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ORIGINAL RESEARCH

Heterogeneity of Fatigue in Patients with Chronic Heart Failure: Latent Categories and Influencing Factors

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Objective: The objective of this study was to analyze the latent categories of fatigue in patients with chronic heart failure (CHF), explore their characteristic differences, and identify the associated influencing factors.

Methods: This cross-sectional study included 289 patients with CHF who were enrolled at 2 tertiary-level hospitals in Shandong, China, from August to December 2023. The convenience sampling method was used to collect data. Furthermore, the level of fatigue, insomnia, anxiety, depression, and social support were evaluated using the Chinese version of the Multidimensional Fatigue Inventory-20, Insomnia Severity Index, Generalized Anxiety Disorder-7, Patient Health Questionnaire-9, and Multidimensional Scale of Perceived Social Support. Latent profile analysis was performed to elucidate the latent categories of fatigue in the patients. In addition, the risk factors associated with the different categories were assessed using multiple logistic regression analyses.

Results: The average fatigue score was 62.45 ± 13.55. The potential fatigue profile of CHF was divided into three categories: low fatigue group C1 (18.6%), moderate fatigue group C2 (47.4%), and high fatigue group C3 (34.0%). Multiple logistic regression analysis showed that C3 patients with CHF were mainly characterized by lower ejection fraction ($OR = 0.01$, $p = 0.008$), insomnia ($OR = 1.19$, $p = 0.005$), and anxiety ($OR = 1.20$, $p = 0.034$). C2 patients indicated lower ejection fraction ($OR = 0.04$, $p = 0.040$), and C1 patients had higher social support ($OR = 0.91$, $p < 0.001$; $OR = 0.93$, $p < 0.001$).

Conclusion: This study indicated that CHF patients had significantly heterogeneous levels of fatigue. Therefore, it is recommended that medical staff could adopt more precise interventions according to different category characteristics to improve the outcomes of patients with CHF.

Keywords: chronic heart failure, fatigue, latent profile analysis, influencing factors

Introduction

Chronic heart failure (CHF) is the final stage of most cardiovascular diseases by high long-term mortality.[1] It has been estimated that currently, there are over 64.3 million heart failure patients worldwide,[2] and the incidence is increasing annually. CHF affects the physical and mental health and patient's quality of life and imposes substantial economic burdens on families and society.[3] The literature has indicated that fatigue is a primary clinical manifestation of CHF, with an incidence rate between 50 to 97.51%.[4] Fatigue can be extremely harmful to patients, and it has been found that for every one-unit increase in fatigue severity, the risk of readmission increased by 45% (95% *CI*: 1.09–1.93, $p = 0.011$).[5] However, medical professionals do not pay significant attention to fatigue due to its low sensitivity as a reflection of cardiac function or volume load.[6] This leads to delayed treatment, prolonged illness, and worsening symptoms.Therefore, the fatigue of CHF urgently needs urgent attention.

Fatigue, as a feeling experienced by patients with heart failure, is influenced by various factors from psychological, physiological, and social aspects.[7] Studies have shown that sex, grade of cardiac function, ejection fraction, NYHA

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cardiac function grade and anemia/hemoglobin level are highly correlated with fatigue.[8] Electrolyte disorders can cause a variety of physical symptoms, including feeling fatigue and weakness.[7] The study have found marked associations between sleep and increased fatigue.[9] The study found significant associations between anxiety, depression, and fatigue in patients with heart failure, with depression mainly related to reduced activity (R^2=0.178,P<0.001) and motivation (R^2=0.110,P<0.001) and anxiety significantly related to mental fatigue (R^2=0.254,P<0.001).[4] Social support level, as a positive coping resource, has been found to act as an inhibitor of heart failure-related fatigue.[8]

While most existing studies have focused on a single influencing factor or have judged the current state of fatigue in patients with chronic heart failure based on the high or low total scores of scales, failing to fully consider the heterogeneity within the group. Latent profile analysis (LPA) is used to determine latent characteristics based on individuals' response patterns to explicit items, to understand the proportion of individuals in each latent profile, and to further identify the heterogeneity present in the sample.[10] Therefore, based on the biological-psycho-social model[11]), this study LPA was used to explore the group heterogeneity of fatigue in CHF patients from physiological, psychological and sociological perspectives.

Materials and Methods

Study Design and Participant

This cross-sectional study was conducted from August to December 2023 and followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBES) Statement. Simple Random Sampling method was used to select CHF patients from the cardiology wards of 2 tertiary hospitals in Shandong, China.

The following inclusion criteria were applied: 1) Patient was diagnosed with heart failure according to the "Chinese Heart Failure Diagnosis and Treatment Guidelines 2018",[12] with cardiac function classes II, III, and IV (NYHA classification); 2) Age ≥ 18 years old, with proficient language skills in expression, reading, and writing; 3) Patient provided signed informed consent and was willing and able to participate. The exclusion criteria were: 1) Patients with mental illness or intellectual disability; 2) Patients with other end-stage diseases, such as renal failure and malignant tumor;3) Patients with sarcopenia.

Sample Size

This study used the LPA method. As provided in the previous research, according to the Bayesian confidence criterion, the optimal sample size was N ≥ 200.[13] After accounting for a 20% dropout rate, the number of included cases was estimated as 250.

Instruments

General Information Questionnaire

The questionnaire gathered demographic and clinical data, including gender, age, body mass index(BMI), education level, work status, marital status, family income, medical expenses payment method, the classification of cardiac function, ejection fraction, heart failure course, Charlson comorbidity index(CCI), and laboratory indicators.

Multidimensional Fatigue Inventory-20 (MFI-20)

The MFI-20 is a standard instrument used for fatigue assessment. The scale comprises five dimensions, including general, physical, and mental fatigue, as well as reduced activity and motivation,[14] and is used for comprehensive evaluation of fatigue. This scale was translated into Chinese by Miao et al in 2008.[15] The scale language is concise, easy to understand, and suitable for assessing fatigue in chronic fatigue syndrome patients who have experienced fatigue for a minimum of two weeks. The scale has a total of 20 items, with each dimension containing 4 items. Furthermore, it uses the Likert 5 scale, with each item of the scale scoring 1–5 points, and the total score is 20–100. The Cronbach's alpha coefficient of the scale is 0.882, with a mean Cronbach's alpha coefficient for each dimension of 0.702.[16] In this study, Cronbach's alpha coefficient of this scale was 0.872.

Insomnia Severity Index (ISI)

The ISI is a commonly used[17] self-assessment and perception measurement tool that assesses insomnia symptoms experienced during the past two weeks. It consists of 7 items, each of which is scored on a scale of 0–4. The total score range is 0–28. Scores 0–7, 8–14, 15–21, and 22–28 represent no insomnia, mild, moderate, and severe insomnia,

respectively. Higher scores indicate more severe insomnia symptoms. Bai CJ et al tested the reliability and validity of the Chinese version of the ISI scale in clinical insomnia patients, which revealed that the scale has good performance, with a Cronbach's alpha coefficient of 0.804.[18] Therefore, it is suitable for assessing insomnia in Chinese patients.

Generalized Anxiety Disorder-7 (GAD-7)

Anxiety was assessed by using the GAD-7, which comprises 7 items,[19] each scored on a scale of 0–3, and the total score range is 0–21. A score of 0–4 = no anxiety, 5–9 = mild anxiety, 10–14 = moderate anxiety, and 15–21 = severe anxiety. The higher the score is, the more severe the level of anxiety is. In China, this scale has demonstrated good reliability, validity, and internal consistency for patients with cardiovascular disease (Cronbach's α = 0.912).[20]

Patient Health Questionnaire-9 (PHQ-9)

Depression was screened using the PHQ-9, which includes nine variables.[21] It is based on the American Diagnostic Standards for Mental Disorders (DSM–IV). The scale uses a Likert 4 scale of 0 (not at all) to 3 (almost daily), resulting in a total score of 27. A score of 0–4, 5–9, 10–14, 15–19, and 20–27 indicates no depression, mild, moderate, moderately severe, and severe depression, respectively. Higher scores indicate higher severity of depression. The PHQ-9 scale has good reliability and validity, with a Cronbach's alpha of 0.86–0.89 and a test-retest reliability of 0.83–0.84.[22] Wang L et al in 2019 indicated that the internal consistency coefficient of the PHQ-9 scale in Chinese patients with cardiovascular disease was 0.84.[23]

Multidimensional Scale of Perceived Social Support (MSPSS)

The MSPSS scale was developed in 1998 to evaluate social support.[24] The scale consists of 12 items, including 3 dimensions, which include family, friends, and social supports. Each item on the scale is 1–7 points, and the total score range is 12–84. The higher the score is, the better the level of social support is. The Cronbach's α of the Mandarin version of this scale in domestic cardiovascular patients was 0.91.[25]

Data Collection

For standardized training, the investigators provided questionnaires to the clinic after obtaining the consent of the department head. To improve the recovery rate of the questionnaire, the researchers explained the purpose and significance of the study to the patients before they answered the questionnaire. After obtaining the patient's consent, paper questionnaires were distributed and collected on-site. Patients who were unable to fill out the questionnaire independently were assisted via the verbal questions and answers method. In total, 300 questionnaires were distributed, 11 invalid were eliminated, and 289 valid were obtained, resulting in an effective recovery rate of 96.3%.

Statistical Analysis

Two researchers independently entered and analyzed the data. SPSS 25.0 was utilized for statistical analysis. The number of model categories was gradually increased to determine the optimal model using Mplus 8.3 software. The adaptation test indicators for the potential profile model included the Akaike information criterion (AIC), Bayesian information criterion (BIC), and the information index aBIC (adjusted for sample size). Smaller values of the above statistical indices indicated a better fit. The model classification accuracy index's entropy value (Entropy) that approached 1 indicated higher classification accuracy, and > 0.80 indicated a classification accuracy of 90%. The Lomonddale's adjusted likelihood ratio test (LMRT) and Bootstrap-based likelihood ratio test (BLRT) were used to determine the significance levels ($p < 0.05$), indicating that model K was superior to model K-1 in explaining variance and the overall fit. The *p-value* of < 0.05 indicated statistical significance.

Results

Common Method Bias Test

This study collected data via a questionnaire survey and thus may have introduced common method bias. To address this issue, Harman's single-factor detection method was used for assessment. For all questions related to different scales, exploratory factor analysis was performed. The results showed that the variation explained by the first common factor was 20.957%, which is less than the recommended standard of 40%,[26] indicating a lack of significant common method bias.

Participants Characteristics

A total of 289 CHF patients were included in this study. Of these, 149 (51.6%) were male and 140 (48.4%) were female. Furthermore, 25 (8.7%) patients were below 44 years old, 54 (24.2%) were between the ages of 44 and 59, and 210 (72.7%) were over 60 years old (Table 1).

Table 1 Univariate Analysis of General Information of CHF Patients in the Different Profiles (N=289, Percentage, %)

Column	Classification	C1 (N=54)	C2 (N=137)	C3 (N=98)	χ^2	*P*
Gender	Male	35 (64.8)	72 (52.6)	42 (42.9)	6.83[a]	0.033*
	Female	19 (35.2)	65 (47.4)	56 (57.1)		
Age (years)	18–44	9 (16.7)	14 (10.2)	2 (2.0)	44.49[a]	<0.001***
	45–59	24 (44.4)	19 (13.9)	11 (11.2)		
	≥60	21 (38.9)	104 (75.9)	85 (86.7)		
Medical payment	Full fee	1 (1.9)	5 (3.6)	4 (4.1)	4.596[a]	0.916
	Provincial medical	3 (5.5)	13 (9.5)	7 (7.2)		
	Employee medical	24 (44.4)	58 (42.3)	34 (34.7)		
	Residents' medical	26 (48.1)	61 (44.5)	53 (54.1)		
BMI	<18.5	3 (5.6)	4 (2.9)	6 (6.1)	2.44[a]	0.866
	18.5–23.9	20 (37.0)	53 (38.7)	42 (42.9)		
	≥24.0	31 (57.4)	80 (58.4)	50 (51.0)		
Place of residence	City	30 (55.6)	72 (52.6)	50 (51.0)	0.29[a]	0.330
	Rural area	24 (44.4)	65 (47.4)	48 (49.0)		
Educational level	Elementary school	1 (20.3)	44 (32.1)	36 (36.7)	9.14[a]	0.330
	Junior school	21 (38.9)	49 (35.8)	39 (39.8)		
	High school	15 (27.8)	32 (24.8)	19 (19.4)		
	University	7 (13.0)	12 (8.7)	4 (4.1)		
Working condition	Mental work	25 (46.3)	37 (19.7)	13 (13.3)	24.54[a]	<0.001***
	Physical work	20 (37.0)	47 (34.3)	37 (37.8)		
	Other	9 (16.7)	53 (38.7)	48 (48.9)		
Marital status	Single (unmarried divorced, widowed)	3 (5.6)	30 (21.9)	41 (41.8)	25.94[a]	<0.001***
	Married	51 (94.4)	107 (78.1)	57 (58.2)		
Living situation	Living alone	4 (7.4)	17 (12.4)	22 (22.4)	7.47[a]	0.024*
	Living with family	50 (92.6)	20 (87.6)	76 (77.6)		
Family monthly income (¥)	<3000	9 (16.7)	35 (25.6)	41 (41.8)	17.65[a]	0.007**
	3000–5000	15 (27.8)	49 (35.8)	29 (29.6)		
	5001–10,000	21 (38.9)	35 (25.5)	22 (22.4)		
	≥10,001	9 (16.7)	18 (13.1)	6 (6.1)		
Smoking history	None	22 (40.7)	76 (55.5)	60 (61.2)	11.64[a]	0.020*
	Quit smoking	11 (20.4)	21 (15.3)	22 (22.4)		
	Still smoking	21 (38.9)	40 (29.2	16 (16.3)		
Drinking history	None	31 (57.4)	91 (66.4)	61 (62.2)	3.67[a]	0.452
	Quit drinking	6 (11.1)	19 (13.9)	16 (16.3)		
	Still drinking	17 (31.5)	27 (19.7)	21 (21.4)		
Course of heart failure(years)	<1	17 (31.5)	48 (35.0)	26 (26.5)	14.98[a]	0.005**
	1–5	26 (48.1)	35 (25.5)	26 (26.5)		
	>5	11 (20.3)	54 (39.4)	46 (46.9)		
Taking medicine	Regular	34 (63.0)	77 (56.2)	65 (66.3)	2.58[a]	0.276
	Irregular	20 (37.0)	60 (43.8)	33 (33.7)		
Number of episodes of heart failure	0	13 (24.1)	46 (33.6)	26 (26.5)	9.57[a]	0.04*
	1–2	21 (38.9)	34 (24.8)	42 (42.9)		
	≥3	20 (37.0)	57 (41.6)	30 (30.6)		

(*Continued*)

Table 1 (Continued).

Column	Classification	C1 (N=54)	C2 (N=137)	C3 (N=98)	χ^2	*P*
Ejection fraction	<0.40	18 (33.3)	66 (48.2)	54 (55.1)	11.36[a]	0.035*
	0.40–0.49	11 (20.4)	30 (21.9)	15 (15.3)		
	≥0.50	25 (46.3)	41 (29.9)	29 (29.6)		
Heart function classification	II	22 (40.7)	58 (42.3)	30 (30.6)	5.00[a]	0.287
	III	21 (38.9)	42 (30.7)	37 (37.8)		
	IV	11 (20.4)	37 (27.0)	31 (31.6)		
NT-proBNP (pg/mL)	<400	12 (22.2)	30 (21.9)	16 (16.3)	1.30[a]	0.523
	≥400	42 (77.8)	107 (78.1)	82 (83.7)		
Hemoglobin (g/L)	<110	6 (11.1)	30 (21.9)	36 (36.7)	13.49[a]	0.001**
	≥110	48 (88.9)	107 (78.1)	62 (63.3)		
Serum potassium (mmol/L)	<3.50	6 (11.1)	11 (8.0)	9 (9.2)	0.97[a]	0.914
	3.50–5.50	48 (88.9)	125 (91.2)	88 (89.8)		
	>5.50	0 (0)	1 (0.7)	2 (2.0)		
Serum calcium (mmol/L)	<2.25	11 (20.3)	25 (18.2)	19 (19.3)	1.070[a]	0.899
	2.25–2.73	20 (37.0)	52 (38.0)	42 (42.9)		
	≥2.74	23 (42.6)	60 (43.8)	37 (37.8)		
Serum sodium (mmol/L)	<135	3 (5.6)	9 (6.6)	12 (12.2)	7.197[a]	0.126
	135–145	36 (66.7)	72 (52.6)	57 (58.2)		
	>145	15 (27.8)	56 (40.9)	29 (29.6)		
CCI	≤2	15 (27.8)	19 (13.8)	12 (12.2)	10.20[a]	0.037*
	3–4	17 (31.5)	39 (28.5)	38 (38.8)		
	≥5	22 (40.7)	79 (57.7)	48 (49.0)		
Mean ± SD						
Insomnia		12.11±5.58	14.28±5.70	17.64±4.81	20.69[b]	<0.001***
Anxiety		10.04±4.87	12.11±4.90	13.86±5.01	10.65[b]	<0.001***
Depression		9.83±5.91	13.04±6.24	12.60±6.77	5.07[b]	0.007**
Social support		62.61±10.07	51.06±12.03	47.29±10.89	32.75[b]	<0.001**

Notes: *Significant at 5%, **Significant at 1%; ***Significant at 0.1%; [a]$\chi 2$; [b]*F*.

Potential Profile Analysis of Fatigue in CHF Patients

One to four profiles were selected to fit the fatigue levels of the patients, which indicated that as the number of potential profiles increased, the AIC, BIC, and aBIC values gradually decreased. When three profiles were retained (n = 3, Entropy = 0.824), the corresponding *p-value* for both LMRT and BLRT was 0.05, suggesting that model 4 was not superior to model 3 in terms of fit. Therefore, three potential fatigue profile models in CHF patients had the best fitting index (Table 2). Furthermore, to verify classification reliability, the probabilities of patients from each category were calculated. The results showed that the correct classification probabilities for the three categories of CHF fatigue were 92.3%, 93.7% and 90.8%, respectively, indicating the reliability of the potential profile analysis (Table 3).

Table 2 Fitting Results of the Potential Profile Analysis and Comparison of Parameters Between Different Models (N=289)

Model	K	Log (L)	AIC	BIC	aBIC	Entropy	P_{LMRT}	P_{BLRT}	Class Probability (%)
1	10	−3789.974	7599.949	7636.613	7604.901	—	—	—	1.00
2	16	−3554.714	7141.427	7200.090	7149.352	0.833	0.0001	0.0000	0.35/0.65
3	22	−3466.951	6977.902	7058.563	6988.798	0.824	0.0002	0.0000	0.474/0.186/0.340
4	28	−3445.834	6947.668	7070.328	6961.536	0.803	0.1245	0.0000	0.17/0.07/0.39/0.37

Abbreviation:AIC, Akaike's Information Criteria; BIC, Bayesian information criteria; aBIC, adjusted bayesian information criterion; LMRT, Lo-Mendell-Rubin Likelihood Ratio Test; BLRT, Bootstrapped likelihood Ratio Test.

Table 3 Probability of Belonging to Categories for the Three Potential Profiles (Percentage, %)

Potential Profile Categories	Probability of Belonging to Latent Class		
	C1	C2	C3
C1	92.3	1.8	5.9
C2	6.3	93.7	0.0
C3	9.2	0.0	90.8

According to the scores of each dimension, fatigue was divided into three potential categories (Figure 1). The C1 category referred to as the "low fatigue group" (54 cases, 18.6%), with an overall score of 41.63±6.47. The C2 category referred to as the "moderate fatigue group" (137 cases, 47.4%), with an overall score of 60.29±6.72. The C3 category referred to as the "high fatigue group" (98 cases, 34.0%), with an overall score of 76.37±6.40 (Table 4).

Univariate Analysis of Factors Influencing Fatigue Symptoms in Patients with CHF

Results from the univariate analysis are shown: statistically significant differences among subgroups in terms of sex, age, work status, marital status, living situation, monthly household income, smoking history, duration of heart failure, number of heart failure attacks during hospitalization, ejection fraction, hemoglobin level, CCI, insomnia, anxiety, depression, and social support ($p < 0.05$) (Table 1).

Multivariate Logistic Regression Analysis of Potential Profiles of Fatigue in Patients with CHF

The data was assessed via unordered multivariate logistic regression analysis. The dependent variables (C1, C2, and C3) were assigned the values of 1, 2, and 3, respectively. Other independent variables were assigned the following values: male = 11; female = 0; age 18 – 44 = 1, age 44 – 59 = 2, age ≥ 60 = 3; episodes of heart failure: < 1 per year = 1, 1 – 2 years = 2, ≥ 3 years = 3; hemoglobin < 110 = 1, hemoglobin ≥ 110 = 2. Bring in the original values of other variables. In this study, C1 was used as the reference category. The model fitting value was significant ($p < 0.05$), indicating a good fit. Multiple logistic regression analysis showed that C3 patients mainly had low ejection fraction ($OR = 0.01$, $p = 0.008$), insomnia (*OR*

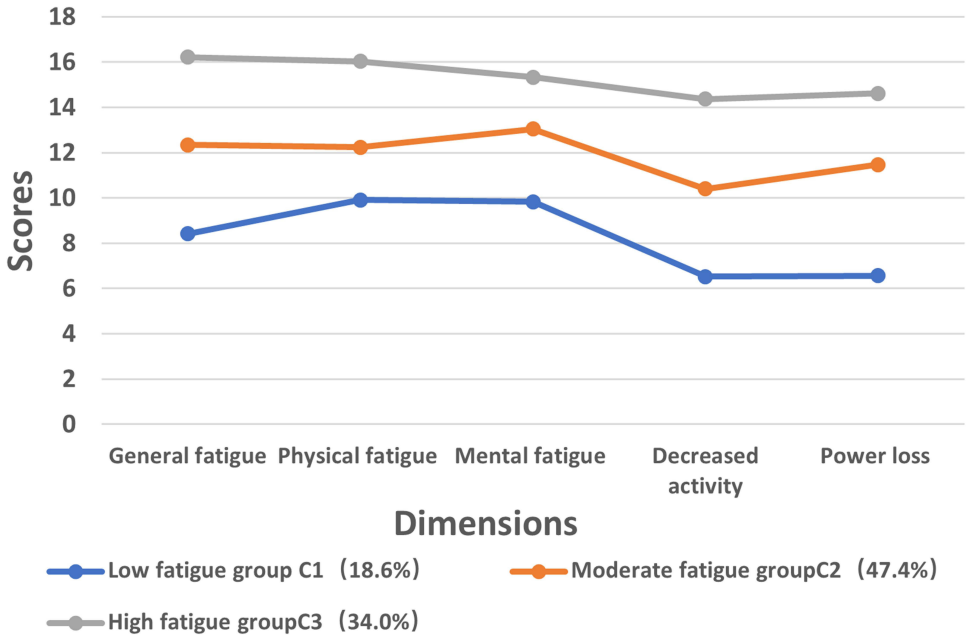

Figure 1 Potential profiles of fatigue in chronic heart failure.

Table 4 Fatigue and Scores of Various Dimensions in CHF Patients

Column	Mean ± SD	C1 (n= 54, 18.6%)	C2 (n= 137, 47.4%)	C3 (n = 98, 34.0%)
General fatigue	12.97±3.33	8.41±1.71	12.34±2.01	16.22±2.09
Physical fatigue	13.57±3.18	9.91±2.37	13.23±2.39	16.03±2.29
Mental fatigue	13.24±2.97	9.83±2.53	13.04±2.21	15.33±2.18
Decreased activity	11.01±3.52	6.52±1.97	10.39±2.75	14.36±2.29
Power loss	11.61±3.52	6.56±1.90	11.47±2.19	14.61±2.19
Total fatigue score	62.45±13.55	41.63±6.47	60.29±6.72	76.37±6.40

Table 5 Results of the Multiple Logistic Regression Analysis of Fatigue Categories in CHF Patients (N=289)

Column	Potential Profile Categories							
	Moderate Fatigue Group C2				High Fatigue Group C3			
Project	*β*	*P*	*0R*	*95% CI*	*β*	*P*	*0R*	*95% CI*
Ejection fraction	−3.24	0.040*	0.04	0.00–0.86	−4.76	0.008**	0.01	0.00–0.28
Insomnia	−0.02	0.706	0.98	0.88–1.09	0.17	0.005**	1.19	1.05–1.34
Anxiety	0.02	0.755	1.02	0.88–1.19	0.18	0.034**	1.20	1.01–1.42
Depression	0.08	0.225	1.08	0.95–1.22	−0.10	0.150	0.91	0.79–1.04
Social support	−0.08	< 0.001***	0.93	0.89–0.97	−0.10	< 0.001***	0.91	0.87–0.95

Notes:*Significant at 5%, **Significant at 1%; ***Significant at 0.1%.

= 1.19, $p = 0.005$), and anxiety ($OR = 1.20$, $p = 0.034$). Whereas C2 patients indicated low ejection fraction ($OR = 0.04$, $p = 0.040$) and C1 patients had higher social support ($OR = 0.91$, $p < 0.001$; $OR = 0.93$, $p < 0.001$) (Table 5).

Discussion

Current Status and Heterogeneity of Fatigue in Patients with CHF

The mean total fatigue score of the 289 CHF patients investigated in this study was 62.45 ± 13.55, which is much higher than a previous international study (36.20 ± 9.30).[27] This is similar to the results of Xu et al (68.08 ± 10.35).[8] Therefore, it was inferred that the degree of fatigue of CHF patients in China is generally at a medium-high level. The results of latent profile analysis showed that fatigue in CHF patients could be divided into three categories: low fatigue group (18.6%), moderate fatigue group (47.4%), and high fatigue group (34.0%). Marked heterogeneity was observed in the levels of fatigue in CHF patients, suggesting that medical staff should use more precise intervening measures based on these fatigue categories to improve the prognosis.

Multivariate Logistic Analysis of Potential Fatigue Profiles in Patients with CHF Compared with C1, C3 and C2 are Mainly Characterized by a Lower Ejection Fraction

Compared with C1, patients with lower ejection fractions had a greater probability of being classified into C3 and C2. Ejection fraction refers to the percentage of stroke output to ventricular end-diastolic capacity and is one of the important indexes to assess cardiac function in heart failure patients.[28] Therefore, the presence of a lower ejection fraction in CHF patients reduces heart function, leading to ischemia and hypoxia in the body. Then CHF patients develop fatigue symptoms. Fatigue, to a certain extent, affect the physical function and activity tolerance of CHF patients,[29] which can cause increased fatigue and significantly reduce the patient's quality of life and prognosis.[30] To address this issue, it is crucial to improve the ejection fraction.

Therefore, the following treatment measures should be taken for CHF patients: ① Combine exertion and rest. It is advisable for these patients to prioritize maintaining a work and rest balance, reduce their workload, and engage in appropriate

exercise as prescribed in cardiac rehabilitation programs.[31] ② Drug therapy.This should be used according to the guidelines to treat the symptoms of heart failure and increase ejection fraction.[32] ③Patient education. Health care workers should strengthen health education for patients with heart failure and avoid high-risk factors.[33] ④ Multidisciplinary treatment (MDT).MDT involves collaboration between experts from various disciplines who discuss cases and formulate the optimal treatment plans based on their combined expertise. This patient-centered MDT model allows personalized treatment, making it the preferred approach for individual patients.[34] Using the above comprehensive strategy, the patient's fatigue can be effectively alleviated, and the activity endurance as well as the quality of life can be improved.

Compared with the C1 and C2, C3 are Mainly Characterized by Insomnia and Anxiety

Compared with C1 and C2, patients with CHF who have higher insomnia indices and greater anxiety are more likely to belong to C3. Studies have indicated that insomnia is common in CHF patients.[35] Long-term insomnia easily leads to patients' lack of energy and mental burnout, as well as aggravates their fatigue state.[36] Insomnia, as a source of stress, affects the patient's mental health and triggers negative emotions such as anxiety.[37] These negative emotions can aggravate both physical symptoms and physiological dysfunction, significantly impacting the patient's quality of life and limiting their physical activity, as well as being an important factor affecting the patient's prognosis.[29]

Therefore, the following treatment measures should be taken for such patients: ① Improve sleep. Measures should be taken to improve patient sleep in patients with heart failure and insomnia, such as ear acupuncture point pressure beans,[38] traditional Chinese medicine fumigation,[39] and cardiac rehabilitation exercise prescriptions such as Ba Duan Jin[40]and Tai Ji Quan.[41] These sleep aids can help improve patient's sleep, promote physical and mental rest and relaxation, and reduce fatigue symptoms. ② Psycho-cardiology. For such patients, attention should be paid to both their mental disease and psychological status.[42]

Compared with the C2 and C3, C1 are Mainly Characterized by Higher Social Support Level

Compared with C2 and C3, CHF patients with higher levels of social support were more frequently observed in C1. Previous research has indicated that good social support can affect patient health from social, psychological, biological, and other perspectives.[43] Social support can provide material and economic assistance, enhancing the treatment and recovery of CHF patients.[44] In addition, supportive behaviors such as care and visits from relatives can provide a sense of familial warmth, alleviate negative emotions caused by the disease, and increase the patient's confidence in overcoming the illness, which, in turn, promotes proactive disease management and other behaviors, thereby improving the symptoms of fatigue.[45] Therefore, medical staff should prioritize the assessment of the social support systems of CHF patients to enhance their physical well-being, reduce fatigue levels and facilitate patient recovery.

Limitations

This study has certain limitations. First, this study adopted the convenience sampling method, which might have caused the risk of sampling and selection bias. Second, this cross-sectional study did not explore the change in fatigue over time. Therefore, in future studies, multi-center, large-sample research designs are recommended for the further identification of risk factors.

Conclusion

In summary, this study revealed that CHF patients experience moderate to high levels of fatigue. Furthermore, CHF fatigue can be divided into three categories: low fatigue group, moderate fatigue group, and high fatigue group. Therefore, it is recommended that medical staff should implement more precise interventions based on the characteristics of fatigue in different groups.

Data Sharing Statement

The data used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval

This study followed the Declaration of Helsinki and the Ethical Guidelines for Epidemiology Research.[46] Ethical approval was granted by the ethics committee of the School of Nursing and Rehabilitation, Shandong University (2023-R-129). All patients provided informed consent and willingly participated in the study.

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Disclosure

The authors report no conflicts of interest in this work.

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