, Japan). The Pittsburgh Sleep Quality Index (PSQI) was administered to assess sleep quality and functional capacity was assessed using the 6-minute walk test (6MWT).

Assessment of sleep quality

Sleep quality of participant was assessed using the PSQI. The questionnaire consisted of two sections: the first section sought information on participants' bio-data including age, sex, and occupation, while the second section sought information on sleep quality. The PSQI was developed by Buysse et al [20] and is a self-reported index that assesses sleep quality during the previous month. It has 19 items, each of which is scored equally between 0 and 3. The index contains seven subscales evaluating subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. The seven component scores are then summed to yield a global PSQI score, which has a range of 0 to 21. Scores greater than 5 were considered poor, as higher scores indicate worse sleep quality [20].

The psychometric properties of the instrument were determined by translating the original PSQI to Yoruba language and back translated to English language by experts. The translation was done by Yoruba language experts and another English expert for back translation in the Department of Linguistics and African Languages Studies of the Obafemi Awolowo University, Ile-Ife, Nigeria. The original version was administered on five patients with CHF and five age- and sex-matched healthy controls who were not part of the main study. After 1 week, the new English version was readministered on the same participants. Responses from the original and new version were subjected to test–retest reliability using Spearman rank correlation coefficient. A test–retest reliability value of $r = 0.72$ was obtained. The questionnaire was self-administered and was collected immediately after completion. However, participants who were not literate in the English language were assisted by a research assistant who translated and read the question aloud to the participant before an option was chosen.

Assessment of functional capacity

The 6-MWT was conducted using a standardized procedure according to the American Thoracic Society [21]. A 30-m corridor within the cardiac care unit of the hospital was marked out by two cones for the test. Participants were allowed to rest for a period of 10 minutes in a sitting position before the commencement of the exercise test. Patients were instructed to walk from the starting point to the end at their own selected pace while attempting to cover as much ground as possible in 6 minutes. They were encouraged every 30 seconds or so in a standardized manner [22]. Rate of perceived exertion was assessed while cardiovascular parameters were recorded immediately after the 6-MWT. The total distance walked in 6-minutes was recorded to the nearest meter and functional capacity (maximum oxygen consumption, VO_2 max) was estimated using a predictive equation [23].

Statistical analysis

Descriptive statistics of frequency, mean, and standard deviation were used to summarize data. Independent t-test was used to determine the difference in age, physical characteristics, and cardiovascular parameters between patients and healthy controls. Furthermore, as appropriate, the independent t-test or Mann–Whitney U-test were used to compare functional capacity and sleep quality between male and female patients and healthy controls. Analysis of covariance (ANCOVA) was conducted to compare the SpQ of patients with CHF and healthy controls using systolic blood

pressure (SBP), diastolic blood pressure (DBP), and BMI as covariates. Multivariate unconditional logistic regression models were used to obtain odds ratio (OR) estimates with 95% confidence intervals (CI) on SpQ. Similarly, as appropriate, Pearson's product moment correlation or Spearman rank correlation test were used to test the relationship between sleep quality, functional capacity, and BMI of patients and healthy controls. SPSS version 19 (IBM Corp., Armonk, NY, USA) was used for the data analysis. Alpha level was set at $p < 0.05$ of significance [23].

Computation: VO_2 max = walking distance/6 min $\times$ 0.1 + 3.5 mL/kg/min

Results

The socio-demographic characteristics and clinical profiles of all participants are presented in Table 1. All participants were comparable in age and physical characteristics ($p > 0.05$) except BMI ($p < 0.05$). Furthermore, there were significant differences in all cardiovascular parameters between patients and healthy controls in pre-6MWT and post-6MWT ($p < 0.05$; Table 2). Table 3 shows the relationship between SpQ and covariates (SBP, DBP, and BMI). There were significant effects of covariates on SpQ. The partial η^2 with an effect size of 0.4148 shows that the proportion of variation in the sleep quality score due to covariates accounts for about 42% of the variation. Table 4 shows the comparison of functional capacity and sleep quality of patients and healthy controls. There were significant differences between 6MWD and estimated VO_2 max between patients and healthy controls: 242.4 $\pm$ 30.1 m versus 467.1 $\pm$ 65.6 m ($t = -3.452$; $p = 0.001$) and 4.62 $\pm$ 0.50 mL/kg/min versus 11.3 $\pm$ 1.6 mL/kg/min ($t = -3.452$; $p = 0.001$), respectively. Furthermore, comparison of the sleep quality scores of male and female patients with CHF showed significant difference in the PSQI score between male and female patients with CHF: 6.6 $\pm$ 3.6 versus 7.4 $\pm$ 3.3 ($t = -3.275$; $p = 0.026$), respectively (Table 5).

Table 6 shows a multivariate analysis in relation with SpQ, functional capacity, and cardiovascular parameters. Healthy controls were approximately five times more likely to walk longer distance (OR, 4.8; CI, 2.0–11.1) and had a better heart rate (OR, 2.8; CI, 1.4–5.3) than patients with CHF. The relationship between functional capacity and SpQ (PSQI total) in the patient group shows negative significant correlation ($r = -0.362$; $p = 0.001$) but positive significant correlation among healthy controls ($r = 0.481$; $p = 0.041$). There were significant but inverse correlations between each SpQ sub-score and functional capacity ($p < 0.05$). Functional capacity had a positive significant correlation with body mass index for both patient ($r = 0.247$; $p = 0.022$) and control ($r = 0.321$; $p = 0.001$) groups (Table 7).

Discussion

The purpose of this study was to investigate the functional capacity and SpQ of patients with CHF and their relationships and also compare with apparently healthy individuals.

Table 1 Socio-demographic characteristics and clinical profile of all participants.

Variable	Patient ($n = 50$)		Control ($n = 50$)	
	n	%	*n*	%
Sex				
Male	16	32.0	20	40.0
Female	34	68.0	30	60.0
Age group (year)				
40–50	14	28.0	34	68.0
51–60	19	38.0	10	20.0
>60	17	34.0	6	12.0
Occupation				
Artisan	22	44.0	14	28.0
Civil servant	11	22.0	18	36.0
Retiree	10	20.0	8	16.0
Self-employed	7	14.0	10	20.0
Educational status				
Primary school	18	36.0	9	18.0
Secondary school	21	42.0	8	16.0
Tertiary school	11	22.0	23	46.0
NYHA functional class				
Class II	32	64.0	—	—
Class III	18	36.0	—	—
CHF diagnosis				
Ischemic heart disease	5	10.0	—	—
Dilated cardiomyopathy	7	14.0	—	—
Hypertensive heart disease 18	36.0	—	—	
Idiopathic	20	40.0	—	—
Medications[a]				
ACE-I or ARB	21	24.0	—	—
Diuretic	22	44.0	—	—
β-Blocker	9	18.0	—	—
Digoxin	8	16.0	—	—
Aspirin	41	82.0	—	—
CCA	1	2.0	—	—

ACE-I = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; CCA = calcium channel antagonist; CHF = chronic heart failure; NYHA = New York Heart Association.

[a] Values may not sum to 100.0% due to combination of drugs.

Findings from our study show that the functional capacity of patients with CHF was significantly lower than healthy controls. This finding is consistent with that of previous studies in which patients with CHF were reported to have lower functional capacity compared with healthy controls [24,25]. The plausible explanation for the difference between patients and healthy controls may be as a result of the underlying pathology caused by heart failure itself. Patients with CHF are known to have poor muscular strength due to changes in the anatomical and physiological structures in the skeletal muscles leading to increasing muscle flaccidity, easy fatigability, extracellular fluid accumulation, dyspnoea, and SDB [8,13,26]. Furthermore, comparison of the findings of the mean functional capacity from our study indicated a lower functional capacity compared to findings of some previous studies [16,17]. The disparity might be due to individual differences, disease

Table 2 Comparison of physical characteristics, pre- and post-6-minute walk test cardiovascular parameters of patient and control groups.

Variables	Patient ($n = 50$) Mean ± SD	Control ($n = 50$) Mean ± SD	*t*-cal	*p* value
Age (years)	57.8 ± 8.9	54.9 ± 7.9	1.94	0.062
Weight (kg)	70.4 ± 11.7	66.2 ± 11.1	−1.57	0.121
Height (m)	1.51 ± 0.2	1.53 ± 0.1	1.66	0.100
BMI (kg/m^2)	30.4 ± 7.0	28.6 ± 6.3	−2.10	0.042*
WHR	0.8 ± 0.4	0.8 ± 0.1	1.63	0.113
Pre-6MWT				
SBP (mmHg)	131.9 ± 22.1	121.9 ± 14.2	−2.897	0.001*
DBP (mmHg)	82.2 ± 13.3	78.0 ± 13.5	2.091	0.042*
HR (bpm)	80.0 ± 14.4	72.2 ± 11.2	−2.880	0.001*
Post-6MWT				
SBP (mmHg)	138.4 ± 21.1	128.9 ± 12.5	−2.263	0.001*
DBP (mmHg)	86.1 ± 13.1	79.1 ± 14.5	−0.981	0.001*
HR (bpm)	77.9 ± 13.9	75.9 ± 11.3	−2.465	0.024*

*$p < 0.05$.
6MWT = 6-minute walk test; BMI = body mass index; DBP = diastolic blood pressure; HC = hip circumference; HR = heart rate; SBP = systolic blood pressure; SD = standard deviation; WC = waist circumference; WHR = waist-to-hip ratio.

Table 3 Results of ANCOVA comparing sleep quality between patients with CHF and apparently healthy controls.

Source	Partial SS	df	MS	*F*	*p* value
Model	35556.06	4	8889.02	1790.69	0.001*
SBP	327.07	2	163.53	32.94	0.001*
DBP	42.97	1	42.97	8.66	0.003*
BMI	3600.92	1	3600.92	725.41	0.001*
Residual	570.86	115	4.96		
Total	36126.93	119	303		
Partial η^2	0.4148				
Adjusted R^2	0.9836				

*$p < 0.05$.
BMI = body mass index; DBP = diastolic blood pressure; df = degrees of freedom; MS = mean of squares; SBP = systolic blood pressure; SS = sum of squares.

Table 4 Comparison of functional capacity and sleep quality scores of healthy control and patients with CHF.

Variable	Patient Mean ± SD	Control Mean ± SD	*p* value
6-MWD (m)	242.4 ± 30.1	467.1 ± 65.6	0.001*
Est.VO_2 max (mL/kg/min)	4.62 ± 0.50	11.3 ± 1.6	0.001*
PSQI total	8.7 ± 1.6	3.8 ± 1.3	0.001*
Subj. SpQ	1.4 ± 0.6	0.9 ± 0.2	0.001*
Sleep latency	1.7 ± 0.7	0.8 ± 0.4	0.001*
Sleep duration	1.2 ± 1.0	0.9 ± 0.5	0.001*
Hab. Sp eff.	0.8 ± 0.4	0.4 ± 0.2	0.001*
Sp disturb.	1.8 ± 0.7	1.2 ± 0.5	0.001*
Use Sp med.	0.5 ± 0.2	0.4 ± 0.1	0.058
Daytime dysf.	0.8 ± 0.3	0.3 ± 0.1	0.001*

*$p < 0.05$.
6-MWD = 6-minute walk distance; Daytime dysf. = daytime dysfunction; Est.VO_2 max = estimated maximum oxygen consumption; Hab. Sp eff. = habitual sleep efficiency; PSQI = Pittsburgh Sleep Quality Index; SD = standard deviation; Subj. SpQ = subjective sleep quality; Use Sp med. = use of sleep medication.

Table 5 Comparison of sleep quality scores of male and female patients with CHF.

Variable	Male Mean ± SD	Female Mean ± SD	*p* value
PSQI total	6.6 ± 3.6	7.4 ± 3.3	0.026*
Subj. SpQ	1.3 ± 0.6	1.4 ± 0.8	0.149
Sleep latency	1.4 ± 0.7	1.7 ± 0.6	0.026*
Sleep duration	1.2 ± 1.0	1.1 ± 0.4	0.371
Hab. Sp eff.	0.6 ± 0.4	0.7 ± 0.4	0.138
Sleep disturbance	1.6 ± 0.7	1.8 ± 0.6	0.001*
Use Sp med.	0.2 ± 0.5	0.7 ± 0.4	0.001*
Daytime dysf.	0.8 ± 0.6	1.2 ± 0.1	0.032*

*$p < 0.05$.
Daytime dysf. = daytime dysfunction; Hab. Sp eff. = habitual sleep efficiency; PSQI = Pittsburgh Sleep Quality Index; SD = standard deviation; Subj. SpQ = subjective sleep quality; Use Sp med. = use of sleep medication.

progression, and procedures for the assessment of functional capacity. Also, several factors, including but not limited to mood of the patients, differences in body weight, and medications prescribed, might account for the variations in functional capacity assessment. Nonetheless, the finding of lower functional capacity implies that patients with CHF are at higher risk of morbidity and mortality compared to healthy individuals. Functional capacity is known to be a strong predictor of survival and a determinant of reduced hospitalization in patients with cardiac challenges.

Our findings show that the mean PSQI score for SpQ of patients with CHF is higher than that of healthy controls. This is in agreement with findings of previous studies that patients with CHF experienced poorer SpQ [13,27]. Furthermore, sleep disorders have been described as a persistent, major concern among patients with CHF [11,27]. This implies that sleep disturbances and frequent waking is a precursor for poor SpQ and a deteriorating health situation in patients with CHF. In addition, Khayat et al [13] reported that overall poor SpQ and excessive daytime sleepiness are strong predictors of mortality in patients with acute heart failure. Sleep is a naturally recurring state and involves changes in brain wave activity, breathing, heart rate, body temperature, and other physiological functions [28]. It implies that alteration in SpQ increases the risk of poor prognosis and premature death [14,27].

Findings from our study also show that female patients with CHF reported poorer SpQ than their male counterparts.

Table 6 Multivariate analysis of effect of sleep quality on functional capacity and cardiovascular parameters in patients with CHF and healthy controls.

Variable	Patient	Control
	OR (95% CI)	OR (95% CI)
6-MWD (m)	0.6 (0.8—1.6)*	4.8 (2.0—11.1)*
Est.VO_2 max (mL/kg/min)	0.8 (0.3—35.9)*	3.2 (0.8—1.8)*
SBP (mmHg)	0.4 (0.6—1.0)	1.8 (1.0—3.2)
DBP (mmHg)	1.1 (0.6—2.0)	1.3 (0.9—1.9)
HR (beat/min)	0.9 (0.4—2.1)*	2.8 (1.4—5.3)*

*$p < 0.05$.
6-MWD = 6-minute walk distance; CI = confidence interval; DBP = diastolic blood pressure; Est.VO_2 max = estimated maximum oxygen consumption; HR = heart rate; OR = odds ratio; SBP = systolic blood pressure.

Table 7 Pearson product moment correlation between functional capacity, sleep quality, and body mass index of patient and control groups.

Variable	Functional capacity, *r* (*p* value)	
	Patient	Control
PSQI total	−0.362 (0.001) **	0.481 (0.041)*
Subjective sleep quality	−0.424 (0.001) **	0.066 (0.172)
Sleep latency	−0.358 (0.001) **	0.057 (0.248)
Sleep duration	−0.121 (0.062)	−0.046 (0.163)
Habitual sleep efficiency	−0.284 (0.037)*	−0.372 (0.023)*
Sleep disturbances	−0.386 (0.001) **	0.153 (0.031)*
Use of sleeping medications	−0.237 (0.001) **	0.081 (0.074)
Daytime dysfunction	−0.381 (0.001) **	0.091 (0.062)
BMI (kg/m^2)	0.247 (0.022)*	0.321 (0.040)*

*$p < 0.05$; **$p < 0.001$.
BMI = body mass index; PSQI = Pittsburgh Sleep Quality Index.

The worse SpQ subscores were significantly higher in sleep latency, sleep disturbance, use of medication, and daytime dysfunction among female patients. Contrary to our findings, a previous study reported that men have higher sleep disorders than women [29]. However, there is a dearth of studies comparing SpQ between male and female patients with CHF. Irrespective of gender, it is believed that unrefreshing sleep is associated with lower physical performance and poor activity of daily living, reduced social-relationship performances, and increased risk of accidents [30,31].

In our study, we also established that body mass index, PSQI total score, and all subscores except sleep duration had inverse significant correlation with functional capacity in patients with CHF. On the contrary, PSQI total score and body mass index had a positive significant correlation with functional capacity. Sharma et al [12] was of the opinion that obesity may be a marker for narrowing of the upper airway because of deposition of pharyngeal fat or reduced end-expiratory lung volume. Although the prevalence of obesity in patients with CHF is not very high, most patients being clinically overweight and mildly obese could account for SDB, leading to poor SpQ [32,33]. It is also believed that obesity and age are significant risk factors for poor SpQ like other patients with OSA. However, the presence of extracellular fluid overload may also increase risk of OSA in patients with CHF. Also, patients with CHF and OSA usually have pharyngeal oedema, narrowing of airways and redistribution of fluid from the legs during supine sleep. This may explain the reason why patients with CHF experience severe fatigue, reduced physical performance, and poor SpQ. We also found that there was an inverse significant relationship between functional capacity and SpQ in patients with CHF. It implies that the moment SpQ of a patient begins to deteriorate, functional capacity also worsens. Although functional capacity alone is an independent predictor of survival in CHF, presence of poor SpQ could double the burden or worsen the cardiovascular health outcomes during rehabilitation. Similarly, Pedrosa et al [34] reported that lower SpQ is an independent predictor of low quality of life. Patients with impaired sleep were shown to be incapable of responding quickly to external stimuli due to reduction in SpQ or quantity, and impaired ability to perform simple and regular activities of daily living that may be beneficial to health [35,36].

The current choice of treatment for sleep disorders, including OSA, is the application of continuous positive airway pressure (CPAP) [12]. However, clinical results have shown that many people failed to tolerate the approach [14,37]. More importantly, addiction to sleep medications is a challenge in patients undergoing cardiac rehabilitation. However, there is growing evidence that rehabilitation exercise is an important adjunct therapy for improving SpQ in patients with CHF [38,39]. Although physical therapists often prescribe exercise to ameliorate physical functioning and improve quality of life, its effects on SpQ have been well-documented [40,41]. For instance, in a multisite randomized controlled trial study by Suna et al [41] involving patients with CHF who underwent exercise advice and another group who received twice weekly structured exercise training. The authors concluded that 12 weeks of twice-weekly supervised exercise training improved SpQ in patients with CHF who were recently discharged from hospital. Similarly, the beneficial effects of exercise training on neurovascular function, functional capacity, and quality of life of patients with systolic dysfunction and heart failure occurs independently of sleep-disordered breathing [41,42]. Furthermore, recent studies have also established that regular participation in physical activity and exercise training in patients with CHF helps to lessen the severity of insomnia, obstructive sleep apnoea, and other sleep disorders [43,44]. Indeed, improvement in daytime physical activity may stimulate longer periods of slow-wave sleep, which is the deepest and most restorative stage of sleep [45].

Study Limitations

The PSQI is a self-reported assessment and might be prone to estimation error and recall bias. However, the instrument was validated prior to the commencement of the study to ensure its validity and reliability. Future studies should include an objective measure of sleep quality by

including polysomnographic or actigraphic assessment. More importantly, our patients were on different antihypertensive medications and some drugs have been reported to affect functional capacity, which might confound the outcome of this study.

Conclusion

Patients with CHF demonstrated lower functional capacity and poorer sleep quality. The results have important implications for physiotherapy clinicians participating in cardiac rehabilitation programmes, underscoring the need to include regular assessment of sleep quality and to include interventions to improve functional capacity and sleep quality in patients with CHF.

Conflicts of interest

The authors have no competing interests to declare.

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Authorship contribution

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