







Developing and Validating of the Family Coping Scale for Patients with Chronic Heart Failure

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Background: Family coping, as an essential part of family management of patients with chronic heart failure (CHF), is an important component of CHF interventions, affecting the health of patients, family members, and the whole family. It is necessary to understand the current situation of family coping in patients with CHF to facilitate the development of family interventions for patients with CHF. This study aims to develop and validate a tool for assessing the family coping scale for patients with CHF.

Methods: The semi-structured interviews, expert consensus meetings, expert consultations, and item analysis were used to develop the initial scale. We employed classical test theory and exploratory factor analysis to scrutinize and refine the items in the scale. To validate the scale, we used confirmatory factor analysis to assess structural validity. We assessed internal consistency, and split-half reliability to ensure the scale's robustness and accuracy.

Results: The FCS-CHF consisted of 24 items, including six dimensions: strategies for better management of CHF, psychological coping, substantial support by family members, emergency coping, overall heart failure awareness, and patients' health behavior. The results of confirmatory factor analysis showed that the scale fitted the data with well construct validity. The results of the confirmatory factor analysis for the overall goodness of fit indices for the fitted model were found to be acceptable for the scale. The scale demonstrates good reliability and validity, meeting the requirements of psychometrics.

Conclusions: The FCS-CHF developed in this study is considered reliable and valid, which can measure family coping in patients with CHF and provide a basis for developing family coping enhancement strategies.

Keywords: chronic heart failure, family coping, scale development, reliability, validity

Background

Chronic heart failure (CHF) is an end stage of various heart diseases with complex clinical syndromes, which is a persistent state of heart failure that can be stable, worsening, or decompensated and is the end-stage manifestation of cardiovascular disease and the most important cause of death, as well as a common critical clinical condition in the 21st century.^{1,2} Recent research data show that the all-cause mortality rate of patients with CHF in developed European countries is from 6.9% to 15.6%,³ and the mortality rate of patients with CHF in China during the "vulnerable period" (within three months after hospital discharge) is 15%.⁴ After the first diagnosis of heart failure, more than half of the patients will be re-hospitalized within one year.⁵ The re-hospitalization rate of patients with CHF in Western countries is 22.1% at three months, and it rises to 50% at six months.⁶ The re-hospitalization rate of patients with CHF in the "vulnerable period" in China is 30%, and the re-hospitalization rate from six to 12 months is 42% to 52%.⁴ The high prevalence, high mortality rate, and high readmission rate of CHF have caused a decline in patients' quality of life and survival, seriously affecting the physical and mental health of the patients and their family members, which has become one of the global public health problems in the 21st century.^{7,8}

CHF is a recurrent acute exacerbation of the disease, and both disease management and prognostic risk stratification are essential tools in the prevention and intervention of CHF,^{9,10} which can help improve symptoms, enhance quality of life, slow or reverse the deterioration of cardiac function, and reduce readmission and mortality rates.¹¹ However, during the disease management of CHF, patients often experience difficulty managing heart failure symptoms, adhering to a treatment plan, completing daily activities, and experiencing negative emotions.¹² It has been evidenced that family is the most common and essential resource for patients with CHF, and how the family copes with the disease may lead to effective or ineffective management of the disease.^{13,14} Family coping is a bridging concept comprising cognitive and behavioral components in which family resources, perceptions, and behavioral responses cooperate to improve family functioning.¹⁵ Previous studies have found that family coping is essential in adapting to stressful events such as chronic disease, disability, etc.^{16–18} Effective family coping is more likely to lead to bon-adaptation (positive adaptation) and vice versa. Therefore, family coping, as an essential part of the management of CHF, is an important component of CHF interventions, affecting the health of patients, family members, and the whole family.^{15,19} It is necessary to understand the current situation of family coping in patients with CHF to facilitate the development of family coping enhancement strategies and family interventions for patients with CHF.

However, a systematic search of the domestic and international literature revealed that there are fewer studies related to family coping assessment tools, and those that have been retrieved have focused on family coping in schizophrenia, eating disorders, stroke, chronically ill children, and regular adult children,^{15,20–22} which are highly population-specific and not applicable to the population of patients with CHF. We have not yet retrieved any measurement tools related to the family coping of patients with CHF. There is an urgent need to develop a family coping scale for patients with CHF to assess their coping status, formulate family coping enhancement strategies, and promote family health, which is essential for clinical practice.

This study aimed to develop an instrument to measure family coping for patients with CHF with the following specific goals: developing an instrument and evaluating the reliability and validity of the developed instrument.

Method

Design

An instrument development and validation study design were adopted following the three phases between March 2023 and January 2024: (1) Phase I: Items development; (2) Phase II: Items reduction; (3) Phase III: Scale evaluation. [Figure 1](#) depicts the whole process in a flow chart.

Phase I - Items Development

To generate the items for the Family Coping Scale for Patients with CHF (FCS-CHF), a research team was initially formed, consisting of seven members, including a nursing professor, two graduate nursing instructors, and four master's students in nursing. The original item pool was generated based on the qualitative research and literature review. The trichotomy of coping strategies proposed by Weiten^{23–25} was adopted to guide the qualitative study, which includes a triad of coping strategies, namely Problem-oriented coping, Appraisal-oriented coping, and Emotion-oriented coping. The qualitative research involved 31 participants in 18 families, including 13 patients and family members, and five patients were interviewed without family members. All the interviews were face-to-face and recorded. The purposeful sampling method following the principle of maximum variation was adopted, considering factors such as age, gender, educational level, family model, family relationship, etc. The family models are categorized as nuclear, stem, extended, and other.^{26,27}

Within 24 hours after the interview, the principal researcher transcribed the interview; two researchers listened to the recording repeatedly and checked it manually, and the content analysis method was used.^{28,29} The trichotomy of coping strategies proposed by Weiten was used to guide the analysis,²⁵ which could inform the initial direction of qualitative data analysis without limiting the identification of new themes. The researchers repeatedly studied the interview transcripts word-by-word to understand the thoughts and feelings of the participants as fully as possible. Two researchers with expertise analyzed the data independently to eliminate the risk of bias. In the cases of differences in the analysis, the

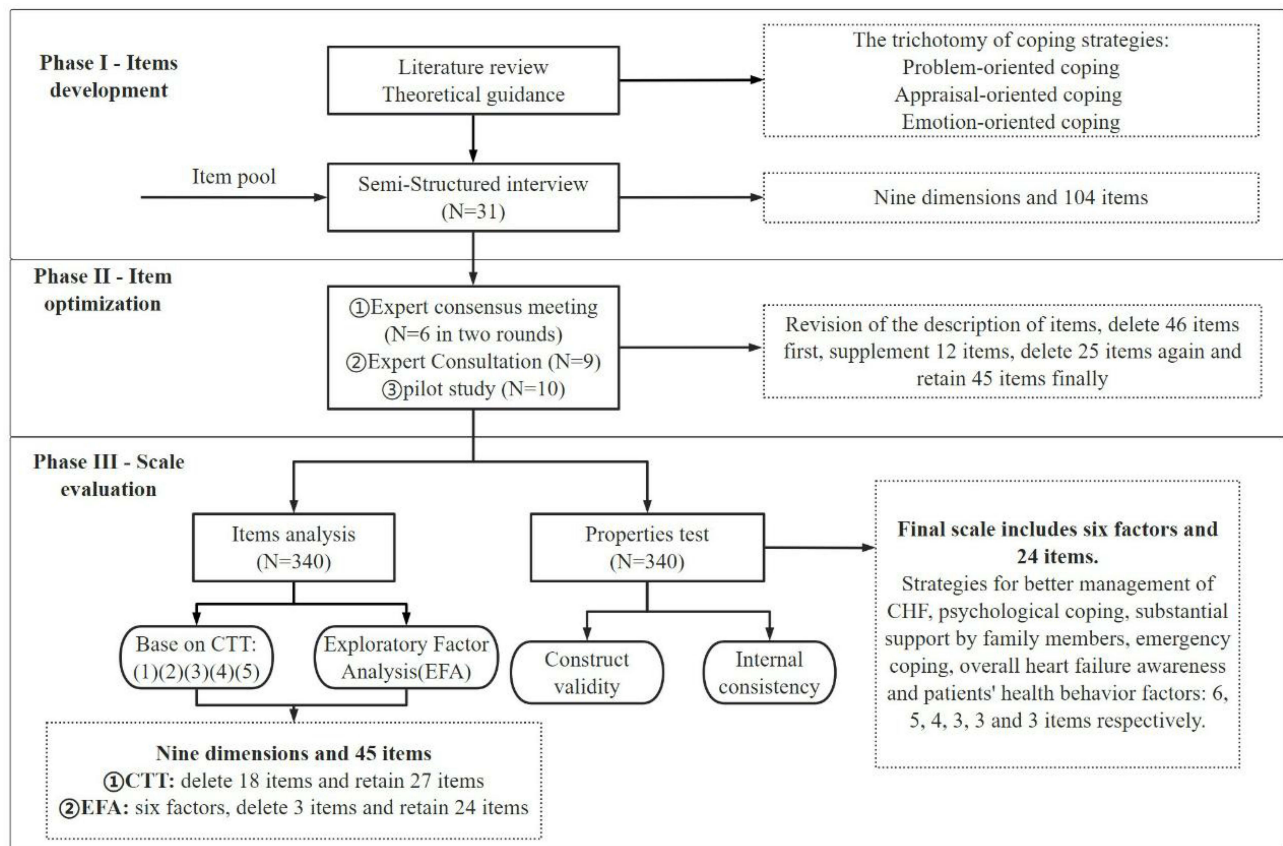


Figure 1 The development procedure of the Family Coping Scale for Patients with CHF.

Notes: CTT: Classical test theory; (1) The critical ratio; (2) Represents correlation coefficient analysis; (3) Cronbach's α coefficient analysis; (4) Commonality; (5) Factor load value.

two researchers communicated with each other to ensure that an inductive process consistent with the study participants' views occurred. The agreement was reached through discussion where differences in analysis appeared. The corresponding author reviewed the final results. The main interview outline was: (1) What is the course of this illness for you/your family? (2) How did you/your family cope with this illness? And how did your family cope together? (3) What ways could have helped the family cope better? Nine categories were extracted: fighting the disease during episode, managing disease in daily life, embarking on a journey for support, understanding the disease in a diverse way, accepting the disease or not, optimistic, worry and powerless, alteration of role responsibilities and adjustment of family interaction. Finally, according to the qualitative results and literature review, we developed an item pool with 104 items.

Phase II - Item Optimization

The 104-item pool was validated by two rounds of expert consensus meetings conducted by a six-member expert panel selected for their cardiovascular and psychological expertise. The six-member expert was composed of one expert in the field of health management and 17 years of working experience; one expert in the field of cardiovascular treatment with 15 years of working experience; two experts in the field of mental health with 15 years of working experience; two experts in the field of cardiovascular disease nursing with ten years of working experience. The criteria for retention or deletion of items include clarity of expression, face validity, appropriateness for the measured construct, and potential for differentiating the target population. Each expert indicated their decision (to remove, keep, or modify) for each item and commented on the modified items. Items consistently being judged to be removed were eliminated, and modifications were made to the modified items. Besides, they can also suggest some items to be added to better measure the concept to be assessed. After item reduction, modification, and addition, the items were used for the first draft of FCS-CHF,

including nine dimensions and 45 items, which were again sent to nine experts for face and content validity validation. These experts had been engaged in the medical and nursing cardiovascular disease or mental health, including three clinical doctors with Ph.D. qualifications and 20 years of working experience who specialized in the diagnosis and treatment of heart failure or cardiovascular diseases; one clinical doctor with Ph.D. qualifications and 15 years of working experience who specialized in diagnosis and treatment of mental health disorders; an associate professor of nursing at a university with Ph.D. qualifications and 17 years of working experience specializing in chronic disease management; three clinical nurse specialists with 20 years of working experience specializing in cardiovascular nursing; and one clinical nurse specialist with 21 years of working experience specializing in psychological nursing. Except for two clinical nursing experts, the other seven experts are master's or doctoral supervisors with extensive research experience, and all of them can provide maximum guidance and assistance in optimizing this scale. The experts commented on whether some items should be added, removed, or modified. They also evaluated each item's relevance level for its corresponding construct on a 4-point scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant).³⁰ The interrater agreement (IR), content validity index for items (I-CVI), scale-level content validity index, universal agreement calculation (S-CVI/UA), scale-level content validity index, averaging calculation method (S-CVI/ Ave) were computed to indicate the content validity.^{30,31} Finally, we constructed the scale with nine dimensions and 45 items.

A pilot study was carried out to evaluate the readability and comprehensibility of the items included in the FCS-CHF. This pilot study involved ten patients with CHF and their family members in the researcher's hospital. They took 15–20 minutes to complete the questionnaire; after completing the questionnaire, a face-to-face interview was conducted with the respondents to understand the difficulty level of the scale items and the problems encountered in the process of completing the questionnaires, and all ten respondents indicated that the items of the scale could be understood and accepted. Until this stage, there were nine dimensions and 45 items.

Phase III - Scale Evaluation

Classical test theory (CTT): In this study, five indices were used in three statistical methods: (1) The critical ratio: the total scores of the scale were ranked from high to low, with the top 27% and the bottom 27%. Items with the absolute value of the decision value (t value) greater than three and a statistically significant difference between the two groups ($p < 0.05$) were retained. (2) Represents correlation coefficient analysis: the correlation coefficient (r) between an item and the total score ≥ 0.4 was retained.³² (3) Cronbach's α coefficient analysis: Items that, when removed, increased the Cronbach's α coefficient were considered for potential removal. (4) Commonality: commonality > 0.2 indicates that the entries are closely related to the total table, have a high degree of homogeneity, and are retained.³³ (5) Factor load value: factor loadings > 0.45 indicate that the entries are closely related to the total table, have a high degree of homogeneity, and are retained.³³

In this study, considering the results of the critical ratio method, the correlation coefficient method between the item and the total score of the scale, and the homogeneity test, and in accordance with the screening criterion of "deleting the items that meet any three the above deletion criteria at the same time" the results show that a total of 18 items satisfy the screening criterion, and need to be deleted, while 27 items were retained.

Exploratory factor analysis (EFA): An EFA was conducted, and the 'Principal Component method was used for factor extraction. Items with factor loading ≥ 0.5 were retained following the maximum variance method orthogonal rotation. However, items with similar load indices (with a difference of less than 0.2) in two or more factors without specificity were eliminated. Before EFA, we calculated the Kaiser–Meyer–Olkin (KMO) measure (optimal value > 0.6). We performed the Bartlett test of sphericity (optimal value: $p < 0.01$) to confirm the suitability of the data for factor analysis.³⁴

Confirmatory factor analysis (CFA): Structural validity was calculated by CFA. The goodness-of-fit of the CFA models was evaluated utilizing the following indices and cutoff levels: the χ^2 -test/degrees of freedom ratio (χ^2/df), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), incremental fit index (IFI), Tucker-Lewis index (TLI), and comparative fit index (CFI). The fit was considered to be acceptable when the $\chi^2/df < 5$, RMSEA and SRMR were ≤ 0.08 , and the IFI, TLI, and CFI were ≥ 0.90 .³⁵

Reliability: The reliability was validated using Cronbach's α coefficient and split-half reliability. The Cronbach's α coefficient of the total scale and each dimension were calculated, and $\alpha > 0.7$ was acceptable reliability.³⁶ Split-half reliability was assessed by calculating the correlation between two halves of the scale, which were divided based on odd-numbered and even-numbered items.³⁷ A Guttman Split-half Coefficient exceeding 0.6 was acceptable.³⁸

Participants

From September 2023 to January 2024, participants were recruited from inpatient wards in several hospitals in Kunming City, Qujing City, Dali City, Yuxi City, and Baoshan City in Yunan Province, China. The patients and their family members meeting the following inclusion criteria were selected: a. Patients with CHF: (i) age ≥ 18 years old; (ii) meeting the diagnostic criteria for heart failure of the 2022 AHA/ACC/HFSA Guidelines for the Management of Heart Failure;³⁹ (iii) normal comprehension and verbal ability. b. Family members of patients with CHF: (i) age ≥ 18 years old; (ii) close relatives living with the patient with CHF; (iii) normal comprehension and language skills.

The sample was collected by distributing an on-site survey. We divided the incoming data into two parts according to parity: one for item analysis and exploratory factor analysis (EFA) and another for confirmatory factor analysis (CFA). Based on the standards of 5 to 10 times the number of scale items⁴⁰ and considering 10% and 20% invalid answers, the required sample size was determined to be a minimum of 250 cases.

The Helsinki Declaration was used to conduct the study and was approved by the First Affiliated Hospital of Kunming Medical University Ethics Committee under Ethics Approval No. 2022–281. Written informed consent was obtained from all participants.

Data Analysis Software

CFA was conducted in AMOS (Version 28.0, IBM, Asia Analytics Shanghai, Windows). All the other analyses were performed using SPSS (Version 27.0, IBM, Asia Analytics Shanghai, Windows). A p-value smaller than 0.05 was set as the statistically significant level for all the analyses.

Results

General Information About the Participants

Eight hundred patients with CHF and their family members participated in this study, and 680 valid samples were included after a series of data-cleaning processes. Among them, 351 were female (51.62%), and 329 were male (48.38%), with an average age of 61.32. 566 were Han (83.24%), a relatively large proportion of the population. There were various types of families: 273 were nuclear family (40.14%), 248 were core family (36.47%), 119 were extended family (17.5%), and 40 were other (5.88%). This diversity contributed to the overall representativeness of our sample, facilitating the generalizability of our study outcomes. A descriptive analysis of the participant's demographic characteristics is listed in [Table 1](#). The entire study sample (n = 680) was divided into two sub-samples randomly (A and B). The factor structure of the FCS-CHF was first examined by EFA in sub-sample A (n=340). To further corroborate the stability of the factor structure, the data from sub-sample B (n=340) were used for CFA.

Results of Items Development

Informed by semi-structured interviews and a comprehensive literature review, we constructed an item pool comprising 104 items of the FCS-CHF. The interviews distilled nine categories of fighting the disease during episode, managing disease in daily life, embarking on a journey for support, understanding the disease in a diverse way, accepting the disease or not, optimistic, worry and powerless, alteration of role responsibilities and adjustment of family interaction.

Results of Items Optimization

Six experts participated in two rounds of consultation. The results of the first round of the expert consensus meeting showed that the initial scale item pool of 104 items was deleted to 58 items and 12 items were added based on experts' opinions, leading to 70 items on the scale. The second round of the expert consensus meeting reduced the scale items from 70 to 45.

Table I The Basic Characteristics of Participants (n=680)

Characteristics	Categories	N	Percentage (%)
Age (years)	≤35	59	8.68
	36~50	107	15.74
	51~65	199	29.26
	66~80	229	33.68
	≥80	86	12.65
Gender	Male	351	51.62
	Female	329	48.38
National	Han	566	83.24
	Minority	114	16.76
Residence	Rural	308	45.29
	Urban	372	54.71
Living style	Living alone	50	7.35
	Living with spouse only	218	32.06
	Living with children only/multiple generations	135	19.85
	Living with spouse and children/multiple generations	255	37.5
	Other	22	3.24
Education level	Primary school or below	304	44.71
	Middle school	186	27.35
	High school	90	13.24
	Associate degree or above	100	14.71
Marriage status	Single	28	4.12
	Married	538	79.12
	Divorced	11	1.62
	Widowed	103	15.15
Number of children currently raised	Zero	46	6.76
	One	176	25.88
	Two	254	37.35
	Three or more	204	30
Occupation	Farmers or migrant workers	302	44.41
	Production and transport workers	26	3.82
	Enterprise or company staff	26	3.82
	Medical staff	8	1.18
	Commercial and service workers	17	2.5

(Continued)

Table 1 (Continued).

Characteristics	Categories	N	Percentage (%)
	Civil servants or career staff	21	3.09
	Retired staff	183	26.91
	Domestic and non-engaged persons	43	6.32
	Other	54	7.94
Modalities for payment of medical expenses	Employee medical insurance	186	27.35
	Basic medical insurance for urban and rural residents	434	63.82
	Retired cadres' health insurance	20	2.94
	Other	21	3.09
	Self-financed	19	2.79
Current health status	Very good	15	2.21
	Well	95	13.97
	Good	237	34.85
	General	295	43.38
	Bad	38	5.59
Whether or not you have a chronic illness	No	359	52.79
	Yes	321	47.21
Family model	Nuclear family	273	40.14
	Core family	248	36.47
	Extended family	119	17.5
	Other	40	5.88
Number of persons in household (persons)	≤2	188	27.65
	3~5	336	49.41
	6~8	123	18.09
	≥8	33	4.85
Total annual household income (ten thousand yuan)	≤5	265	38.97
	6~10	173	25.44
	11~15	91	13.38
	16~20	74	10.88
	21~29	18	2.65
	≥30	59	8.68

We prepared the first draft of the scale, which contains nine dimensions and 45 items. We distributed it by E-mail to nine experts to assess the content of the scale dimensions and items. The content validity index was calculated using the consultant scoring scale dimensions and items. The results showed that $IR=0.82$, $S-CVI/UA=0.89$, $S-CVI/Ave=0.99$ for the scale dimensions, $S-CVI/UA=0.822$, $S-CVI/Ave=0.980$ for the scale items, and the items' $I-CVI$ were all ≥ 0.89 , suggesting that the scale's content validity is good.

For scoring, participants were asked to rate the items on a seven-point Likert scale, with options ranging from 1 (very inconsistent) to 7 (very consistent). The total score ranged from 45 to 315, with 11 reverse scoring items, with higher scores indicating better family coping in patients with CHF.

Results of Scale Evaluation

Based on the results of CTT analysis, a comprehensive set of item screening methods was employed, including the critical ratio method, correlation between items and total score, and homogeneity test (reliability analysis, commonality and factor loadings). Items were rigorously assessed and discarded based on stringent criteria. The absolute value of the critical ratio ranged from 0.74 to 0.683, with 7 items < 0.3 and the other 38 items > 0.3 , which is a good result. The correlation coefficients between the items and the scores on the total scale ranged from -0.321 to 0.683 , with 18 items < 0.4 and the other 27 items > 0.5 , which is a good result. Cronbach's coefficient alpha value of the FCS-CHF is 0.854, and Cronbach's coefficient alpha coefficient of the 45 items after the deletion of a certain item ranged from 0.842 to 0.870, but 11 items didn't satisfy the Cronbach's coefficient analysis method. The factor analysis showed that 22 items satisfied the factor analysis screening criteria. In summary, there were 18 items that satisfied only one or two statistical methods, which needed to be eliminated. There were a total of 27 items that satisfied at least 3 statistical methods. See Table 2 in detail.

The KMO measure yielded a high value of 0.918 in the first round, and Bartlett's test of sphericity was significant ($p < 0.05$), confirming the appropriateness of the data for factor analysis. Principal component analysis indicated the extraction of the common factors with eigenvalue > 1 . The results of the exploratory factor analyses showed a total of six factors. These factors collectively accounted for 63.84%, and detailed results are shown in Table 3. As a result, several items were removed during

Table 2 Results of the Item Selection Using Classical Test Theory

Item	The Absolute Value of the Critical Ratio	Correlation Coefficient	Cronbach's α Coefficient Analysis	Commonality	Factor Load Value	Item Evaluation
FC1	8.19*	0.467*	0.849*	0.225*	0.474*	I
FC2	12.55*	0.574*	0.850*	0.400*	0.632*	I
FC3	9.79*	0.506*	0.850*	0.287*	0.535*	I
FC4	10.97*	0.486*	0.849*	0.336*	0.580*	I
FC5	3.88*	0.237	0.856	0.017	0.130	III
FC6	2.59	0.157	0.856	0.001	0.036	III
FC7	5.04*	0.288	0.853*	0.048	0.218	III
FC8	9.89*	0.489*	0.849*	0.171	0.413	II
FC9	6.30*	0.308	0.853*	0.031	0.175	III
FC10	4.29*	0.247	0.855	0.016	0.126	III
FC11	9.24*	0.426*	0.851*	0.167	0.409	II
FC12	7.76*	0.403*	0.851*	0.120	0.347	II
FC13	5.99*	0.355	0.852*	0.080	0.283	III
FC14	7.72*	0.405*	0.851*	0.103	0.321	II
FC15	10.07*	0.561*	0.848*	0.345*	0.587*	I
FC16	19.35*	0.683*	0.842*	0.608*	0.780*	I
FC17	19.44*	0.655*	0.844*	0.567*	0.753*	I

(Continued)

Table 2 (Continued).

Item	The Absolute Value of the Critical Ratio	Correlation Coefficient	Cronbach's α Coefficient Analysis	Commonality	Factor Load Value	Item Evaluation
FC18	18.66*	0.654*	0.844*	0.578*	0.760*	I
FC19	16.57*	0.652*	0.844*	0.544*	0.738*	I
FC20	7.05*	0.406*	0.851*	0.134	0.366	II
FC21	11.65*	0.607*	0.850*	0.443*	0.665*	I
FC22	7.86*	0.447*	0.850*	0.251*	0.501*	I
FC23	12.88*	0.617*	0.850*	0.448*	0.669*	I
FC24	-11.58*	-0.567	0.864	0.461	-0.679	III
FC25	13.25*	0.643*	0.848*	0.494*	0.703*	I
FC26	6.05*	0.345	0.852*	0.119	0.344	III
FC27	8.49*	0.456*	0.850*	0.221*	0.470*	I
FC28	10.92*	0.556*	0.847*	0.274*	0.523*	I
FC29	-4.80*	-0.269	0.870	0.210	-0.458	III
FC30	10.00*	0.521*	0.849*	0.248*	0.498*	I
FC31	9.76*	0.488*	0.851*	0.251*	0.501*	I
FC32	7.00*	0.355	0.852*	0.104	0.323	III
FC33	3.78*	0.155	0.855	0.021	0.144	III
FC34	1.13	0.143	0.856	0.000	0.018	III
FC35	0.74	0.104	0.857	0.000	0.005	III
FC36	1.85	0.163	0.855	0.002	0.042	III
FC37	2.63	0.226	0.854*	0.013	0.115	III
FC38	16.86*	0.654*	0.847*	0.570*	0.755*	I
FC39	17.85*	0.676*	0.847*	0.594*	0.771*	I
FC40	15.34*	0.655*	0.846*	0.504*	0.710*	I
FC41	7.54*	0.465*	0.850*	0.235*	0.485*	I
FC42	3.44*	0.242	0.854*	0.037	0.192	III
FC43	2.35	0.174	0.855	0.010	0.098	III
FC44	13.40*	0.554*	0.847*	0.314*	0.560*	I
FC45	2.13	0.178	0.855	0.002	0.043	III

Notes: *Selected by this method. Item evaluation: I=excellent, II=good, III=poor.

the screening process: item 25, item 15, and item 11 all had factor loading coefficients of <0.5 for the six factors, so the three items were deleted to rerun the exploratory factor analysis. The orthogonal rotation results of the second exploratory factor analysis showed that the factor loading coefficients of each item were good (Table 4).

Table 3 Assumptions of One-Dimensionality of the Dimensions for the Scale

No.	Indicators	Total	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
First	Eigenvalues	17.24	4.71	3.21	2.85	2.27	2.12	2.08
	Ratio	63.86	17.46	11.89	10.56	8.42	7.85	7.69
	KMO	0.918						
	Bartlett's Test of Sphericity	$P < 0.001$						
	Number of items	27						
Second	Eigenvalues	16.11	4.49	2.99	2.76	2.02	1.98	1.88
	Ratio	67.11	18.69	12.46	11.48	8.39	8.26	7.83
	KMO	0.909						
	Bartlett's Test of Sphericity	$P < 0.001$						
	Number of items	24						

Abbreviations: KMO, Kaiser-Meyer-Olkin; P, p-value.

Table 4 Exploratory Factor Analysis for the FCS-CHF Six Factor Model

Item	Principal Component					
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
FC18	0.872					
FC17	0.870					
FC16	0.852					
FC19	0.830					
FC4	0.622					
FC27	0.587					
FC41		0.790				
FC38		0.723				
FC39		0.707				
FC40		0.650				
FC31		0.515				
FC23			0.753			
FC21			0.736			
FC22			0.678			
FC44			0.521			
FC3				0.623		
FC1				0.623		
FC2				0.608		
FC28					0.756	

(Continued)

Table 4 (Continued).

Item	Principal Component					
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
FC30					0.754	
FC20					0.560	
FC8						0.693
FC12						0.682
FC14						0.597

Abbreviation: FCS-CHF, the Family Coping Scale for Patients with CHF.

Following the extensive screening and refinement process, the FCS-CHF is now made up of 24 items and organized into six dimensions: six items in the dimension of strategies for better management of CHF; five items associated with psychological coping; four items related to substantial support by family members; three items in the dimension of emergency coping; three items concerning about overall heart failure awareness and three items pertaining to patients' health behavior.

The confirmatory factor analysis (CFA) provided valuable insights into the construct validity of the FCS-CHF (Table 5). The overall indices of goodness of fit for the adjusted model were found to be acceptable for the FCS-CHF: $\chi^2/df=2.707$, RMSEA=0.068, SRMR=0.071, IFI=0.916, TLI=0.901, CFI=0.916. These results indicate that the final FCS-CHF (Appendix S1) demonstrates favorable construct validity, reinforcing its ability to measure the intended construct accurately.

The Cronbach's α coefficient for the FCS-CHF was 0.902, ranging from 0.525 to 0.910 for each dimension, and the split-half reliability was 0.846, as shown in Table 6.

Table 5 Goodness-of-Fit Statistics of the Scale

Fitness index	χ^2/df	SRMR	RMSEA	CFI	IFI	TLI
Pre-correction	2.864	0.071	0.074	0.907	0.907	0.891
Post-correction	2.707	0.068	0.071	0.916	0.916	0.901
Criteria	<3.000	<0.080	<0.080	>0.900	>0.900	>0.900

Abbreviations: SRMR, Standardized Root Mean Square Residual; RMSEA, Root Mean Square Error of Approximation; CFI, Comparative Fit Index; IFI, Incremental Fit Index; TLI, Tucker-Lewis Index.

Table 6 Cronbach's α Coefficient for the FCS-CHF

Dimension	Cronbach's α	Number of Items
Strategies for better management of CHF	0.910	6
Psychological coping	0.851	5
Substantial support by family members	0.703	4
Emergency coping	0.625	3
Overall heart failure awareness	0.604	3
Patients' health behavior	0.525	3
Scale overall	0.902	24

Abbreviations: CHF, Chronic Heart Failure; FCS-CHF, the Family Coping Scale for Patients with CHF; IR, Interrater Agreement; I-CVI, Content Validity Index for Items; S-CVI/UA, Scale-level Content Validity Index/Universal Agreement; S-CVI/Ave, Scale-level Content Validity Index/Average; CTT, Classical Test Theory; EFA, Exploratory Factor Analysis; CFA, Confirmatory Factor Analysis; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; IFI, Incremental Fitting Index; TLI, Tucker-Lewis Index; CFI, Comparative Fitting Index.

Discussion

To the authors' knowledge, this is the first study to develop and undertake a detailed validation of a scale to assess family coping for patients with CHF. This study was conducted under the guidance of the trichotomy of coping strategies, and a preliminary FCS-CHF was developed through interviews with patients with CHF and their families and a literature review. The instrument's validity was evaluated through factor analysis. It consists of 24 items organized into six dimensions (strategies for better management of CHF, psychological coping, substantial support by family members, emergency coping, overall heart failure awareness, and patients' health behavior). In developing the item pool, the themes that emerged from the qualitative findings were used to build on the related constructs and guide the development. The draft of the item pool was based on the interview data in the qualitative phase and a critical review of existing related literature. In the development of the scale, the developed item pool was validated by expert consensus selected for their expertise in cardiovascular nursing and psychological nursing, which could strengthen the face and content validity of the scale. The dimensions and items of the first draft scale were consulted by experts in cardiovascular disease healthcare, psychiatric-mental healthcare, and chronic disease health management. The process would also help fine-tune the language and relevance of the developing instrument, which is becoming more popular and highly recommended by researchers.⁴¹

In assessing the psychometric properties of the FCS-CHF, the evidence for the construct validity of the FCS-CHF was supported by exploratory and confirmatory factor analysis. In the study, the EFA of the FCS-CHF yielded a six-factor model that explained 67.11% of the variance in the study. Confirmatory factor analysis (CFA) supported a six-factor structure during the scale validation. Results indicated a moderately good fit for the instrument, offering confirmatory evidence for the factor structure. An RMSEA of less than 0.06 is considered a close fit, while values between 0.06 and 0.08 are acceptable.⁴² The CFI, IFI, TLI, and SRMR values supported the model's acceptable fit.^{43,44} We employed Cronbach's α coefficient and split-half reliability to gauge the scale's reliability. Coefficients exceeding 0.7 signifies strong internal consistency for the FCS-CHF.⁴⁵ All dimensions demonstrated good internal consistency except that Cronbach's α coefficient of the three dimensions (emergency coping, overall heart failure awareness, and patients' health behavior) was slightly less than 0.7. All three dimensions had only all three items, which may have contributed to the lower Cronbach's alpha coefficients for all three dimensions.^{46,47} Future studies will further optimize the reliability indices of the scale.

Limitations and Directions for Future Research

There were several strengths of this study to be underlined. First, we adhered to a rigorous and transparent scale development process, ensuring the precision and practicality of the FCS-CHF. Second, we employed a comprehensive approach combining CTT and factor analysis methods to assess item quality thoroughly. Third, the development of the FCS-CHF is based on the family's perspective as a whole, which is in line with the requirements of the World Health Organization (WHO) that "health starts from the family". Nonetheless, it is essential to acknowledge certain limitations. Due to the restriction of practical conditions, the questionnaire survey was only collected in several tertiary hospitals in Yunnan Province, which is of a specific geographical nature, and the sample size and representativeness are limited. Some of the indexes of the reliability and validity test of the scale were not the optimal results, and the scale can be further amended and optimized in the future. Future studies will carry out multi-center, large-sample investigations to apply and evaluate the effectiveness of the FCS-CHF and further validate and revise the scale. As we move forward, future research can explore the applicability of FCS-CHF in diverse cultural contexts, further validating and adapting the scale to analyze the relationship between patients and their family members in a paired survey to explore the relationship between the two and the factors that influence them, to develop appropriate intervention strategies, and to promote family-centered disease management.

Conclusion

In this study, we successfully developed and validated the Family Coping Scale for Patients with Chronic Heart Failure (FCS-CHF), a new instrument for assessing family coping for patients with CHF. The scale demonstrated strong reliability and validity, making it a valuable tool for evaluating family coping for patients with CHF. It has been

evidenced that family engagement is critical to achieve positive health care outcomes, therefore, healthcare professionals can design family-centered interventions based on their coping by utilizing the results of FCS-CHF assessments to improve the health of patients and their family members.^{48,49}

Data Sharing Statement

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

Ethical Statement

The study was conducted by the Helsinki Declaration and was approved by the First Affiliated Hospital of Kunming Medical University Ethics Committee under Ethics Approval No. 2022-281. Before data collection, written informed consent was obtained from each participant. Our manuscript does not contain data from any individual person, and we state “Not applicable”.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

We declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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