ISSN 2434-0758
J. Asian. Reha. Sci.

Journal of Asian Rehabilitation Science

Vol.8 No.3 Nov. 2025

Journal of Asian Rehabilitation Science

The Society of Asian Rehabilitation Science

The Journal of Asian Rehabilitation Science (ISSN 2434-0758) is published for the Society of Asian Rehabilitation Science. The journal is published quarterly.

The editors welcome original papers with significant areas of physical therapy, occupational therapy and speech and language therapy.

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The Journal of Asian Rehabilitation Science
Vol.8 No.3, November
2025

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J. Asia. Reha. Sci.8 (3): 22 – 33, 2025

The Journal of Asian Rehabilitation Science

Original Article

A Study of Factors Affecting Sarcopenia in Outpatients on Dialysis: Comparison with General Outpatients from a Multidimensional Viewpoint

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Abstract: [Purpose] This study investigates and compares risk factors for sarcopenia in dialysis patients and among older outpatients attending a cardiology clinic. [Subjects and Methods] A cross-sectional design was utilized, including 24 patients undergoing dialysis treatment and a control group. Participants were stratified into sarcopenia and non-sarcopenia groups for comparative analysis. [Results] Significant differences were identified in lifestyles and musculoskeletal functions based on the basic checklist ($p < 0.05$). Logistic regression analysis highlighted red blood cell (RBC) count (odds ratio: 1.13, 95% CI: 1.02–1.15, $p < 0.05$) as a significant variable within the dialysis group. [Conclusion] These findings underscore the need for targeted interventions to mitigate sarcopenia and frailty, emphasizing the enhancement of daily functional activities and promotion of social participation among dialysis patients to improve quality of life.

Keywords: Hemodialysis, General elderly population, Frailty, Sarcopenia

(This article was submitted Sep. 15, 2025, and was accepted Oct. 15, 2025)

I. INTRODUCTION

According to the statistical survey committee of the Japanese Society for Dialysis Therapy, the number of chronic maintenance dialysis patients in Japan reached 349,000 in 2021 and continues to rise[1)]. Nutritional disorders frequently occur in patients undergoing long-term hemodialysis, primarily due to increased catabolism from complications and loss of amino acids and blood proteins during dialysis treatments [2, 3)]. Recently, it has been reported that nutritional disorders contribute to muscle mass loss, a common complication of hemodialysis. Consequently, screening for muscle mass loss has gained importance among hemodialysis patients [4, 5)].

In 2010, the European Working Group on Sarcopenia in Older People defined sarcopenia as a syndrome characterized by a progressive decline in skeletal muscle mass and strength, leading to an overall deterioration in health [6)]. The prevalence of sarcopenia among hemodialysis patients varies depending on multiple factors, including age, gender, measurements used, diagnostic criteria, and timing of assessments. Among hemodialysis patients in Asia, the frequency of sarcopenia is approximately 40%, according to the diagnostic criteria set by the Asian Working Group for Sarcopenia [7, 8)].

Sarcopenia among hemodialysis patients is associated with a negative impact on life expectancy [9)]. Sarcopenia is also associated with impaired mobility, decreased ability to perform daily activities, and loss of independence. Sarcopenia can interfere with daily functioning and heighten the risk of falls [10)]. Most hemodialysis patients are elderly; therefore, they often face complications from nutritional disorders, sarcopenia, and frailty, which can

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adversely affect their daily living activities and quality of life. Such multimorbidity can also lead to other health outcomes, such as the onset and progression of cardiovascular diseases, falls, fractures, hospitalizations, and an overall poor prognosis. Therefore, it is crucial to implement continuous measures against sarcopenia and frailty to improve quality of life among hemodialysis patients.

Frailty refers to an increased vulnerability to various health issues stemming from age-related functional changes and diminished physiological reserve [11]. It is estimated that frailty occurs in one out of every two to three dialysis patients, considerably increasing their risk of reduced life expectancy and hospitalization.

Mechanisms underlying sarcopenia differ by disease context. Among people with chronic kidney disease, links to sarcopenia likely involve inflammatory mediators, metabolic and hormonal dysregulation, gut-microbiota dysbiosis, and alterations in non-coding ribonucleic acids (RNAs) [12]. During heart failure, skeletal myofibers undergo complex, heterogeneous remodeling across disease development and progression, including shifts in myofibrillar protein composition and altered myofibrillar responsiveness to neurohormonal signaling [13]. Among people with chronic obstructive pulmonary disease, sarcopenia arises from intertwined mechanisms, including metabolic alterations, physical inactivity, mitochondrial dysfunction, oxidative stress, and low-grade systemic inflammation; these collectively drive age-related muscle deterioration [14].

Although associations between hemodialysis and sarcopenia are well documented [12], evidence on how sarcopenia affects activities of daily living remains limited, and few studies have compared hemodialysis patients with older outpatients attending a cardiology clinic. Accordingly, this study aims to identify factors associated with sarcopenia in hemodialysis patients and to compare these factors—including daily life functions assessed with the Kihon Checklist (KCL)—with those observed in the older outpatients attending a cardiology clinic.

II. PARTICIPANTS AND METHODS

1. Subjects

This study involved patients receiving hemodialysis at [removed for blinding purposes], Japan, who had been undergoing treatment for at least 6 months. Eligible patients (N = 24) were stable and did not have severe comorbidities, such as malignancies or infections. The control group (N = 46) consisted of elderly outpatients attending a cardiology clinic. All participants were clinically stable and had no severe comorbidities (e.g., active malignancy or acute infection).

Both groups were classified according to whether they had sarcopenia or not, using the Asian Working Group for Sarcopenia 2019 diagnostic criteria. Patients with insufficient laboratory data for analysis were excluded from the study.

2. Methods

Blood tests were conducted to measure albumin levels, cholesterol levels, and lymphocyte counts. The simplified version of the Nutritional Risk Index for Japanese Hemodialysis Patients (NRI-JH) was then used for blood data and biochemical tests. This index, which includes measurements of albumin, total cholesterol, creatinine, and body mass index (BMI), classifies patients into three risk categories (low, medium, and high) based on their scores. Post-dialysis weight was used for BMI calculations, while pre-dialysis values were applied for biochemical tests [15].

The Health Check-up Questionnaire basic checklist (hereinafter, this is called "The Kihon checklist (KCL) assessments) ", a frailty assessment tool developed by the Japanese Ministry of Health, Labour, and Welfare, was used to screen for daily living function. The KCL assessment questions (KQ) consists of 25 yes/no questions categorized into seven domains as shown in Table 1: Instrumental activities of daily living（IADL;KQ 1-5), physical function (KQ 6-10), nutritional status (KQ 11-12), oral function (KQ 13-15), social activities (KQ 16-17), cognitive function (KQ 18-20), and depressive mood (KQ 21-25). It has been reported to correlate with frailty and sarcopenia, with eight or more applicable items indicating potential concerns (Table1) [16].

The Simple Frailty Index was also used to assess frailty[17]. A basic checklist was used to evaluate the daily functioning of elderly participants, comprising simple yes/no questions addressing nutrition and shrinking (FQ-1), physical function (FQ-2), physical activity (FQ-3), forgetfulness (FQ-4), and emotions/exhaustion (FQ-5). Scores of three or more were classified as frail. FQ denotes Frailty Index; these questions can be seen in Table 2.

Table 1. The Health Check-up Questionnaire basic checklist (The Kihon checklist (KCL) assessments)

No			Questions	Answer	
1	IADL	KQ-1	Do you go out by bus or train by yourself?	0. YES	1. NO
2		KQ-2	Do you go shopping to buy daily necessities by yourself?	0. YES	1. NO
3		KQ-3	Do you manage your own deposits and savings at the bank?	0. YES	1. NO
4		KQ-4	Do you sometimes visit your friends?	0. YES	1. NO
5		KQ-5	Do you turn to your family or friends for advice?	0. YES	1. NO
6	Physical function	KQ-6	Do you normally climb stairs without using handrail or wall for support?	0. YES	1. NO
7		KQ-7	Do you normally stand up from a chair without any aids?	0. YES	1. NO
8		KQ-8	Do you normally walk continuously for 15 minutes?	0. YES	1. NO
9		KQ-9	Have you experienced a fall in the past year?	1. YES	0. NO
10		KQ-10	Do you have a fear of falling while walking?	1. YES	0. NO
11	Nutritional status	KQ-11	Have you lost 2kg or more in the past 6 months?	1. YES	0. NO
12		KQ-12	Height: cm, Weight: kg, BMI: kg/m2 If BMI is less than 18.5, this item is scored.	1. YES	0. NO
13	Oral functions	KQ-13	Do you have any difficulties eating tough foods compared to 6 months ago?	1. YES	0. NO
14		KQ-14	Have you choked on your tea or soup recently?	1. YES	0. NO
15		KQ-15	Do you often experience having a dry mouth?	1. YES	0. NO

16	Social activities	KQ-16	Do you go out at least once a week?	0. YES	1. NO
17		KQ-17	Do you go out less frequently compared to last year?	1. YES	0. NO
18	Cognitive function	KQ-18	Do your family or your friends point out your memory loss? e.g."You ask the same question over and over again."	1. YES	0. NO
19		KQ-19	Do you make a call by looking up phone numbers?	0. YES	1. NO
20		KQ-20	Do you find yourself not knowing today's date?	1. YES	0. NO
21	Depressive mood	KQ-21	In the last 2 weeks have you felt a lack of fulfillment in your daily life?	1. YES	0. NO
22		KQ-22	In the last 2 weeks have you felt a lack of joy when doing the things you used to enjoy?	1. YES	0. NO
23		KQ-23	In the last 2 weeks have you felt difficulty in doing what you could do easily before?	1. YES	0. NO
24		KQ-24	In the last 2 weeks have you felt helpless?	1. YES	0. NO
25		KQ-25	In the last 2 weeks have you felt tired without a reason?	1. YES	0. NO

Abbreviations: KQ, Kihon Checklist (KCL) assessment questions.

Table 2. Frailty screening index

1	FQ-1	1.Have you lost 2kg or more in the past 6 months	Yes=1
2	FQ-2	2.Do you think you walk slower than before?	Yes=1
3	FQ-3	3.Doyou go for a walk for your health at least once a week?	No=1
4	FQ-4	4.Can you recall what happened 5 minutes ago?	No=1
5	FQ-5	5.In the past 2 weeks, have you felt tired without a reason?	Yes=1

Abbreviations: FQ, Frailty Index questions.

Body composition was assessed using the InBody S-10 (Inbody Japan, Tokyo, Japan), which employs bioelectrical impedance analysis. This device applies electrical currents at various frequencies (1 kHz to 1 MHz) through the body. Whole-body impedance was measured using an ipsilateral foot-hand electrical pathway, allowing for analysis of body composition in the right and left arms, legs, and trunk. The Skeletal Muscle Index (SMI) was calculated by summing the skeletal muscle mass (in kg) of the extremities and dividing by the square of height (m^2).

Exercise was also measured, with those who engaged in aerobic exercise during dialysis for at least five days per week coded as exercising (vs. not).

To effectively assess sarcopenia, it is essential to measure grip strength, body composition, age, weight, comorbidities, and relevant blood test results. Sarcopenia was diagnosed based on cutoff points established by the Asian Working Group for Sarcopenia: an SMI <7.0 kg/m^2 in men and <5.7 kg/m^2 in women. Grip strength was measured using the dominant hand while seated, with the elbow flexed. The highest value from two consecutive measurements was recorded for sarcopenia diagnosis. Grip strength cutoffs were set at 28 kg for men and 18 kg for women. Physical performance was evaluated by measuring usual walking speed, based on the Sarcopenia Clinical Practice Guideline (2017). Walking speed was calculated by dividing the distance traveled by the time taken. A walking speed of less than 1 m/s indicated sarcopenia [18]. Participants were informed of their results and provided with feedback regarding therapeutic effects.

Statistical Analysis

Subjects were categorized into dialysis and control groups, before being further divided into four groups based on the presence or absence of sarcopenia. The normality of endpoint values was assessed, followed by post-hoc tests comparing among the four groups of ANOVA tests. Proportional tests were applied to aggregated questionnaire data, and a χ^2 goodness-of-fit test was conducted for multiple groups. Binomial logistic regression analysis was performed, using the presence or absence of sarcopenia as the dependent variable.

Binary univariate logistic regressions were used to assess associations between the candidate independent variables and outcomes. Variables showing significant associations were then reduced via a stepwise selection procedure, and the final model was determined with additional consideration of clinical plausibility.

To mitigate overfitting due to the small sample size, we restricted the multivariable model to 3–4 a priori clinically selected predictors in accordance with events-per-variable considerations and fitted bias-reduced logistic regression models. We report odds ratios with 95% confidence intervals (CIs).

Statistical analyses were conducted using SPSS version 20 for Windows (IBM), with a significant level set at 0.05.

Ethics approval and consent to participate

This study was approved by the Ethics Review Committee of the Faculty of Fukuoka Medical Technology, Teikyo University (approval n. The protocol adhered to the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of Teikyo University (Teirin 24-12). Data were anonymized to protect participant identification. The study has been approved, and confirmation that it conforms to recognized ethical standards is required such as the Declaration of Helsinki.

III. RESULTS

Table 3 shows the patient characteristics. The hemodialysis group comprised 24 patients (12 in the sarcopenia group, 12 in the non-sarcopenia group), with a mean age of 74.3 ± 8.2 years and a mean length of dialysis of 8.3 ± 6.6 years. The control group included 46 patients (14 in the sarcopenia group, 32 in the non-sarcopenia group), with a mean age of 76.1 ± 9.9 years. Age distributions were comparable between the hemodialysis and control groups. Sarcopenia prevalence was higher in males across both the hemodialysis group (18 males, 6 females) and the control group (32 males, 14 females). Notably, the prevalence of sarcopenia was significantly higher in males than in females in both groups.

Red blood cell (RBC) counts were lower in the hemodialysis group compared with the control group. The Skeletal Muscle Index (SMI), a key criterion for diagnosing sarcopenia, was also lower in the

hemodialysis group compared with the control group. Blood tests revealed that blood urea nitrogen and creatinine levels were abnormally elevated in the hemodialysis group, while cholesterol, BMI, albumin, RBC, and hemoglobin levels were lower (Table 3).

Table 4 shows Total Scores of KCL assessment and the Simple Frailty Index were no significant differences in the hemodialysis group.

Significant differences in Total Scores of simple Frailty Index and KCL assessment were observed only in the control group.

IADL were a problematic area for the hemodialysis group ($p < 0.05$), while the problematic areas of the control group included physical function, oral function, and depressive mood (Table 4).

Logistic regression analysis of sarcopenia was conducted using a stepwise method (conditional), with the presence or absence of sarcopenia as the dependent variable and items showing significant differences as independent variables (Table 5). Among the hemodialysis group, there were statistically significant associations between sarcopenia and RBC (odds ratio: 1.12, 95% confidence interval:1.02 -1.15, $p < 0.05$). Among the control group, SMI (odds ratio: 0.14, 95% confidence interval: 0.02-0.92, $p < 0.05$) and walking speed (odds ratio: 0.01, 95% confidence interval: 0.04-0.14, $p < 0.05$) were significantly associated with sarcopenia.

Table 3. Patient characteristics and comparisons between groups.

	Dialysis patients		Control group			
	Sarcopenia (+) (n=12)	Sarcopenia (-) (n=12)	Sarcopenia (+) (n=14)	Sarcopenia (-) (n=32)	ANOVA p-value	Post-hoc test
Age	79.3±8.8	69.3±7.6	81.8±7.3	70.3±12.7	<0.05	f
Sex (n (%) male)	8 (66.7)	10 (83.3)	11 (78.6)	21 (65.6)	<0.05	b,c,e,f
Height (cm)	159.7±5.8	168.8±8.2	149.2±6.6	155.5±28.1	<0.05	a,b,d,e,f
Weight (kg)	54.8±8.9	67±11.7	46.8±9.1	61.5±13.5	<0.05	a,d,f
Body Mass Index (BMI) (kg/m^2)	21.3±3.4	23.3±2.4	20.9±3.1	23.9±5.3	<0.05	c,f
Dialysis history (year)	9.4±7.8	7.1±5.4				-
Exercise (yes) †,	6 (50.0)	10 (83.0)	8 (57.0)	24 (75.0)	<0.05	a, f
Blood tests						
Total protein (g/dl)	6.6±0.2	6.5±0.5	7.1±0.4	6.9±1.3		-
Albumin (g/dl)	3.6±0.3	3.5±0.4	4±0.4	3.9±0.7		-
Blood-sugar level (mg/dl)	129.1±19.5	128.5±61.3	99.6±10.4	103.8±25.8		-
Total cholesterol (mg/dl)	158.2±46.6	145.4±37.5	205±34.7	194.3±37.9	<0.05	b,c,d,e
High Density Lipoprotein (mg/dl)	51.2±18.1	51.1±15.2	71.5±16.6	60.2±15.6	<0.05	b,d,
Low Density Lipoprotein (mg/dl)	87.3±29.5	75.5±26.2	112.1±38.1	116±27.2	<0.05	c,e
Triglyceride (mg/dl)	101.3±48.8	97.5±33.8	101.6±54	104.6±38.5		-
Blood Urea Nitrogen (mg/dl)	46.1±10.7	48.7±14.6	16.9±4.2	16.1±5.6	<0.05	b,c,d,e
Creatinine (mg/dl)	8.2±1.3	10.3±2.7	0.8±0.4	0.9±0.3	<0.05	a,b,c,d,e
UA (mg/dl)	6.1±1.5	6.7±1.1	5.3±1.3	5.4±1.5		-

Table 3(continued). Patient characteristics and comparisons between groups.

	Hemodialysis patients		Control group			
	Sarcopenia (+) (n=12)	Sarcopenia (-) (n=12)	Sarcopenia (+) (n=14)	Sarcopenia (-) (n=32)	ANOVA p-value	Post hoc test
AIB NRI	1.1±1.9	1.3±1.8	0.3±1	0.1±0.7	<0.05	e
Cre-NRI (mg/dl)	2.4±1.9	1.9±2	2.2±2	3.1±1.7		-
NRI-JH	4.7±3.3	3.4±3.2	4.3±3.2	3.9±2.1		-
Red Blood Cell (RBC) count (/μL)	351.8±22.5	378.1±17.4	411.4±75.8	429.9±78.1	<0.05	a,b,c,e
Hemoglobin (g/dl)	10.77±2	11.1±0.6	12.5±1.6	13.3±2.5	<0.05	a,b,c,e,f
Complications						
Cardiovascular disease (n (%))	10 (83.3)	11 (91.7)	3 (21.4)	9 (28.1)		-
Diabetes (n (%))	7 (58.3)	7 (58.3)	2 (14.3)	3 (9.4)		-
Cerebrovascular disease (n (%))	1 (8.3)	0 (0.0)	1 (7.1)	1 (3.1)		-
Chronic Obstructive Pulmonary	0 (0.0)	0 (0.0)	3 (21.4)	1 (3.1)		-
Hypertension (n (%))	10 (83.3)	10 (83.3)	8 (57.1)	24 (75)		-
Dyslipidemia (n (%))	0 (0.0)	0 (0.0)	9 (64.3)	10 (31.3)		-

Note.

Data means standard deviation unless otherwise stated.

a = Hemodialysis, Sarcopenia (+) vs. Hemodialysis, Sarcopenia (-); b = Hemodialysis, Sarcopenia (+) vs. Control, Sarcopenia (+); c = Hemodialysis, Sarcopenia (+) vs. Control, Sarcopenia (-); d = Hemodialysis, Sarcopenia (-) vs. Control, Sarcopenia (+); e = Hemodialysis, Sarcopenia (-) vs. Control, Sarcopenia (-); f = Control, Sarcopenia (+) vs. Control, Sarcopenia (-); NRI = Nutritional Risk Index; JH = Japanese hemodialysis patients. n.s. = not statistically significant (p≥.05). †, Participants classified as "Exercise (yes)" were those who engaged in nearly 40 minutes of daily physical activity, corresponding to approximately 10 MET-hours per week. Cardiovascular disease was defined as arrhythmias, peripheral arterial and aortic disease, coronary artery disease, or heart failure. Only non-severe cases that did not limit activities of daily living were included.

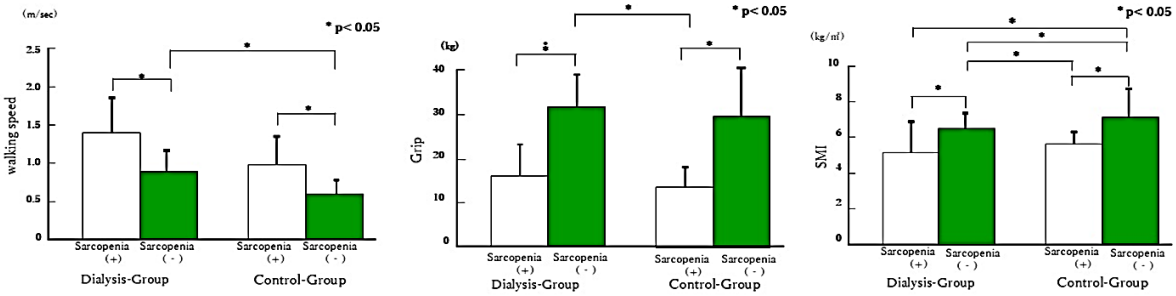

Figure 1. Comparison between dialysis patients and control groups
ANOVA and post hoc tests. *P < 0.05

Figure 1 shows that walking speed was significantly slower, and grip strength was reduced in both groups. SMI was significantly lower in the hemodialysis group.

Table 4. Clinical assessment scores and comparisons between groups.

		Hemodialysis patients		Control group			
		Sarcopenia (+) (n=12)	Sarcopenia (-) (n=12)	Sarcopenia (+) (n=14)	Sarcopenia (-) (n=32)	ANOVA p-value	Post hoc test
Frailty Index Total Score		1.7±1.1	1.2±0.8	1.9±0.7	0.9±0.7	<0.05	f
Frailty Index (n, %)							
Nutrition/shrinking		1 (8.3)	2 (16.7)	1 (7.1)	2 (6.3)		-
Walking speed		6 (50.0)	7 (58.3)	8 (57.1)	9 (28.1)		-
Seclusion		4 (33.3)	3 (25)	4 (28.6)	7 (21.9)		-
Forgetfulness		5 (41.7)	0 (0.0)	6 (42.9)	10 (31.3)	<0.05	a
Emotions		3 (25.0)	0 (0.0)	3 (21.4)	3 (9.4)		-
KCL assessment (n, %)							
IADL	Go out by Bus	7 (58.3)	5 (41.7)	4 (28.6)	5 (15.6)	<0.05	b, c
	Shopping	7 (58.3)	2 (16.7)	2 (14.3)	1 (3.1)	<0.05	a, b, c
	Manage your money	8 (66.7)	2 (16.7)	0 (0.0)	3 (9.4)	<0.05	a, b, c
	Visit friends	11 (91.7)	7 (58.3)	5 (35.7)	3 (9.4)	<0.05	a, b, d, f
	Friends for advice	7 (58.3)	2 (16.7)	2 (14.3)	2 (6.3)		-
Physical function	Climb stairs	5 (41.7)	3 (25.0)	8 (57.1)	5 (15.6)	<0.05	c, f
	Normally stand up	0 (0.0)	1 (8.3)	5 (35.7)	3 (9.4)		-
	Normally walk	2 (16.7)	2 (16.7)	3 (21.4)	3 (9.4)		-
	Experienced a fall	2 (16.7)	6 (50.0)	3 (21.4)	2 (6.3)	<0.05	d
	Fear of falling	3 (25.0)	3 (25.0)	7 (50.0)	4 (12.5)	<0.05	f
Nutritional status	Lost Weight	0 (0.0)	1 (8.3)	2 (14.3)	3 (9.4)		-
	BMI	2 (16.7)	0 (0.0)	0 (0.0)	4 (12.5)		
	Eating tough foods	0 (0.0)	1 (8.3)	5 (35.7)	3 (9.4)	<0.05	f
Oral function	Choked	4 (33.3)	1 (8.3)	5 (35.7)	2 (6.3)		
	Dry mouth	3 (25.0)	4 (33.3)	7 (50.0)	5 (15.6)		
Social activities	Go out at least weekly	0 (0.0)	1 (8.3)	3 (21.4)	0 (0.0)		
	Go out less frequently	6 (50.0)	3 (25.0)	6 (42.9)	5 (15.6)	<0.05	c, f
Cognitive function	Memory loss	0 (0.0)	1 (8.3)	4 (28.6)	1 (3.1)	<0.05	f
	Make a call	3 (25.0)	1 (8.3)	3 (21.4)	2 (6.3)		
	Not knowing date	6 (50.0)	4 (33.3)	6 (42.9)	4 (12.5)	<0.05	c, f
Depressive mood	Lack of fulfilment	3 (25.0)	4 (33.3)	1 (7.1)	2 (6.3)		
	Lack of joy	2 (16.7)	3 (25.0)	4 (28.6)	3 (9.4)		
	Helpless	3 (25.0)	3 (25.0)	8 (57.1)	3 (9.4)	<0.05	f
	Felt tired	3 (25.0)	2 (16.7)	2 (14.3)	3 (9.4)		
KCL assessment Total Score		7.2±4.1	5.6±2.7	7.4±4.8	1.8±4.7	<0.05	c, f
Total domain scores							
IADL		2.6±1.4	1.3±1.2	1.2±1.6	0.6±0.9	<0.05	a, b, c, e
Physical function		1±0.9	1.1±0.8	1.9±1.4	1±1.3	<0.05	b, e, f
Nutritional status		0.2±0.4	0.1±0.2	0.1±0.3	0.2±0.4		
Oral function		0.8±0.9	0.5±0.6	1±1	0.4±0.7	<0.05	f
Social activities		0.8±0.6	0.3±0.4	0.6±0.7	0.3±0.4		
Cognitive function		0.6±0.7	0.4±0.7	0.5±0.8	0.3±0.5		
Depressive mood		1.6±0.9	0.9±1.3	1.8±1.8	0.6±1.2	<0.05	f

Data are mean ± standard deviation unless otherwise stated. a = Hemodialysis, Sarcopenia (+) vs. Hemodialysis, Sarcopenia (-); b = Hemodialysis, Sarcopenia (+) vs. Control, Sarcopenia (+); c = Hemodialysis, Sarcopenia (+) vs. Control, Sarcopenia (-); d = Hemodialysis, Sarcopenia (-) vs. Control, Sarcopenia (+); e = Hemodialysis, Sarcopenia (-) vs. Control, Sarcopenia (-); f = Control, Sarcopenia (+) vs. Control, Sarcopenia (-); n. s. = not statistically significant ($p \geq .05$).

Table 5. Multiple logistic regression analysis

		β	Wald	Odds Ratio (95% CI)	*p* value
Hemodialysis patients	Red blood cell (RBC) count	0.12	6.66	1.13(1.02 – 1.15)	<0.05
Control group	Skeletal muscle index (SMI)	-1.95	4.15	0.14 (0.02 - 0.92)	<0.05
	Walking speed	-9.80	5.97	0.08 (0.04 - 0.14)	<0.05

The dependent variable was the presence of sarcopenia. The independent variables were reduced via stepwise selection, and, in the final models. The independent variables in Hemodialysis patients were walking speed, grip strength, Red Blood Cell (RBC) count. The independent variables in Control group were walking speed, grip strength, SMI.

IV. DISCUSSION

The prevalence of sarcopenia in our outpatient hemodialysis group was found to be 50% (12 out of 24 patients). This prevalence is notably high, aligning with existing literature that reports rates of sarcopenia in dialysis patients ranging from 27.4% to 68.0% [19]. Patients in this study had been on dialysis for an average of more than 8 years and were primarily very elderly. A study by the Tokyo Metropolitan Geriatric Hospital and Gerontology Center indicated that the prevalence of sarcopenia increases with age, from approximately 22% in both men and women aged 75–79 years to 40% in those aged 80 or older [20].

The elevated prevalence of sarcopenia in the hemodialysis group may be attributed to nutritional disorders, as indicated by low SMI values and low albumin levels. Dialysis patients are particularly susceptible to protein-energy wasting, which is characterized by a decrease in skeletal muscle mass, visceral protein, and fat stores [21]. Protein-energy wasting can arise from inadequate nutrient intake, increased catabolism due to inflammation, the accumulation of uremic toxins, and nutrient loss during dialysis, ultimately leading to sarcopenia.

In our study, the sarcopenia group exhibited less exercise and reduced social activity. Additionally, RBC, hemoglobin, and hematocrit levels were lower than in the control group. Prior research indicates that anemia diminishes activities of daily living (ADL) and that inpatients with hemoglobin levels below 10 g/dL experienced decreased independence in ADL at discharge, suggesting a clear association between hemoglobin levels and functional outcomes [22].

Prior research has also found that hemodialysis patients often experience a chronic decline in physical activity due to restrictions, leading to a motor function decrease to approximately 70% of that observed in healthy individuals [23].

Hemodialysis is a primary treatment for end-stage kidney disease. Beyond its physiological burden, dialysis can adversely affect patients' social participation and quality of life. It may also cause anxiety and/or depression, which may further contribute to reduced social engagement [24].

Engaging in regular exercise was associated with sarcopenia in this study. In the hospital from which participants were recruited, aerobic exercise during dialysis is encouraged, and its effectiveness was evident in the lower incidence of sarcopenia among patients who engaged in regular exercise. Previous studies have reported that aerobic exercise during dialysis can reduce fatigue both during and after sessions [25].

Binomial logistic regression analysis revealed that anemia (RBC levels) and walking speed were associated with sarcopenia in the hemodialysis group, whereas SMI and walking speed were associated with sarcopenia in the control group. In this study, sarcopenia was diagnosed according to the criteria established by the Asian Working Group for Sarcopenia, which focuses on muscle mass and physical performance. The loss of skeletal muscle mass associated with aging (often due to early declines in type II muscle fibers and morphological changes at neuromuscular junctions) might contribute to reduced physical performance [26, 27]. However, in the hemodialysis patient population, renal anemia is a significant factor. It results from insufficient erythropoietin production in the kidneys, compounded by factors such

as impaired erythropoiesis and nutritional deficiencies.

Iron deficiency anemia can be a further risk factor impacting sarcopenia, highlighting the role of iron in maintaining skeletal muscle mass and strength [28]. Additionally, chronic increases in cardiac workload and activation of the renin-angiotensin system due to fluid volume fluctuations can trigger inflammatory cytokine production, promoting muscle protein catabolism and type II muscle fiber atrophy [29]. These mechanisms appear to be specific contributors to sarcopenia in hemodialysis patients, distinct from the general age-related factors typically associated with muscle weakness [30].

This study reaffirms the critical need for exercise guidance to prevent sarcopenia in hemodialysis patients. The endocrine system, including growth hormones, is involved in protein synthesis, and engaging in exercise (both resistance and aerobics) can stimulate insulin-like growth factor 1 secretion, which is beneficial for muscle health. Research suggests that well-designed dietary interventions alone may not be sufficient to synthesize muscle protein effectively, and that exercise is one of the more important factors. Thus, it is imperative to encourage hemodialysis patients to engage in physical activity to enhance muscle strength and prevent frailty and sarcopenia [31].

Limitations

This study has several limitations. First, the cross-sectional design precludes causal inference. Second, it was conducted at a single center, which may limit generalizability. Third, there is likely residual confounding, particularly because detailed exercise intervention information was unavailable and comprehensive dietary data were lacking. Notably, protein intake among hemodialysis patients often differs between dialysis and non-dialysis days [32], underscoring the need to assess outcomes under conditions of stable nutritional status. Fourth, the small sample size limits statistical power. Future studies should increase participant numbers, adopt multicenter designs, and incorporate longitudinal or interventional approaches with standardized measures of exercise and nutrition to better control confounding and strengthen causal interpretation.

In conclusion, nutritional guidance, increased exercise, and fostering social engagement are vital strategies for preventing frailty and sarcopenia among patients with chronic kidney disease. Collaborative efforts within the community are essential for effective intervention.

FUNDING AND CONFLICT OF INTEREST

Not applicable.

ACKNOWLEDGMENTS

We thank the staff, including the nurses, clinical engineers, and doctors at the dialysis unit, Iida Clinic, for their cooperation in collecting the data for this study.

We thank Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript.

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J. Asia. Reha. Sci.8 (3): 34 – 41, 2025

The Journal of Asian Rehabilitation Science

Original Article

Exploring the Internal Structure of State Anxiety in Hospitalized Patients with Heart Failure: A Preliminary Analysis

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Abstract: [Purpose] Anxiety is common among patients with heart failure and has been shown to negatively impact prognosis and self-care behaviors. This study examined the factor structure of a State Anxiety Scale (STAI-Y1) during early hospitalization and explored its association with clinical background characteristics. [Participants and Methods] Forty in patients with heart failure were assessed within three days of admission using the Japanese STAI-Y1. The internal structure was evaluated by exploratory factor analysis (principal axis factoring with Promax rotation) after confirming sampling adequacy and sphericity. Participants were additionally classified into anxiety (≥55) and non-anxiety (<55) groups based on the STAI-Y1 cutoff, and background variables were compared. Sensitivity analyses included bootstrapped Spearman correlations treating STAI-Y1 as a continuous outcome and a leverage sensitivity excluding the top 10% of STAI-Y1 scores. [Results] four-factor solution was supported, explaining 67.8% of the variance: Emotional Calmness and Positive Affect, Emotional Tension and Arousal, Negative Emotional Responses, and Emotional Arousal. No statistically significant associations were observed between STAI-Y1 and clinical background variables in group comparisons or in bootstrapped correlation analyses; results were unchanged after the leverage sensitivity. [Conclusion] State anxiety in hospitalized patients with heart failure appears to be multidimensional, suggesting value in identifying qualitative features to tailor psychological care. These findings are preliminary given the small and imbalanced sample, and require confirmation in larger, more diverse cohorts.

Keywords: Heart failure, Anxiety, Exploratory factor analysis

(This article was submitted Sep. 15, 2025, and was accepted Nov. 5, 2025)

I. INTRODUCTION

Heart failure (HF) is a clinical syndrome characterized by structural or functional abnormalities of the heart resulting in congestion, elevated intracardiac pressure, reduced cardiac output, or systemic hypoperfusion [1)]. These pathophysiological changes manifest as various symptoms, including dyspnea, peripheral edema, fatigue, and diminished exercise tolerance. In Japan, the number of individuals affected by HF was estimated to be 1.2 million in 2022, with projections indicating an increase to over 1.3 million by 2030, thereby highlighting its growing societal and healthcare burden [2)]. In recent years, increasing attention has been directed toward the psychological dimensions of HF, particularly anxiety, which affects approximately 37.4% of the patients [2)]. Anxiety exerts deleterious effects on quality of life, clinical prognosis, and adherence to self-care behaviors and

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has also been shown to impair both physical and social functioning [3]. Accordingly, a precise evaluation of anxiety and comprehensive understanding of its contributing factors are essential for the development of holistic and patient-centered HF care strategies.

The State-Trait Anxiety Inventory (STAI), developed by Spielberger et al. [4], is widely used for assessing anxiety in both psychological and medical contexts. Specifically, the STAI-Y1 subscale measures state anxiety, which is defined as a transient emotional response to situational stressors. In Japan, a culturally adapted version of the STAI (STAI-JYZ) was developed by Hidano et al. [5]. Despite its widespread use, most prior studies have employed only the total STAI-Y1 score to quantify anxiety severity, treating it as a unidimensional construct. Investigations of the latent factor structure, particularly within cardiac populations, remain limited. Moreover, few studies have conducted item-level analyses considering both the cultural context and clinical relevance [3].

Elucidating the factor structure of the STAI-Y1 may enhance the granularity of psychological assessment in clinical settings, allowing for individualized care tailored not only to overall anxiety levels but also to specific qualitative features, such as somatic tension, cognitive apprehension, and emotional dysregulation. This differentiation may reduce the risk of misclassification, promote more targeted interventions, and support the proactive management of anxiety. The primary objective of this study was to identify the underlying factor structure of the STAI-Y1 in patients with HF, thereby providing insights into the qualitative dimensions of anxiety in this population. The secondary objective was to explore the potential associations between state anxiety levels and patients' clinical background characteristics.

II. PARTICIPANTS AND METHODS

1) Participants

This study enrolled 81 consecutive patients (mean age: 79.0 ± 12.8 years; 44 men and 37 women) who were hospitalized for HF at the International University of Health and Welfare Hospital, between August 2024 and May 2025. All the participants provided informed consent. HF was diagnosed by physicians according to the Framingham criteria [6]. The exclusion criteria were as follows: a diagnosis of dementia, a score of ≤20 on the Revised Hasegawa's Dementia Scale (HDS-R), impaired consciousness or severely compromised general condition, and a history of psychiatric disorders or current use of anxiolytic or antipsychotic medications. The Ethics Committee of the International University of Health and Welfare approved the study protocol (Approval No. 24-TC-001). Written and verbal informed consent was obtained from all the participants in accordance with the Declaration of Helsinki.

2) STAI-Y1

Anxiety was assessed using the officially published Japanese version of the State–Trait Anxiety Inventory Form Y-1 (STAI-Y1; Jitsumu Kyoiku Shuppan Co., Ltd., Tokyo, Japan), which was used without any modification. The questionnaire was administered by trained research staff—independent of the patients' attending physicians—within three days of hospital admission. Because psychological status immediately after admission is likely influenced by acute stress, uncertainty regarding treatment, and abrupt lifestyle changes, assessment within three days was considered appropriate for capturing situational anxiety during the acute phase.

The STAI-Y1 consists of 20 items encompassing both negative emotions from the Anxiety–Present (P) scale—for example, "I feel nervous," "I feel strained" and "I am worried that something bad will happen"—and positive emotions from the Anxiety–Absent (A) scale—for example, "I feel calm," "I feel secure," and "I feel relaxed." According to the STAI manual [2], the inventory comprises two 10-item subscales: the P scale and A scale, each rated on a four-point Likert scale. All analyses were conducted using officially licensed materials and standardized administration procedures. The questionnaire wording, structure, and content were not modified; therefore, additional permission from the copyright holder was deemed unnecessary.

3) Clinical Background Factors

Sociodemographic variables included age, gender, cohabitation status, employment status, and educational attainment, as well as functional status as measured by the Barthel Index and level of care needed. Medical variables included the New York Heart Association (NYHA) functional classification [1], duration of HF, history of hospitalization, history of surgery, and comorbidities. These data were obtained from the patients' medical records.

4) Statistical Analysis

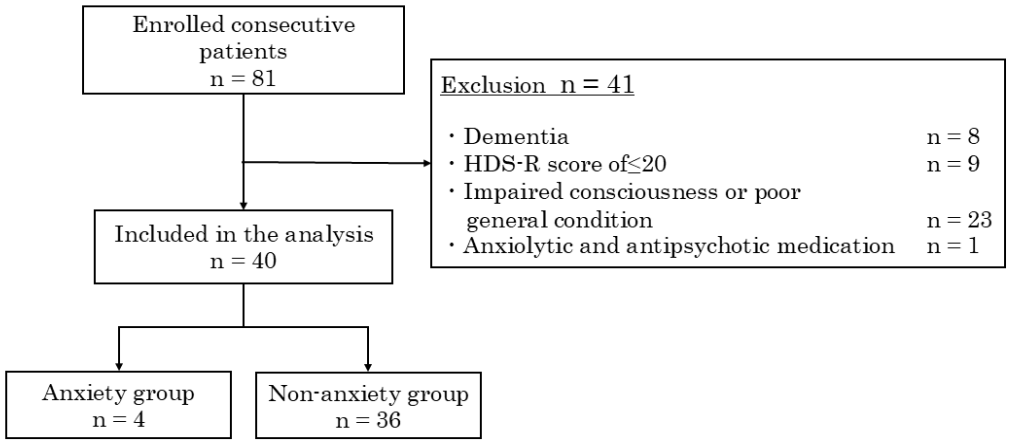
The internal structure of the STAI-Y1 was examined using exploratory factor analysis (principal axis factoring) with Promax rotation. Sampling adequacy (Kaiser–Meyer–Olkin [KMO]) and sphericity (Bartlett's test) were confirmed. The number of factors was determined based on parallel analysis, eigenvalues >1, and scree plot inspection. Items with factor loadings ≥0.40 were retained. The interpretation and labeling of factors were determined through expert discussion among professionals in psychology and rehabilitation sciences. The internal consistency of each factor extracted from the exploratory factor analysis was assessed using Cronbach's alpha coefficients. In accordance with the STAI manual [5], a total score of ≥55 was defined as indicative of high anxiety. Participants were accordingly categorized into an anxiety group (≥55) and non-anxiety group (<55). Comparisons of background characteristics between the two groups were conducted using the Mann–Whitney U test for continuous variables and the chi-squared test for categorical variables. In addition to the group comparison, continuous outcome analyses and leverage sensitivity analyses were performed. For the continuous outcome analyses, Spearman's rank correlation coefficients were calculated between the total STAI-Y1 scores and continuous or ordinal clinical variables (e.g., age, NYHA class, Barthel Index, Charlson Comorbidity Index), with 95% confidence intervals obtained by 1,000 bootstrap resamples. For the leverage sensitivity analysis, the top 10% of participants based on STAI-Y1 scores were temporarily excluded, and the analyses were re-estimated to assess the influence of high-leverage observations on overall results.

All the statistical analyses were performed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Statistical significance was set at a two-tailed P value <0.05.

III. RESULTS

After excluding 8 patients with a confirmed diagnosis of dementia, 9 patients with an HDS-R score of ≤20, 23 patients with impaired consciousness or poor general condition, and 1 patient with a history of psychiatric illness or current use of anxiolytic or antipsychotic medication, a total of 40 patients (mean age: 72.7 ± 14.5 years; 25 male and 15 female) were included in the final analysis (Fig. 1). There were no missing data.

Figure 1 Flow Diagram of Patient Recruitment



Principal component analysis identified the following four distinct factors: "Emotional Calmness and Positive Affect," "Emotional Tension and Arousal," "Negative Emotional Responses," and "Emotional Arousal" (Table 1). The cumulative contribution rate based on the rotated sum of squared loadings was 67.8%. Factor labeling was guided by established psychological classification frameworks4) and patterns of anxiety expression were observed in individuals with HF.

Table 1 Results of Factor Analysis of the STAI-Y1

	Emotional Calmness and Positive Affect	Emotional Tension and Arousal	Negative Emotional Responses	Emotional Arousal
A; (8) I feel satisfied	0.907	−0.196	0.031	−0.072
A; (16) I feel content.	0.891	0.165	0.126	−0.312
A; (10) I feel comfortable.	0.852	0.011	−0.094	0.052
A; (11) I feel confident	0.845	0.120	−0.121	0.059
A; (1) I feel calm	0.829	−0.005	0.172	0.069
A; (19) I feel stable	0.827	−0.066	−0.143	0.069
A; (15) I feel relaxed	0.731	0.039	−0.002	0.149
A; (5) It's easygoing	0.658	0.034	0.035	−0.061
A; (2) I feel secure	0.652	−0.120	−0.128	0.313
A; (20) I feel happy	0.649	0.286	−0.240	−0.187
P; (3) I feel nervous	−0.038	0.822	0.108	−0.047
P; (12) I'm in a hypersensitive state	0.072	0.744	0.228	0.065
P; (4) I feel stressed	0.222	0.649	0.053	0.100
P; (18) I feel confused	−0.218	0.038	0.801	0.000
P; (14) I feel hesitant	−0.159	0.189	0.788	−0.087
P; (9) I'm scared	0.223	−0.059	0.641	0.370
P; (13) I feel irritated	0.037	0.338	0.523	0.064
P; (7) I am worried that something bad will happen	0.043	0.251	−0.036	0.768
P; (6) I'm in a state of agitation	0.116	−0.204	0.277	0.744
P; (17) I'm in a state of distress	−0.307	0.457	−0.250	0.591
Cronbach's α	0.933	0.802	0.773	0.684

P, Anxiety–Present item; A, Anxiety–Absent item

Exploratory factor analysis using principal axis factoring with Promax rotation revealed a clear four-factor solution. Sampling adequacy was verified by a KMO measure of 0.717, and Bartlett's test of sphericity was significant ($\chi^2 = 534.168$, df = 190, $P<0.001$), indicating that the data were suitable for factor analysis.

The number of factors was determined based on parallel analysis, eigenvalues greater than 1.0, and inspection of the scree plot, all of which supported a four-factor solution. The four factors accounted for a total of 67.8% of the variance. The internal consistency reliability of each extracted factor was confirmed by Cronbach's α coefficients, which ranged from 0.684 to 0.933.

The first factor, "Emotional Calmness and Positive Affect," encompassed all 10 items of the A-scale, with factor loadings ranging from 0.65 to 0.91.

The second factor, "Emotional Tension and Arousal," included three items from the P-scale—items 3, 4, and 12—with factor loadings between 0.65 and 0.82.

The third factor, "Negative Emotional Responses," included items 9, 13, 14, and 18, indicating heightened emotional reactions such as anxiety and agitation, with factor loadings from 0.52 to 0.80.

The fourth factor, "Emotional Arousal," comprised P-scale items 6, 7, and 17, reflecting anticipatory worry and cognitive distress, with loadings ranging from 0.59 to 0.77.

Table 2 Comparison of background factors between two groups

		Total (n = 40)	Anxiety group (n = 4)	Non-anxiety group (n = 36)	P value	Effect size
STAI, points		44.7 ± 9.2	59.8 ± 6.1	43.0 ± 7.7	< 0.001	0.514
Age, years		72.6 ± 14.7	70.5 ± 21.1	72.9 ± 14.2	0.946	0.011
Gender	Male	25 (62.5)	2 (50.0)	23 (63.9)	0.586	0.086
	Female	15 (37.5)	2 (50.0)	13 (36.1)		
Educational background	junior high school graduation	15 (37.5)	1 (25.0)	14 (38.9)	0.589	0.163
	High school graduate	21 (52.5)	3 (75.0)	18 (50.0)		
	University graduate	4 (10.0)	0 (0.0)	4 (11.1)		
Employment status	Yes	19 (47.5)	1 (25.0)	17 (47.2)	0.342	0.150
	No	21 (52.5)	3 (75.0)	19 (52.8)		
Living with family	Yes	32 (80.0)	4 (100.0)	6 (16.7)	0.574	0.167
	No	6 (15.0)	0 (0.0)	28 (77.8)		
Nursing care certification	No	27 (67.5)	3 (75.0)	24 (66.7)	0.723	0.127
	Identified as needing assistance	5 (12.5)	0 (0.0)	5 (13.9)		
	Certified as requiring long−term care	8 (20.0)	1 (25.0)	7 (19.4)		
History of hospitalization	Yes	35 (87.5)	3 (75.0)	22 (61.1)	0.426	0.126
	No	5 (12.5)	1 (25.0)	4 (11.1)		
Surgical history	Yes	36 (90.0)	4 (100.0)	32 (88.9)	0.482	0.111
	No	4 (10.0)	0 (0.0)	4 (11.1)		
History of re−hospitalization	Yes	16 (40.0)	1 (25.0)	15 (41.7)	0.519	0.102
	No	24 (60.0)	3 (75.1)	21 (58.4)		
Charlson Comorbidity Index, point		5.7 ± 2.3	6.0 ± 1.6	5.7 ± 2.4	0.596	0.084
Barthel Index at the time of hospitalization		73.5 ± 22.4	58.8 ± 25.6	75.1 ± 21.8	0.173	0.215
Duration of history of heart failure	Less than 1 year	23 (57.5)	3 (75.0)	20 (55.6)	0.455	0.118
	More than 1 year	17 (42.5)	1 (25.0)	16 (44.4)		
New York Heart Association functional classification	Grade 1	8 (20.0)	0 (0.0)	8 (22.2)	0.493	0.245
	Grade 2	19 (47.5)	3 (75.0)	16 (44.4)		
	Grade 3	6 (15.0)	0 (0.0)	6 (16.7)		
	Grade 4	7 (17.5)	1 (25.0)	6 (16.7)		

In a subgroup analysis, participants were divided into an “anxiety group” (n = 4) and a “non-anxiety group” (n = 36) based on the STAI-Y1 cutoff score of 55. The mean STAI-Y1 scores in the two groups were 59.8 ± 6.1 and 43.0 ± 7.7, respectively, demonstrating a statistically significant difference (P<0.001, Effect size = 0.514) (Table 2).

However, no significant differences were observed between the groups in any of the clinical background variables, including demographic, social, and medical characteristics.

In addition, sensitivity analyses using bootstrapped Spearman’s correlation coefficients revealed no significant associations between the total STAI-Y1 score and other clinical variables (age, ρ = −0.07, P = 0.66, 95% CI = −0.42 to 0.29; New York Heart Association functional classification, ρ = 0.13, P =0.42, 95% CI = −0.21 to 0.43; Charlson Comorbidity Index, ρ = 0.01, P = 0.93, 95% CI = −0.27 to 0.33; Barthel Index at the time of hospitalization, ρ = −0.08, P = 0.64, 95% CI = −0.39 to 0.24; Furthermore, after excluding four participants with particularly high STAI scores (n = 36), no significant correlations were observed either (age, ρ = −0.08, P = 0.63, 95% CI = −0.42 to 0.29; New York Heart Association functional classification, ρ = 0.11, P = 0.51, 95% CI = −0.23 to 0.43; Charlson Comorbidity Index, ρ = −0.03, P = 0.87, 95% CI = −0.32 to 0.30; Barthel Index at the time of hospitalization, ρ = 0.06, P = 0.75, 95% CI = −0.28 to 0.39).

IV. DISCUSSION

In this study, factor analysis of the STAI-Y1 in patients with HF identified four distinct factors: “Emotional Calmness and Positive Affect,” “Emotional Tension and Arousal,” “Negative Emotional Responses,” and “Emotional Arousal.” The cumulative contribution rate based on the rotated sum of the squared loadings was 67.8%, indicating satisfactory explanatory power for the factor structure. Although the STAI, originally developed by Spielberger et al. [4] and subsequently adapted into Japanese by Hidano et al. [5], is most commonly used as a unidimensional index of anxiety severity in clinical research, its theoretical foundation posits two affective dimensions: “presence of anxiety” (P-scale) and “Positive Affect Factor” (A-scale). Specifically, Spielberger conceptualized state anxiety as comprising two independent affective dimensions: the “presence of anxiety” (P-scale), reflecting negative affect and physiological tension, and the “absence of anxiety” (A-scale), reflecting calmness, confidence, and other positive emotional states. This bidimensional framework implies that low anxiety is not merely the absence of fear but the presence of positive affective calmness. However, few studies have examined the internal structure of STAI-Y1 in detail, particularly in a clinical setting.

The first factor, “Emotional Calmness and Positive Affect,” comprised all 10 items from the A-scale and reflected positive emotional states such as calmness, comfort, satisfaction, and self-assurance. Higher scores on this factor indicated lower levels of anxiety and may reflect emotional stability and self-efficacy. In contrast, the STAI-Y1 total score is computed by summing the P-scale items and reverse-scoring the A-scale items, thereby providing a single-dimensional estimate of anxiety “intensity.” Although this approach is practical, it may obscure the qualitative nuances of anxiety such as autonomic arousal, cognitive worry, and heightened emotional reactivity by collapsing them into a single metric. For example, patients who exhibited heightened physiological tension but minimal cognitive or emotional distress may receive the same total score as those with globally elevated anxiety levels. Therefore, sole reliance on the total score may result in the underestimation or mischaracterization of anxiety symptomatology. The factors identified in this study offer valuable insights into the multidimensional and qualitative structure of anxiety in patients with HF. This multidimensional pattern provides a more refined psychometric understanding of state anxiety in HF and highlights how anxiety may manifest through distinct physiological, cognitive, and emotional components rather than a single dimension. The second factor, “Emotional Tension and Arousal,” included P-scale items such as “I feel nervous,” “I feel stressed,” and “I am in a hypersensitive state,” which reflect heightened autonomic reactivity. Autonomic dysfunction and the interplay between physical symptoms and psychological stress may contribute to these manifestations in patients with HF. The third factor, “Negative Emotional Responses,” comprised items

such as which reflect emotional instability, fear-based responses, and impaired emotional regulation. The fourth factor, “Emotional Arousal,” was characterized by items such as representing anticipatory worry and maladaptive cognitive appraisal.

Collectively, these findings suggest that the P-scale items of the STAI-Y1 do not represent a single psychological construct but can be classified into three subdomains—physiological, cognitive, and emotional— each reflecting a distinct aspect of anxiety. This multidimensional framework is consistent with Spielberger’s state–trait anxiety theory [4] and underscores the importance of adopting multidimensional assessment approaches in clinical anxiety evaluation. Beyond these psychometric findings, this study also examined whether state anxiety levels were associated with clinical evaluation of anxiety.

Importantly, no significant associations were observed between state anxiety level and any clinical variables in this cohort. To address potential concerns regarding limited statistical power or the influence of extreme values, supplementary sensitivity analyses were performed using bootstrapped Spearman correlations and a leverage sensitivity approach excluding the top 10% of STAI-Y1 scores. These analyses yielded results consistent with the main findings, suggesting that the luck of significant associations was not attributable to outlier effects but reflected the overall trend within the sample. This indicates that anxiety severity may not be adequately explained by biomedical parameters, such as disease severity or physical functioning alone. Rather, it is likely modulated by complex psychosocial influences, including personality traits, illness perceptions, and social support. Previous studies have demonstrated that depressive symptoms are associated with increased somatic complaints and poorer quality of life, and that dispositional characteristics such as negative affectivity and social inhibition predict anxiety and depressive symptomatology [7-9]. Furthermore, insufficient social support has been linked to depression and poorer survival outcomes in patients with chronic illnesses [10]. These findings support a biopsychosocial model in which anxiety is viewed not merely as a consequence of HF, but as a dynamic construct arising from the interplay among biological, psychological, and social determinants.

From a clinical perspective, incorporating the factor structure of the STAI-Y1 into psychological assessments rather than relying solely on the total score may facilitate more individualized and targeted interventions. Identifying the specific anxiety domains that are elevated in a patient (e.g., cognitive versus emotional) can inform the development of tailored psychological support strategies.

This study had several limitations. First, the sample size was relatively small (n = 40); and particularly, the anxiety group (n = 4) was limited, reducing the statistical power of the subgroup analyses. Thus, the subgroup results should be interpreted with caution, as they are exploratory in nature. Second, this study was conducted at a single institution and employed a cross-sectional design, limiting both generalizability and temporal validity. Third, the potential changes in the factor structure of anxiety over time or with disease progression were not assessed. Additionally, state anxiety was evaluated within three days of admission to capture situational anxiety during the acute phase; however, because state anxiety is transient and context-dependent, the results may not fully reflect patients’ stable anxiety tendencies. Psychological and social variables that may influence anxiety were not also assessed.

Nearly half of the initially enrolled patients (41 of 81) were excluded, including 23 patients with impaired consciousness or poor general condition. Therefore, these findings may apply primarily to a relatively stable subgroup of patients with HF, and the possibility of selection bias should be considered. Moreover, although confounding factors were carefully considered based on previous studies, several potentially relevant variables—such as medication status, patterns of acute exacerbation, and longitudinal changes in disease course—were not evaluated. Consequently, the influence of these unmeasured confounders cannot be entirely ruled out. These limitations suggest that the present findings preliminary and hypothesis-generating, emphasizing the need for further research incorporating psychosocial assessments and longitudinal follow-up designs.

In conclusion, factor analysis of the STAI-Y1 in patients with HF revealed four underlying dimensions: “Emotional Calmness and Positive Affect,” “Emotional Tension and Arousal,” “Negative Emotional Responses,” and “Emotional Arousal,” These findings highlight the importance of multidimensional

approaches in assessing anxiety and underscore the limitations of relying solely on total scores. Future research should aim to replicate and validate these findings in larger and more diverse cohorts, and to explore longitudinal changes in anxiety profiles throughout the course of HF.

FUNDING AND CONFLICT OF INTEREST

The authors have no conflicts of interest directly relevant to the content of this article.

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