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ORIGINAL RESEARCH

The Translation, Culture-Adaptation and Psychometric Evaluation of the Cardiac Rehabilitation Barriers Scale Among Chinese Older Population

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Purpose: This study aimed to translate and cross-culturally adapt the cardiac rehabilitation barriers scale to the Chinese, and examine its reliability and validity among the older population.

Methods: An approach comprising translation, cultural adaptation, reliability, and validity examination in the Chinese version was conducted in two hospitals in Jilin, China. The *t*-tests were used to compare the sex differences between each item. Participants included Chinese individuals >60 who were eligible for the cardiac rehabilitation program.

Results: In total, 325 participants completed the questionnaire with an average age of 61.23 ± 9.68 years. The item-total correlations were 0.432 to 0.678. Factor analysis of CRBS-C (Kaiser Meyer Olkin = 0.867, Bartlett's test p = 0.000) revealed four factors: logistical factors, comorbidities/functional status, perceived need/healthcare factors, and work/time conflict. The confirmatory factor analysis (CFA) indicated a good model fit ($\chi 2/df = 1.84$, RMSEA = 0.051, CFI = 0.953, TLI = 0.945, SRMR=0.046). Cronbach's alpha was 0.88 for the scale, ranging from 0.801 to 0.88 for each item, which indicates the internal reliability was acceptable.

Conclusion: The Chinese version of the CRRS has acceptable reliability and validity in the Chinese elderly population.

Keywords: cardiac rehabilitation, internal reliability, cross-cultural adaptation, exploratory factor analysis, confirmatory factor analysis

Introduction

Cardiovascular disease is the leading cause of premature death and disability worldwide, especially in China.[1] With the economic and social development and population aging acceleration, the prevalence of CVD in China is increasing. In 2019, there were more than 330 million cases of CVD in China, and 2 out of every 5 deaths from it.[2] Meanwhile, as one of the world's fastest-aging countries, 254 million people in China are more than 60 years old, and this number is projected to reach 402 million by 2040.[3] Accounting for older adults (> 60 years) is expected to lead to higher rates of cardiovascular disease, mortality rate, and readmission rate.[4]

Cardiac rehabilitation (CR) as a multidisciplinary and comprehensive approach that could effectively reduce mortality of cardiac events, has been regarded as a Class Ia recommendation by the American Heart Association (AHA), the American College of Cardiology (ACC), and the European Society of Cardiology (ESC).[5,6] Despite the well-known benefits, CR utilization across the world is still low, ranging from 10% to 50%, especially for the older population.[7,8]

Reasons for CR underuse are identified and involve factors at the patient, provider, and health system levels.[9] In an attempt to improve CR attendance and accessibility, a valid scale was necessary to address potential barriers to be mitigated among Chinese, especially for the older population. The Cardiac Rehabilitation Barriers Scale (CRBS) was developed by Grace et al in Canada which assesses barriers to CR participation and enrolment from patient to health system level.[10] The final version consists of 21 items and was regarded as the most widely administered and comprehensive tool to assess CR barriers.[11,12] It

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was developed following a review of the literature, and revised with input from cardiologists, and CR staff. The original version of the CRBS consists of 21 items, which are composed of four subscales: logistical factors, comorbidities/functional status, perceived need/healthcare factors, and work/time conflict.10 Each item is scored on a 5-point Likert-type scale(1 - strongly disagree to 5 -strongly agree), with higher scores indicating greater barriers to the CR program. To date, it has been translated into 14 languages, including Colombian-Spanish, French, Persian, Brazilian Portuguese, and Korean. Only one simplified Chinese version of CRBS has been published. In that study, most of the samples (95%) were those who did not participate in the CR program.[13]

Therefore, the study aimed to translate and cross-culturally adapt the CBRS into Chinese, and to psychometrically validate the Chinese version in the elderly population.

Methods

Translation and Cross-Cultural Adaptation

Based on the best practices, two bilingual native Chinese speakers, that were fluent in the English language performed the translation process.[14–16]

One of the translators was a cardiologist who had over 10 years of experience in the CR field and who had translated English books. The other translator was an English language PhD proficient in English and Chinese.

The translations were performed independently, and then the two translation versions were reviewed for discrepancies until a consensus was reached. Then, the first translated version underwent backward translation to English by another translator, who did not know about the original version of the scale. The expert panel which was comprised of cardiologists, experts in the CR field, physiatrists, linguists, and CR nurses reviewed the differences between the first version and the back-translated version and developed a preliminary version of the Chinese version of CRBS.

Next, 30 randomly selected volunteers were asked to perform the pretest of the preliminary version. Each subject answered the Chinese version of CRBS, and each item could be selected either “clear” or “not clear”. Some modifications could be made to ensure comprehension.[17] Interviewees were patients diagnosed with coronary heart disease, stable angina, and no severe cognitive impairment.

Participants

Patients were recruited from outpatient CR clinics and cardiology wards in 2 hospitals in Jilin Province, China. From October 2022 to March 2023. Patients ≥60 years old who were eligible for the CR program were included. Exclusion criteria include communication and comprehension deficits; serious visual or cognitive illness, and other conditions that would preclude them from completing the questionnaire.

Procedure

One of the CR nurses familiar with the Chinese version of CRBS administrated the questionnaire in person and collected the data via self-report. Before participation, patients were informed of the significance, objective, and anonymous characteristics of the study. As recommended a sample size of 10 subjects per item for the factor analysis, and the 20% drop-up rate, at least 252 participants were recruited.[18] Sociodemographic information and clinical data were obtained from the electronic medical record.

The Psychometric Properties Test and Statistical Analysis

SPSS V.26 (IBM) and Analysis of Moment Structures (AMOS) 18.0 were used for the statistical analysis. A descriptive statistic was performed of participant characteristics. Categorical variables were described as absolute and relative frequency, and continuous variables were performed using means ± standard deviation. The independent samples *t*-test was used for sex differences in each CRBS item. P value <0.05 was considered significant. We also use Pearson’s correlation coefficient to compare each item score and the total score of the scale, and the r-value less than 0.4 will be deleted.[19]

The content validity of the scale on a 4-point Likert-type scale, ranging from 1 (not at all) to 4 (highly relevant) was evaluated by the expert panel who were involved in the cultural adaptation process, and assessed by the item-level content validity index (I-CVI) and the scale-level content validity index(S-CVI).[20] I-CVI was the ratio of the experts ranking the item for 3 or 4 scores, and the S-CVI was the average value of all the I-CVI scores. As recommended, an I-CVI of more than 0.78 and an S-CVI score of 0.9 or higher were considered satisfactory.[21,22]

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to assess the construct validity of the CRBS. As prerequisites, the Kaiser-Meyer-Olkin (KMO) value>0.6, and $p < 0.05$ for Bartlett's test of sphericity, then the CFA was performed to verify the factorial structure.[23] Factor analysis was performed with the principal components method, with varimax as the rotation method. A scree plot helps identify the number of retained factors.[24]

Consistent with the original scale, the CRBS scale was specified as a 4-factor, 21-item model to assess model fit. The structural equation modeling with a maximum likelihood parameter estimation method was used to generate parameter estimates. Based on previous reports, $1 \leq$ chi-square/df index(χ^2/df)≤ 3, goodness-of-fit index (GFI), comparative fit index (CFI), Tucker–Lewis Index (TLI), and the incremental index of fit(IFI) >0.9, root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR)<0.08 were considered a good model.[25,26]

Cronbach's alpha was used to test the internal consistency, while the value more than 0.6 was considered satisfactory.[27] To evaluate the test–retest reliability, 50 participants were required to readminister the questionnaire again after the first completion with an interval of one week.[28] The Intraclass Correlation Coefficient (ICC) was calculated based on absolute agreement type and two-way mixed effects model, for which more than 0.7 was regarded as good reliability.[27,29]

Internal consistency analysis and test-retest reliability analysis were performed to test the scale's reliability. The EFA was conducted to determine the factor structure within the 21 items, and the item could be loaded if the matrix coefficient was greater than 0.4. The CFA was used to confirm the fitness of the exploratory model.

Results

Translation and Cultural Adaptation

Most of the items were retained with subtle adjustments in several domains consistent with the Chinese cultural background. According to the experts' opinions, the modifications are as follows: Item 20 "it took too long to get referred and into the program" was deleted, and the item "COVID-19".

Sample Characteristics

Among the 325 participants, the ages ranged from 60 to 81 years old (with an average of 61.23±9.68). Of these, 86% of the respondents participated in Urban Employees Basic Medical Insurance (UEBMI), 12% in Urban Resident Basic Medical Insurance (URBMI), and 2% out-of-pocket. Two-thirds of the participants were male (63.5%, n = 206). The proportion of CHD populations was 43.4%. 279(86%) participated in Phase 2 CR, only 5.8% participated in Phase 1 CR, and 8.2% in Phase 3. Other characteristics of the participants are shown in Table 1.

Table 1 Basic Characteristics of the Participants

	All Participants (n=325)	**One-Week Post-Test Participants (n= 50)**
Age, y (M±SD)	61.23±9.68	66.52±5.33
Gender (%)		
Male	206 (63.5%)	37 (74%)
Female	119 (36.5%)	26 (13%)

(*Continued*)

Table 1 (Continued).

	All Participants (n=325)	One-Week Post-Test Participants (n= 50)
Marital status (%)		
Married	319 (98.2%)	47 (94%)
Single	4 (1.2%)	3 (6%)
Widow/er	2 (0.6%)	0 (0)
Healthcare insurance coverage (%)		47 (94%)
UEBMI	279 (86%)	3 (6%)
URBMI	39 (12%)	0 (0)
Out-of-pocket	7 (2%)	34 (68%)
Comorbidities		
CHD	141 (43.4%)	6 (12%)
Diabetes	10 (3.1%)	2 (4%)
Hypertension	58 (17.8%)	2 (4%)
Hyperlipidaemia	12 (3.7%)	0 (0%)
Arrhythmia	26 (8%)	6 (12%)
PCI	75 (23.1%)	0 (0%)
CABG	3 (0.9%)	6 (12%)
Smoking Status		
Non-smoker/former smoker	287 (88.3%)	42 (84%)
Current smoker	38 (11.7%)	8 (16%)
Anxiety/Depression		
Yes	102 (31.9%)	11 (22%)
No	223 (68.1%)	39 (78%)
Phase of CR		
1	19 (5.8%)	2 (4%)
2	280 (86%)	45 (90%)
3	26 (8.2%)	3 (6%)
All-cause readmission		
Yes	48 (14.9%)	11 (22%)
No	277 (85.1%)	39 (78%)
Adverse event		
Yes	5 (1.8%)	1 (2%)
No	320 (98.2%)	49 (98%)

Abbreviations: UEBMI, Urban Employees Basic Medical Insurance; URBMI; Urban Resident Basic Medical Insurance.

Content Validity

The I-CVIs ranged from 0.83 to 1.0, and the S-CVI was 0.94, which represents acceptable content validity (Supplementary Table 1).

Construct Validity

Construct validity was analyzed using EFA. The KMO value was 0.867, and Bartlett's sphericity was χ^2=3327.59 (P=0.000), indicating the appropriateness of factor analysis. Four factors with eigenvalues ≥ 1.0 were extracted, which accounted for 62.937% of the total variance. The four factors are named logistical factors, comorbidities/functional status, perceived need/healthcare factors, and work/time conflict. Table 2 shows the eigenvalues and the each variance explained by the four factors.

Table 2 Exploratory Factor Analysis of CRBS, n=325

Factor Item	Logistical Factors	Comorbidities/ Functional Status	Perceived Need/ Healthcare Factors	Work/Time Conflict
1.Distance	0.727			
2.Cost	0.773			
3.Transportation problems	0.792			
4.Family responsibilities	0.636			
8.Severe weather	0.752			
21.COVID-19	0.692			
13.I do not have the energy		0.827		
9.I find exercise tiring or painful or tiring		0.809		
15.I am too old		0.805		
7.I could exercise at home		0.804		
20.CR team did not contact me		0.657		
14.Other health problems prevent me from going		0.748		
5.I did not know about CR			0.765	
6.I do not need CR			0.785	
16.My cardiologist did not feel it was necessary for me			0.846	
18.I can manage my own problem			0.791	
19.I prefer exercise alone, not in a group			0.735	
11.Time constraints				0.773
10.Travel				0.711
12.Work responsibilities				0.672
17.Many people with heart problems do not go to CR centers, and they are fine				0.75
Variance explained (%)	16.283	30.128	10.294	6.232
Cumulative variance explained (%)	16.283	46.411	56.705	62.937
KMO(p-value)	0.867 (0.000)			

Abbreviation: KMO, Kaiser-Meyer-Olkin.

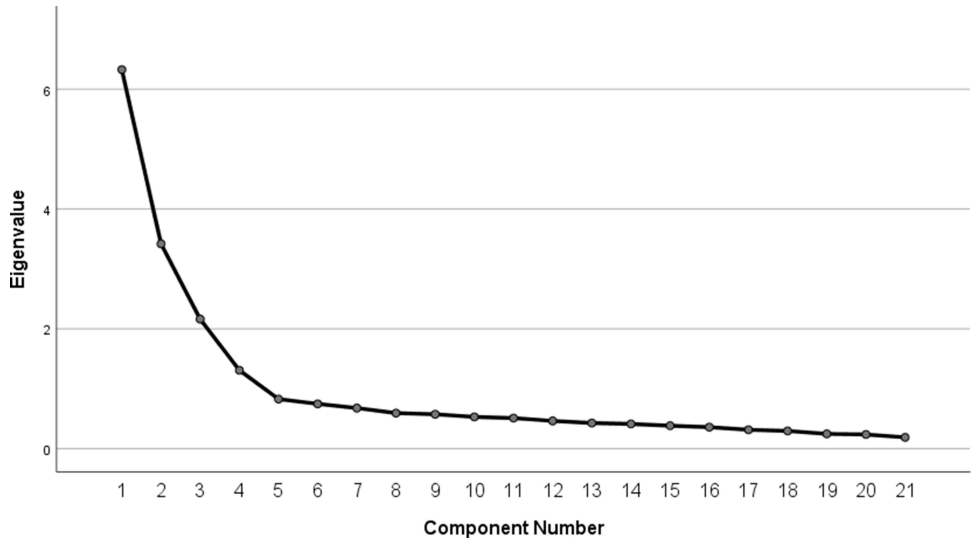

Figure 1 Scree plot.

The scree plot is shown in Figure 1. Further, CFA confirmed the four-factor model. The initial analysis revealed fit indices approaching acceptable levels (GFI = 0.881, CFI = 0.915, TLI = 0.902, RMSEA=0.068, IFI = 0.915). Based on the modification indices (MI) recommendations, the model fit could be improved if the error covariance between items 8 and 11, items 14 and 15, and items 1 and 3 were free to covary. After the modifications, all the fit metrics have reached the recommended level ($\chi 2/df$ =1.84, RMSEA = 0.051, CFI = 0.953, TLI = 0.945, SRMR=0.046), demonstrating that the four-model of the CRBS was acceptable. (Figure 2) (Table 3)

Reliability

Cronbach's alpha value was accepted for each extracted factor (0.801–0.88). Test–retest reliability was also excellent. The ICC value was 0.99 for logistical factors, 0.942 for comorbidities/functional status, 0.894 for perceived need/healthcare factors, and 0.91 for work/time conflict, respectively. (Table 4). The correlations between each item and the total scores ranged from 0.432 to 0.678 ($p<0.01$). (Table 5).

4.5 In this study, the mean CRBS score was 62.92±12.53. There were no differences in scores on each item based on gender (Table 6).

Discussion

The Chinese versions of the CRBS were translated, culture-adapted, and validated in elderly patients who participated in the CR program in mainland China. Through the Delphi process, the original scale was made some adjustments for the cultural adaption. The translated version of CRBS consists of four factors and 21 items and shows accepted internal consistency, reliability, and validity among older populations.

In China, there is no corresponding referral system in the CR center, consider this, the item "it took too long to get referred and into the program" was deleted. Meanwhile, in 2019, the coronavirus disease-2019 (COVID-19) outbreak and pandemic had a significant influence on the CR program. Patients with chronic diseases were encouraged to live and work at home to avoid the potential exposure to COVID-19. The center-based CR programs were closed or suspended, and the expert consensus suggested keeping the safety distance between rehabilitation therapists and patients. As per the previous survey, 49.1% of programs completely stopped CR delivery, while 27.1% stopped for a period due to the coronavirus pandemic.[30] Hence, "COVID-19" as a barrier of CR was added to this version.

The number of items and the factor structure are consistent with the original English version, as well as the Malay, Greek, and Persian versions (logistical factors, comorbidities/functional status, perceived need/healthcare factors, and work/time conflict), and the overall psychometric properties were favorable.[10,31–33] Contrarily, the Brazilian, Turkish,

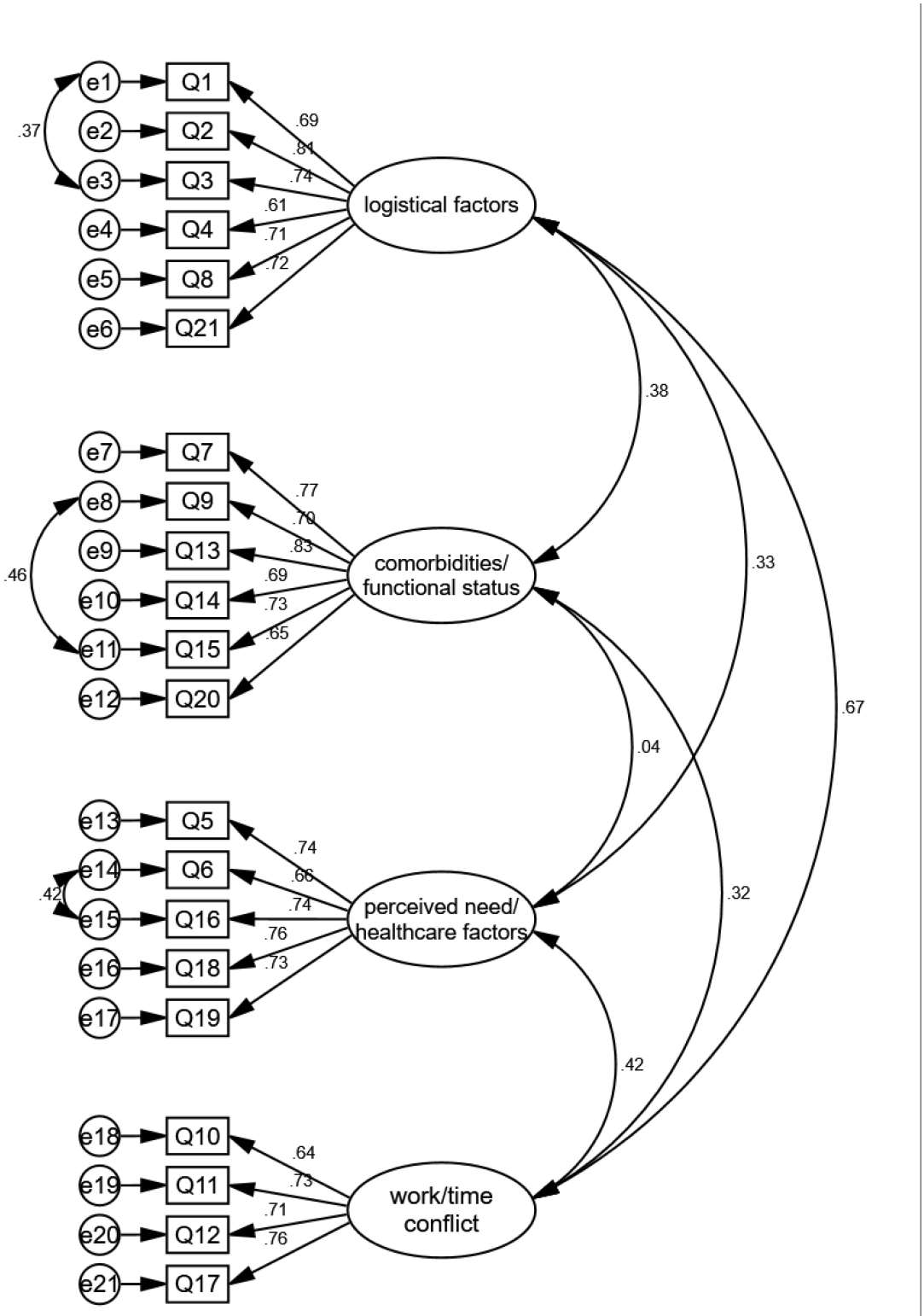

Figure 2 Confirmatory factor analysis model with modifications.

and Mandarin versions identified five factors, and the Korean version revealed six factors, namely: comorbidities/ functional limitations, perceived need, external factors (similar to work/time conflicts), logistical factors, healthcare system factors and already exercising.[13,34–36] However, the items loading on each factor were different when compared

Table 3 Goodness of Fit Indices for the Four-factor Model in the Confirmatory Factor Analysis

	χ^2/df	RMSEA	GFI	SRMR	AGFI	NFI	IFI	TLI	CFI
Criterion	≤3	<0.08	>0.9	<0.08	>0.9	>0.9	>0.9	>0.9	>0.9
Result	1.840	0.051	0.912	0.048	0.888	0.903	0.953	0.945	0.953

Abbreviations: GFI, goodness-of-fit index; AGFI, adjusted goodness–of–fit index; CFI, comparative fit index; TLI, Tucker–Lewis index; IFI, incremental index of fit; RMSEA, root mean square error of approximation; SRMR, Standardized root mean square residual; NFI, normed fit index.

Table 4 Internal Consistency and Reliability of the Cardiac Rehabilitation Barriers Scale

CRBS Item	Alpha	ICC	95% CI	p
Logistical factors	0.866	0.99	0.985–0.993	0000
Comorbidities/functional status	0.858	0.942	0.917–0.96	0.000
Perceived need/healthcare factors	0.88	0.894	0.646–0.953	0.000
Work/time conflict	0.801	0.91	0.753–0.957	0.000
Total	0.88	0.96	0.95–0.97	0.000

Abbreviations: ICC, intraclass correlation coefficient; CI, Confidence Interval.

Table 5 The Item-to-Total Correlation results of the Chinese Version of CRBS

Item	Item-to-Total Correlation	p
Logistical factors		
1.Distance	0.655	0.000
2.Cost	0.678	0.000
3.Transportation problems	0.647	0.000
4.Family responsibilities	0.573	0.000
8.Severe weather	0.603	0.000
21.COVID-19	0.602	0.000
Comorbidities/functional state		
13.I do not have the energy	0.552	0.000
9.I find exercise tiring or painful or tiring	0.491	0.000
15.I am too old	0.520	0.000
7.I could exercise at home	0.492	0.000
20.CR team did not contact me	0.533	0.000
14.Other health problems prevent me from going	0.432	0.000

(*Continued*)

Table 5 (Continued).

Item	Item-to-Total Correlation	p
Perceived need/healthcare factors		
5.I did not know about CR	0.453	0.000
6.I do not need CR	0.446	0.000
16.My cardiologist did not feel it was necessary for me	0.467	0.000
18.I can manage my own problem	0.439	0.000
19.I prefer exercise alone, not in a group	0.488	0.000
Work/time conflict		
11.Time constraints	0.56	0.000
10.Travel	0.513	0.000
12.Work responsibilities	0.615	0.000
17.Many people with heart problems do not go to CR centers, and they are fine	0.620	0.000

Table 6 Sex Difference by CRBS Item

CRBS Item	Total (n=325)	Male (n=207)	Female (n=118)	p
1.Distance	3.66±1.08	3.61±1.1	3.75±1.1	0.262
2.Cost	3.15±1.17	3.11±1.18	3.24±1.16	0.334
3.Transportation problems	3.41±1.16	3.41±1.15	3.43±1.2	0.845
4.Family responsibilities	3.06±1.08	3.05±1.07	3.1±1.11	0.67
8.Severe weather	3.31±1.12	3.29±1.15	3.36±1.08	0.585
21.COVID-19	2.85±1.08	2.86±1.07	2.85±1.12	0.89
13.I do not have the energy	2.96±1.16	3.01±1.16	2.87±1.19	0.294
9.I find exercise tiring or painful or tiring	2.98±1.14	3.01±1.11	2.92±1.19	0.491
15.I am too old	2.93±1.15	2.98±1.09	2.84±1.25	0.319
7.I could exercise at home	2.77±1.13	2.82±1.01	2.69±0.97	0.258
19.I prefer to exercise alone, not in a group	2.89±1.17	2.9±1.19	2.88±1.14	0.843
20.CR team did not contact me	2.75±1.1	2.77±1.07	2.71±1.15	0.605
14.Other health problems prevent me from going	2.57±0.99	2.64±0.99	2.44±0.97	0.071
5.I did not know about CR	3.85±0.97	3.88±0.97	3.78±0.99	0.373
6.I do not need CR	2.74±1.13	2.79±1.13	2.66±1.11	0.315
16.My cardiologist did not feel it was necessary for me	3.31±1.12	3.28±1.14	3.35±1.09	0.585
18.I can manage my own problem	2.76±1.05	2.81±1.05	2.67±1.04	0.254
11.Time constraints	2.95±1.11	2.92±1.1	3±1.12	0.547

(*Continued*)

Table 6 (Continued).

CRBS Item	Total (n=325)	Male (n=207)	Female (n=118)	p
10.Travel	2.63±1.06	2.56±1.04	2.75±1.09	0.116
12.Work responsibilities	2.45±1.04	2.41±1	2.51±1.1	0.4
17.Many people with heart problems do not go to CR centers, and they are fine	2.85±1.09	2.82±1.08	2.92±1.11	0.41
Total mean score	62.92±12.53	62.77±12.63	62.77±12.63	0.882

with the original version. For example, item 17 "many people with heart problems don't go to CR centers, and they are fine" loaded onto the "Work/time conflict" factor, but on the "perceived need/healthcare factors" in the English version, and item 7 "I could exercise at home" and item 20 "CR team did not contact me" loaded onto the "Comorbidities/ functional status" factor, but on the "perceived need/healthcare factors" in the English version. These differences are due to cultural background diversity and population specificity. Overall, the factor structure of the scale is viable.

In this study, one week was applied to establish the test–retest reliability, which was satisfactory for all four subscales. Internal consistency of the scale was established with a Cronbach's alpha value of 0.88. Good internal aggregation was proved by the correlation between each item with the total score (0.432–0.678, P<0.001). Despite the established psychometric properties, the utility of the CRBS in the older population is unknown. To our best known, this is the first reliable and valid study of CRBS among the older population participating in the CR program in China.

The top barriers identified in this study included "I didn't know about CR", "Distance", "Transportation problems", and "My cardiologist didn't feel it was necessary for me", which had also been as main barriers in other studies.[13,32] Certainly, lack of physician endorsement and lack of awareness are well-known barriers to CR. Female and older populations, who could gain the most benefit from CR, usually tend to perceive lower physician endorsement.[37,38] Travel conditions and distances from home to the CR center are also important for patients with chronic diseases, especially for older people. CR in China is still in the process of developing and maturing, and the referral of CR has also been limited by a lack of enough CR centers nationwide in China. Hence, new CR delivery models are urgently needed. One potential approach is home-based cardiac rehabilitation (HBCR), which can be carried out in various methods, including telemedicine and wearable sensors.

Limitation

First, the participants were recruited from Jilin Province, which was located in the northeast of China, the generalizability to people of other regions remained to be established. Secondly, most of the included participants were male, and patients with Urban Employees Basic Medical Insurance, which may have a selection bias. Finally, 86% of the respondents participated in the Phase II CR program, and barriers may be different during different periods. Further research should be conducted to assess barriers between CR attendees and non-attendees.

Conclusion

The translated Chinese version of CRBS consists of 21 items, and four subscales, with good psychometric properties. It showed good reliability (internally consistent, test–retest), content (including face), and construct (including cross-cultural and structural) validity. In the Chinese older population, the key barriers to participation CR program include"I didn't know about CR", "Distance", "Transportation problems", and "My cardiologist didn't feel it was necessary for me". Mitigation strategies could be further applied to increase CR program utilization in China.

Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the Affiliated Hospital of Changchun University of Chinese Medicine (protocol code CCZYFYKYLL2023-164).

Data Sharing Statement

The data presented in this study are available on request from the corresponding author.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Disclosure

The authors declare no conflicts of interest in this work.

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