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ORIGINAL RESEARCH

Development and Validation of the CHD-PEBBS: A Scale to Assess Perceived Exercise Benefits and Barriers in Coronary Heart Disease Patients

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Background: The level of perceived exercise benefits and barriers is one of the key influencing factors of cardiac exercise rehabilitation (CER). There is a lack of validated tools to assess coronary heart disease (CHD) patients' exercise perception.

Purpose: The aim of this study is to develop a scale assessing CHD patients' perceived exercise benefits and barriers (CHD-PEBBS) and test its reliability and validity.

Methods: A total of 205 CHD patients were recruited for a cross-sectional survey. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to extract factors, delete items and evaluate construct validity. The Cronbach's alpha coefficient and test–retest reliability were used to test the reliability of the scale.

Results: Based on the health belief model, this study developed a perceived benefits and barriers framework. CFA showed that the fit indices (such as χ^2/df=2.281, CFI=0.93, RMSEA=0.079) were all acceptable A total of 6 factors were extracted through EFA, with a cumulative variance contribution rate of 75.52%. The perceived benefits subscale included 3 dimensions: "improving physiological indicators", "improving quality of life" and "improving physiological function" with a total of 12 items. The perceived barriers subscale also included 3 dimensions: "lacking of exercise support", "worrying about adverse consequences" and "poor exercise experience or perception" with a total of 10 items. The Cronbach's alpha coefficient of the scale was 0.917, and the test–retest reliability was 0.941.

Conclusion: The CHD-PEBBS shows good reliability and validity, which may be used to evaluate the CER perception level of CHD patients, offering precise targets and pathways for exercise rehabilitation interventions in nursing.

Keywords: barriers, benefits, coronary heart disease, cardiac rehabilitation exercise, scale development

Introduction

Coronary heart disease (CHD) is an ischemic heart disease caused by vascular spasm, luminal stenosis or occlusion due to coronary atherosclerosis. Globally, CHD remains the leading cause of cardiovascular mortality,[1] accounting for approximately 45% of cardiovascular-related deaths and 12% of total global deaths.[2] The mortality of CHD was 126.9/100000 in urban regions and 135.88/100000 in rural regions in China in 2020.[3] If various cardiovascular risk factors still exist, patients undergoing drug therapy or received operation are still at a high risk of recurrence and death,[4] and the disease prolongation brings a heavy burden to individuals, families and healthcare systems.[5,6]

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Cardiac rehabilitation (CR) includes five major prescriptions: medication, exercise, nutrition, psychological and behavioral interventions, smoking cessation and alcohol restriction.[7] As one of a main body of CR,[8] cardiac exercise rehabilitation (CER) can effectively reduce the incidence of acute ischemic coronary events, readmission, medical costs and improve the patients' quality of life,[9,10] which is considered to be the cornerstone of cardiovascular disease prevention and control.[11] CER is also an important component of the entire process management of the cardiovascular disease.[12] CER could effectively increase CHD patients' exercise endurance, improve their coronary artery ischemia symptoms,[13] delay the progression of coronary atherosclerosis, and help them to recover physiological and social functions.[14] Although CER has definite efficacy and high safety, the participation rate of CER in CHD patients is still low.[15,16] Only 40% of patients with cardiovascular disease maintained regular exercise within one year of discharge, and 37% of patients expressed unwillingness to participate in regular exercise.[17] Subjectively, patients with CHD patients have heterogeneity in their exercise perception, resulting in different exercise preferences. Also, after experiencing acute cardiovascular events, patients often worry that CER will be detrimental to maintain heart function, especially worry that exercise may lead to adverse cardiac events recurrence. Objectively, there are differences in accessible cardiac rehabilitation resources and support, and patients' compliance with cardiac rehabilitation is generally low. There they are not willing to attend or even avoid to participate in CER.[18]

Turner and Reed prompted cognitive/perceptive factors were the primary determinants of promoting healthy behavior.[19] Hall et al proposed that the level of exercise perception shed a potent predictive effect on patients' exercise participation behavior.[20] The two determining factors of perception are perceived benefits and perceived barriers to health promotion behavior.[21] Shajrawi et al also confirmed that perceived benefits and barriers of exercise rehabilitation were the key factors affecting CHD patients' exercise rehabilitation behaviors.[22] Keessen conducted semi-structured interview with 16 heart disease patients and concluded that understanding the necessity of exercise rehabilitation could help them adhere to CR.[23] Due to the concerns about the risk of recurrence of heart disease caused by exercise, patients after percutaneous coronary intervention often experience kinesophobia. Kinesophobia is influenced by patients' perception of the benefits, importance, type, duration and volume of exercise.[24] The less knowledge patients have, the lower their exercise rehabilitation compliance. Hence, it can be seen that improving the poor perception of CER in CHD patients is an effective way to improve their compliance of CER. Timely evaluation of the CHD patients' exercise perception can help to clarify the patients' exercise preference and screen the high-risk patients with poor exercise rehabilitation perception, helping to explore the cardiac rehabilitation intervention strategies in cardiac nursing practice, and improve the CER adherence and participation precisely.

Currently, there are no tools available for assessing the perceived benefits/barriers level of exercise among CHD patients. Exercise Benefits/Barriers Scale (EBBS), developed by Sechrist, is used to evaluate the perceived benefits/barriers level of exercise among the general population.[25] The EBBS, though widely used in the general population, does not address CHD-specific concerns such as physiological function indicators related to rehabilitation outcomes, exercise-induced fear of adverse events, or challenges with post-intervention adherence. This study aims to develop and validate the Coronary Heart Disease Patient-Perceived Exercise Benefits and Barriers Scale (CHD-PEBBS), ensuring its reliability and applicability for assessing CER perceptions among CHD patients.

Methods

Design, Sample, and Settings

A cross-sectional study design was conducted in the current study. The sample size should be at least five individuals per item.[26] Therefore, the sample size was at least 125 according to the 25 items in the pre-final version of CHD-PEBBS (listed below). The paper version of the questionnaire was distributed face-to-face. Researchers developed standardized instruction and read them out to patients before the survey, requiring them to provide objective and truthful responses. Researchers explained the purpose and significance of the study to patients and obtain informed consent from the patients themselves and their families. If the patient could only answer the question orally, researchers filled it out on the spot. To minimize interviewer bias, well-trained staff members provided clarifications only upon request, using predefined neutral explanations. This process strictly excluded any guiding or suggestive questions/responses, as well as personal biases.

Demographic Information

General demographic and clinical information: The general condition included age, gender, residence, marital status, educational level, employment status, cardiac function, comorbidity, duration of disease and other clinical information.

Participants

From September to November 2022, CHD patients who were hospitalized in the cardiology department of two affiliated hospitals of Nanchang University were selected using convenience sampling method.

Inclusion criteria: (1) Complies with the diagnostic criteria for CHD in the 2019 European Society for the Diagnosis and Management of Chronic Coronary Syndrome Guidelines;[27] (2) Duration of disease ≥1 year; (3) Clear awareness and normal communication skills. (4) Informed consent and voluntary participation in this study.

Exclusion criteria: (1) Severe chronic diseases such as respiratory failure, chronic liver and kidney failure or malignant tumors. (2) Concomitant mental disorders or cognitive impairments. (3) Grade IV cardiac function (functional status) was classified according to the New York Heart Association (NYHA) classification. Patients with Grade IV cardiac function was considered to be not suitable to attend any physical activity without discomfort.[28] (4) Movement disorders caused by physical disabilities or functional impairments.

Ethical Considerations

Researchers obtain informed consent from the patients themselves and their families. The information obtained from questionnaires was protected. This study complied with the Declaration of Helsinki. Moreover, the 2nd affiliated hospital of Nanchang University's Office of Research Ethics (Nanchang, China) approved the study (1–2,024,040). All methods were performed in accordance with the relevant guidelines and regulations.

Procedure

Development of Original Version Scale

This study constructed a scale based on the health belief model (HBM) theory. As one of the most widely used theory for understanding health behaviors, HBM was initially used to explain the reasons for low participation in disease prevention programs from the motivational and inhibitory factors perspective. Previous studies have used the HBM as a theoretical framework to analyze the motivation (eg, social support) and barriers (eg, kinesiophobia) to attendance in community-based CER for CHD patients.[29] HBM contains perceived susceptibility (perception of individual risk); perceived severity (level of a person considers the condition as serious); perceived benefits (one's judgment on the usefulness of a behavior in weakening risk) and perceived barriers (assessment of the obstacles of adopting a behavior).[30] Given that the HBM theory emphasizes that individuals take corresponding actions by evaluating perceived benefits and barriers, HBM has been used in related research on patient participation in preventive health management. The EBBS scale evaluates the exercise perception level from the dual dimensions of exercise benefits and exercise barriers. Therefore, based on the HBM theory and referring to the content of the EBBS, the CHD-PEBBS was confirmed as a dual dimensional structure of exercise benefits and exercise barriers.

A literature search and patient interview were explored to establish the items pool. CHD patients (n=10) were interviewed conveniently to share their views and experiences regarding perception of exercise benefits and barriers. The interview outline is shown in Supplementary Material 1. The interview data was analyzed by Colaizzi's seven step method.[31]

Then, the original version of the scale was established, including 7 dimensions: "physiological/physical functions", "quality of life", "objective condition", "lack of social support", "poor exercise perception", "psychological factor" and "poor exercise experience" with 48 items totally.

Revised Scale Based on Expert Inquiry and Cognitive Interview

Criteria for expert selection were shown in the Supplementary Material 2. The contents and rating score of the expert inquiry questionnaire were shown in the Supplementary Material 3. Once the expert opinions reached a consensus, the expert inquiry ended. The expert inquiry was evaluated with expert positivity (questionnaire response rate), expert authority (expert authority coefficient) and expert opinion concentration (Kendall harmony coefficient).[32] Items with an average of relevance ≥4.0, a content validity index (CVI) ≥0.78, and a coefficient of variation ≤0.25 would be retained.[33]

After expert inquiry, the pre-final version of CHD-PEBBS was formed, which was divided into two subscales: the exercise benefits subscale and the exercise barriers subscale, with 5 dimensions and a total of 25 items. The exercise benefits subscale included 2 dimensions: "improving physiological/physical function" (items 1, 2, 3, 4, 5, 6, 7, 8) and "improving quality of life" (items 9, 10, 11, 12). The exercise barriers subscale included 3 dimensions: "objective conditions and supports" (items 13, 14, 15, 16, 17, 18), "perception evaluation" (items 19, 20, 21) and "symptom perception" (items 22, 23, 24, 25). The items were scored using the Likert-4 rating system, each item contained 4 options: "strongly agree", "agree", "disagree", and "strongly disagree", corresponding to "4, 3, 2, 1", respectively. The items in exercise barriers subscale were scored in reverse. The higher the total score was, the more positive the exercise perception was, and vice versa, the more negative it was.

A cognitive interview was conducted in order to avoid misunderstandings of the scale content among patients[34] and to improve the readability of the scale. We selected 5 CHD patients of different age, disease duration, marital status and educational levels through purposive sampling, and conducted interview on each item. According to the Williams iterative testing method, we performed several iterations until no new opinions arose and no items required modification. The required time to complete the scale was 10–15 minutes. After cognitive interview, there was no change in the scale structure, only the expression of some items was modified to make it better understood.

Data Analysis

Data analysis was conducted using SPSS 26.0 and AMOS 24.0. Qualitative data were described using frequency and percentage. Quantitative data conformed to be a normal distribution was described using mean±standard deviation. A P-value <0.05 was considered statistically significant.

Validity analysis: we use principle component analysis (PCA) and the varimax rotation method for exploratory factor analysis (EFA) to probe the underlying structure of the items. The Kaiser–Meyer–Olkin (KMO) index of sampling adequacy and Bartlett's test of sphericity co-efficient were carried. The eigenvalue greater than 1 was reserved for factor extraction. Factor loadings >0.40 were considered to be significant.[35] Confirmatory Factor Analysis (CFA) was explored to evaluate the factor structure. To test the model fit, we used several goodness of fit indices: chi-square fit statistics/ degree of freedom (χ^2/df<3, indicating good fit), goodness-of-fit index (GFI>0.85, indicating good fit), normed fix index (NFI>0.80, indicating good fit), relative fit index (RFI>0.80, indicating good fit), incremental fix index (IFI>0.90, indicating good fit), comparative fit index (CFI>0.90, indicating good fit) and root mean squared error of approximation (RMSEA≤0.08, indicating good fit).[36,37]

Reliability analysis: the Cronbach's alpha coefficient was calculated to analyse the internal consistency with the minimally acceptable alpha values of 0.7.[38] Test–retest reliability was assessed using the intraclass correlation co-efficient (ICC) in a sub-sample of 30 randomly selected CHD patients after a 2-week interval, where values >0.70 were considered adequate.[39]

Results

Expert Inquiry results

Three cardiologists, 2 cardiac rehabilitation specialists, 1 psychosomatic physician and 4 clinical nurses participated in the inquiry. The first round of expert inquiry had a response rate of 90%. According to the first round of expert feedback, the revised items were listed in the Supplementary Material 4.

The response rate for the second round of inquiry was 100%. All experts were consistently agreed with the items and had not deleted any item. Only some descriptions had been adjusted. For example, the description "I'm worried that exercise will trigger another heart attack (myocardial infarction)" was revised to "I'm worried that exercise will trigger another heart attack (myocardial infarction or angina)". Also, the expression of all items in the scale was unified by saying "I think. or I lack.".

After two rounds of expert inquiry, the Kendall's coefficient of concordance W (Kendall's W) was 0.309, the coefficient of variation (CV) was 0–0.24 ($P<0.001$), indicating that the coordination of expert opinions was stabilizing, and the expert inquiry is terminated.[40,41] The total scale content validity index (S-CVI) was calculated to be 0.85, and the items content validity indices (I-CVI) were 0.79~1.

Cognitive Interview results

Five CHD patients, including 3 males and 2 females, participated in cognitive interview, and the information reached saturation. The average age was 62.40±10.66 years old; The average disease duration was 3.42±1.21 years. Based on the feedback from cognitive interview, we adjusted the expression of 2 items to make them easier to be understood. (1) The interviewee considered that the statement "exercise is beneficial for controlling high blood pressure" was relatively limited. Therefore, we had changed it into "exercise is beneficial for controlling my blood pressure". (2) The interviewee considered that the statement "I think coronary heart disease patients should not participate in exercise" was incomplete. Thus, we had changed it into "I think coronary heart disease patients should rest more, and not participate in exercise".

After expert inquiry and cognitive interview, the pre-final version of the CHD-PEBBS was formed.

Demographics of CHD Participants

A total of 250 questionnaires were distributed, 238 were collected, and 12 patients withdrew from the study midway. Questionnaires with obvious regular or incomplete answers were excluded. Two hundred five were valid, with an effective rate of 86.1%. Among the participants, there were 134 males (65.37%) and 71 females (34.63%). The age of the participants ranged from 36 to 80 years old, with an average of 66.98±9.20 years old. Patients with other comorbidities, such as hypertension, hyperlipidemia and diabetes, were 81 (39.51%) (see Table 1).

Psychometric Evaluation

Item Analysis

The results of the critical ratio analysis showed that there was no statistically significant difference ($P>0.05$) between items 13 and 14, which were deleted. The differences between the other items were statistically significant ($P<0.05$). The correlation analysis showed that the correlation coefficients r of items 13, 14, and 17 are less than 0.3, showing a low

Table 1 Demographics of CHD Patients (n=205)

Characteristics		n (%)
Marital status	Married(yes)	188(91.71)
Education level	College or above	34(16.59)
	Senior high school or vocational school	27(13.17)
	Junior high school	59(28.78)
	Primary school or below	85(41.46)
Residence	City	170(82.93)
	Countryside	35(17.07)
Employment status	Employed	22(10.73)
	Unemployed	183(89.27)
Duration of disease (years)	≤3	49(23.90)
	>3	156(76.10)
Cardiac function	Grade II	91(44.39)
	Grade III	114(55.61)
Comorbidity	Yes	81(39.51)
	No	124(60.49)

Abbreviation: CHD, Coronary heart disease.

Table 2 Item Analysis

Item	Critical Ratio (*P*)	Correlation Coefficients (r)	Cronbach's Alpha (After Items Deleted)	Note
1	<0.001	0.695	0.898	
2	<0.001	0.649	0.899	
3	<0.001	0.637	0.899	
4	<0.001	0.644	0.899	
5	<0.001	0.599	0.900	
6	<0.001	0.431	0.903	
7	<0.001	0.494	0.902	
8	<0.001	0.453	0.902	
9	<0.001	0.644	0.899	
10	<0.001	0.632	0.899	
11	<0.001	0.675	0.898	
12	<0.001	0.458	0.903	
13	0.797	0.025	0.909	Delete
14	0.157	0.080	0.909	Delete
15	<0.001	0.577	0.900	
16	<0.001	0.550	0.901	
17	0.020	0.183	0.907	Delete
18	<0.001	0.527	0.902	
19	<0.001	0.597	0.900	
20	<0.001	0.570	0.900	
21	<0.001	0.642	0.899	
22	<0.001	0.574	0.900	
23	<0.001	0.757	0.895	
24	<0.001	0.788	0.895	
25	<0.001	0.723	0.896	

correlation; The Cronbach's alpha coefficient of items 13, 14, and 17 were 0.909, 0.909, and 0.907, respectively, which were higher than the Cronbach's alpha coefficient 0.904 of the total scale. Hence, items 13, 14 and 17 were deleted. After deletion, there are 22 items retained in the final version of the scale, and the Cronbach's alpha coefficient had been increased to 0.917 (see Table 2).

Validity Analysis

EFA was explored. The KMO and Bartlett's sphericity tests showed that the data was suitable for factor analysis (KMO=0.866, Chi-square=3503.231, $P<0.001$). Using PCA, 6 common factors with a load value of 0.4 and the eigenvalues greater than 1 were extracted. The cumulative contribution rate was 75.52%. The final version of the scale consists of 6 factors (dimensions) named F1: "improving physiological indicators", including items 1, 2, 3, 4, 6. F5: "improving physiological function", including items 5, 7, 8. F2:"improving quality of life", including items 9, 10, 11, 12. F3: "lack of exercise support", including items 15, 16, 19, 20. F6:"poor exercise experience or perception", including items 18, 21, 22. F4: "worrying about adverse consequences", including items 23, 24, 25. The F1, F2, and F5 are belonging to the exercise benefits perception subscale, and the F3, F4, and F6 are belonging to the exercise barriers perception subscale (see Table 3).

Confirmatory factor analysis: we conducted CFA on the CHD-PEBBS scale by establishing a structural equation. It showed that the χ^2/df was 2.281, and the RMSEA was 0.079, GFI=0.84, NFI=0.88, RFI=0.86, IFI=0.93, CFI=0.93, reflecting the model fit was not very well. Through correction, the χ^2/df was 1.583, and the RMSEA was 0.053, GFI=0.89, NFI=0.92, RFI=0.90, IFI=0.97, CFI=0.97, suggesting good model (see Figure 1).

Table 3 Exploratory Factor Analysis with an Extraction of Six Factors (n=205)

	Item	F1	F2	F3	F4	F5	F6
A1	I think exercise is beneficial for controlling blood pressure	**0.885**	0.096	0.153	0.134	0.210	0.152
A2	I think exercise is beneficial for regulating blood sugar	**0.925**	0.110	0.080	0.145	0.099	0.097
A3	I think exercise is beneficial for regulating blood lipids	**0.920**	0.125	0.049	0.147	0.091	0.099
A4	I think exercise can help maintain stable heart function and reduce readmission	**0.688**	0.194	0.203	0.114	0.218	0.091
A6.	I think exercise can help maintain a normal/ stable weight	**0.555**	−0.072	−0.039	0.234	0.234	0.110
A5	I think exercise can help improve activity endurance	0.315	0.164	0.066	0.150	**0.702**	0.234
A7	I think exercise can improve the immune system and prevent the occurrence of colds	0.216	0.116	0.090	0.086	**0.811**	0.109
A8	I think exercise can promote food digestion and improve appetite	0.162	0.105	0.100	0.007	**0.847**	0.102
B9	I think exercise can help improve negative emotions such as anxiety or depression	0.142	**0.825**	0.080	0.178	0.137	0.174
B10	I think exercise can make you fall asleep faster and sleep longer	0.139	**0.867**	0.147	0.145	0.070	0.086
B11	I think exercise can help improve the quality of life	0.144	**0.841**	0.099	0.213	0.119	0.191
B12	I think I can gain a sense of achievement from doing exercise	−0.022	**0.721**	0.134	0.096	0.072	0.037
C15	I think no one has guided me on how to exercise	0.131	0.144	**0.840**	0.069	−0.002	0.156
C16	I think my family always worries about unexpected situations when I do exercise, they does not encourage me to do it	0.210	0.199	**0.683**	−0.096	−0.056	0.335
D19	I think I am not familiar with exercise methods or intensity	0.016	0.132	**0.787**	0.329	0.196	0.041
D20	I lack understanding of the benefits of exercise	0.042	0.064	**0.820**	0.287	0.178	0.029
D18	I think because I cannot persist in doing exercise, I have decided not to participate in it	0.069	0.061	0.270	0.124	0.218	**0.662**
D21	I think coronary heart disease patients should rest more, and not suitable to participate in exercise	0.292	0.091	0.093	0.255	0.156	**0.744**
E22	I think I do not want to continue doing exercise due to fatigue caused by doing exercise	0.108	0.367	0.088	0.083	0.093	**0.694**
E23	I think that exercise will increase the risk of falls	0.244	0.324	0.199	**0.772**	0.063	0.213
E24	I think exercise will increase my heart rate during/after doing exercise	0.267	0.277	0.280	**0.788**	0.091	0.208
E25	I think exercise may trigger another heart attack (myocardial infarction or angina)	0.313	0.229	0.177	**0.810**	0.109	0.116

Notes: Bold numbers represent the factor loadings of each item under the same factor.

Reliability Analysis

The internal consistency reliability coefficient of the scale was 0.917, the internal consistency reliability coefficient of each factor was 0.707–0.935, and the internal consistency reliability coefficient of each item was 0.895–0.917. The test–retest reliability of the scale was 0.941, and the test–retest reliability of each factor was 0.857–0.938 ($P<0.01$). These indicated the internal consistency reliability is good.

Discussion

This paper aims to develop the CHD-PEBBS and complete psychometric evaluation. To our knowledge, this is the first scale used for evaluating CHD patient-perceived exercise benefits and barriers during CER. The CHD-PEBBS will help to scientifically screen high-risk patients with high tendency of poor exercise rehabilitation behavior and clarify the latent factors of the low adherence and participation of CER, so as to provide evidence for developing precise rehabilitation nursing intervention for CHD patients. By leveraging these insights, targeted cognitive interventions can be designed to address misconceptions, enhance motivation, and ultimately improve patients' adherence to CR programs. The CHD-PEBBS thus bridges the gap between patient perceptions and clinical practice, offering a proactive strategy to optimize rehabilitation outcomes in CHD populations.

The CHD-PEBBS is constructed on the HBM theory and draws inspiration from the benefits/barriers structure of the EBBS, which reflects the dual characteristics of exercise perception evaluation, fully ensuring the rationality of the scale structure.[30,42] The items are further optimized through expert inquiry and cognitive interview. The response rate of the

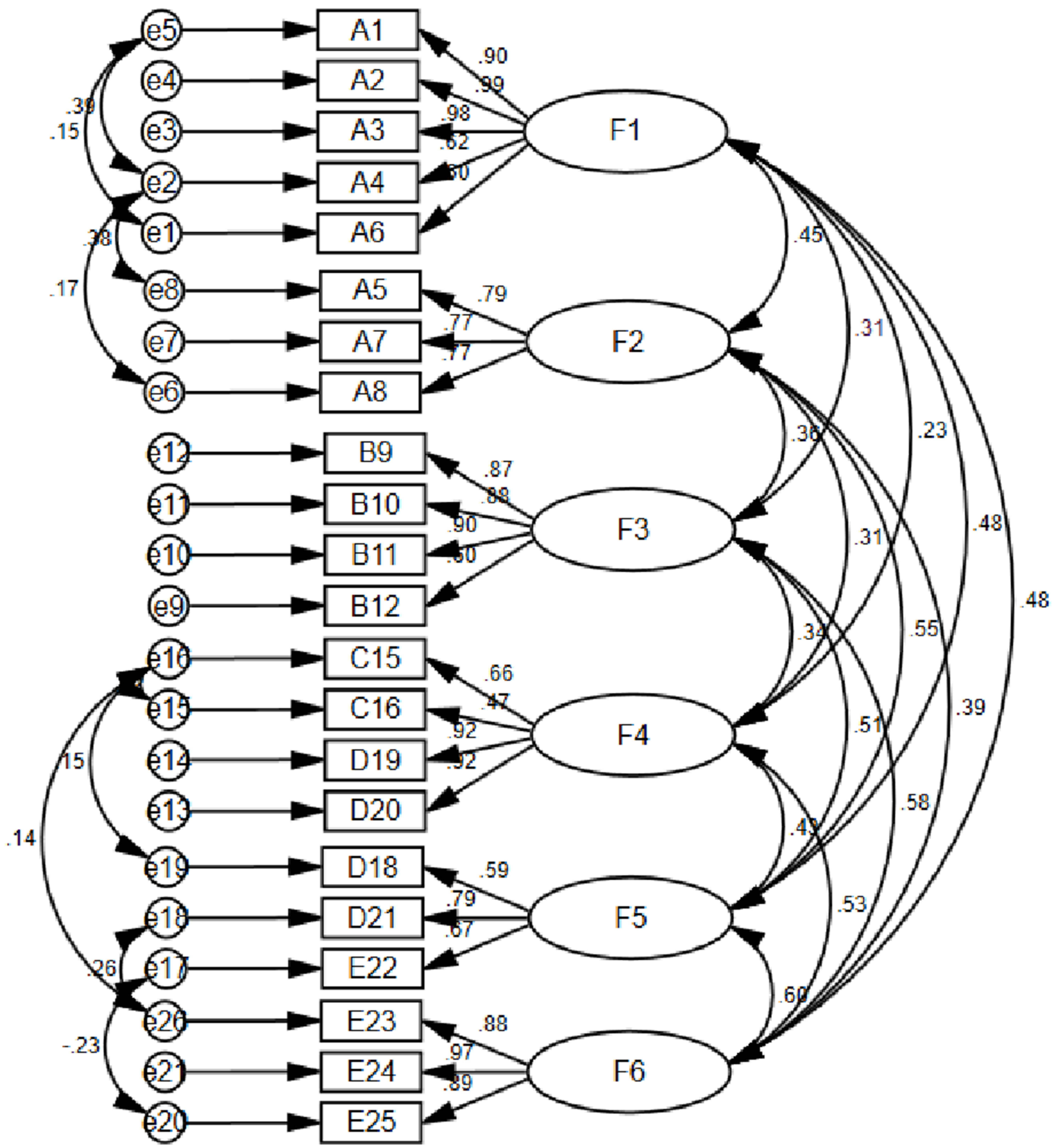

Figure 1 F1, improving physiological indicators. F2, improving physiological function. F3, improving quality of life. F4, lack of exercise support. F5, poor exercise experience or perception. F6, worrying about adverse consequences. A1 to A8, B9 to B12, C15 and C16, D18 to D21, E22 to E25 represent the items of the CHD-PEBBS. e1–20, measurement error.

experts inquiry and the Kendall coefficient indicate high expert positivity and coordination, which reflects reliable inquiry results.[43] The S-CVI and the I-CVI are all >0.78, indicating good content validity.[44] The results of EFA and CFA demonstrate the CHD-PEBBS has acceptable construct validity. The Cronbach's alpha coefficient of total scale and each dimension meet the measurement requirements. The test–retest reliability of the total scale and each dimension indicate good reliability and stability of the scale.[1,45]

The dimension basically conforms to the preset scale structure. The “improving physiological/physical function” dimension in the perceived benefits subscale (pre-final version) is finally divided into two dimensions: one is F1 “improving physiological indicators”, the other is F5 “improving physiological function”. After long-term treatment, CHD patients have developed a deeper understanding of the disease, forming a differentiated perception of physiological indicators and physical functions, which may lead to the separation of these two dimensions.

The item 15 and 16 in the “objective conditions and supports” dimension and the item 19 and 20 in the “perception evaluation” dimension of the perceived barriers subscale (pre-final version) are combined into the F3. The exercise support received by patients affects their perception level of exercise.[45] The lower the exercise support level is, the higher the patient’s exercise barriers perception level is.[46–48] Owing to lacking of exercise support, patients may change their exercise perception.[48] The merged F3 belongs to the perceived exercise barriers, which is named “lack of exercise support”.

The item 22 in the “symptom perception” dimension and the item 18 and 21 in the “perception evaluation” dimension in the perceived barriers subscale (pre-final version) were merged into the F6, named “poor exercise experience and perception”. The patient’s own perception of “fatigue after exercise” tends to be an individualized experience after doing exercise rather than a homogeneous poor feeling.

The CHD-PEBBS is a tool developed for assessing the perceived level of exercise benefits/barriers in CHD patients, which is comprehensive and targeted. On the one hand, the exercise benefits perception subscale of the CHD-PEBBS includes 3 dimensions: “improving physiological indicators”, “improving physiological function” and “improving quality of life”. In EBBS, the exercise benefits perception subscale includes 5 dimensions: “physical performance”, “preventive health”, “psychological state”, “improving quality of life” and “social interaction”. From the content of the items included in each dimension, the “improving physiological indicators” and the “improving physiological function” dimensions in CHD-PEBBS are similar to the “physical performance” and the “preventive health” dimensions in EBBS, respectively. The “physical performance” in the EBBS focuses more on indicators such as muscle strength enhancement and muscular tension improvement, while the CHD-PEBBS focuses more on physiological indicators such as blood pressure, blood sugar and blood lipids, which are closely related to the disease condition of CHD patients, better reflecting the physical function of CHD patients. The universal and more general evaluation item “cardiovascular function improvement” in the EBBS is changed to more targeted expressions: “exercise can help maintain heart function stability and reduce readmission times” in the CHD-PEBBS. Cardiovascular function is a professional term with a broad connotation, which could not effectively assess the CHD patients’ exercise benefits perception of improving heart function. For the CHD population, improving heart function, reducing disease recurrence and readmission are inevitably the focus of their self-management process, becoming their unique needs.[49,50]

The dimension “preventive health” in the EBBS includes items such as “preventing heart attacks”, “preventing hypertension” and “living longer”, all of which are universal items for the general population. In the “improving physiological function” dimension of the CHD-PEBBS, patients pay more attention to activity endurance, low immunity leading to colds, digestion and appetite. During the self-management process, patients are advised to attach importance to observing activity endurance to understand cardiac function, focusing on immunity to reduce colds, avoiding constipation, etc., in order to prevent heart attacks.

The “improving quality of life” dimension in the CHD-PEBBS represents negative emotions, sleep quality and sense of achievement after CER. All these contents almost completely cover the evaluation targets of the “psychological state”, “improving quality of life” and “social interaction” in the EBBS. Quality of life, also known as health-related quality of life, includes physical, psychological, social, responsibility, self-evaluation of health and economic status, etc.[51,52] Quality of life in CHD patients is related to sleep quality.[53,54] Sleep improvement can also help regulate negative emotions and reduce the triggering factors of myocardial infarction.[55]

On the other hand, the exercise barriers subscale of CHD-PEBBS includes 3 dimensions: “lack of exercise support”, “poor exercise experience or perception” and “worry about adverse consequences”. The “lack of exercise support” dimension of the CHD-PEBBS focuses on subjective and objective exercise supports, which mainly covers the “family encouragement” and “exercise facilities” dimensions in the EBBS. The “exercise hardware support” dimension of EBBS were not included in the CHD-PEBBS, which may be correlated to the high accessibility of fitness equipment for community residents in China.[56] The items in the "subjective exercise motivation support" dimension of EBBS, such as "embarrassed to exercise" and "people wearing sportswear look funny", do not appear in the CHD-PEBBS. This may be because the participants recruited in the study were mainly elderly CHD patients, who preferred to pay more attention to the experience and effects of CER rather than the attire and awkwardness associated with exercise.

In terms of time expenditure, as most elderly CHD patients are unemployed, the family and job responsibilities time expenditure may not be the main reason influencing their participation in CER.[57] Therefore, time expenditure did not appear in the CHD-PEBBS.

Focusing on the characteristics of CHD patients and their special needs for exercise guidance-related support,[58] the CHD-PEBBS scale adds corresponding items such as exercise guidance, methods, intensity and benefits. The items in the "poor exercise experience or perception" dimension in the CHD-PEBBS are related to the items in the "exercise intensity" dimension of the EBBS. Acceptable exercise methods and reasonable exercise intensity are beneficial for CHD patients to achieve their exercise goals.[59] The dimension "poor exercise experience and perception" of the CHD-PEBBS reinforces the poor experience and perception of CHD patients during CER, which makes them unwilling to participate in exercise. For example, the experience of fatigue during exercise may lead to quitting from CER. The CHD-PEBBS also focuses on exercise adverse consequences, such as "increase heart rate, the risk of falling and heart attack", which are commonly not paid attention to by the general population. In summary, the CHD-PEBBS basically covers the content of the EBBS. Moreover, the CHD-PEBBS introduces specific evaluation items based on the characteristics of the CHD patients.

This study has several limitations. The participants in this study come from two tertiary hospitals in a geographical region of China. The sample mainly consists of urban patients, with fewer rural patients. Compared with the urban patients, the rural patients may have different exercise perception due to relative limited access to medical information or resources. Also, only inpatients who underwent follow-up visits using convenience sampling method were enrolled, whose condition were generally clinically homogeneous but more severe than that of outpatients. Therefore, there may be a selection bias in this study. In the future, the sample size can be further expanded by selecting different regions and institutions, and expanding the number of CHD patients included in outpatient follow-up visits to further revise and improve the scale. Second, due to the cross-sectional design used in this study, it is not possible to evaluate the longitudinal effectiveness or responsiveness of CHD-PEBBS to changes in exercise perception levels over time. A longitudinal study design is needed to confirm its sensitivity to changes in patient exercise perception. Future research should assess (1) how CHD-PEBBS scores correlate with actual exercise adherence over time; (2) the potential for Digital Adaptation-Integrating CHD-PEBBS into mobile health applications could facilitate remote monitoring and intervention.

Conclusions

This study has successfully developed the CHD-PEBBS. The final version of the scale includes two subscales: the perceived benefits subscale and the perceived barriers subscale, with 5 dimensions and a total of 22 items. The reliability and validity of the scale are acceptable, and it is an effective and practical tool for quickly identifying CHD patients with poor exercise perception. The CHD-PEBBS is simple and convenient to use. It provides reference for implementing personalized cardiac rehabilitation nursing guidance or intervention. The CHD-PEBBS has the potential for digital adaptation, and integrating it into mobile health applications could facilitate remote monitoring and intervention. We recommend this scale to conduct cardiac rehabilitation motivation analysis, compliance analysis and behavioral intervention evaluation for cardiac exercise rehabilitation.

Abbreviations

CHD, coronary heart disease; CHD-PEBBS, coronary heart disease patient perceived exercise benefits/barriers scale; EFA, exploratory factor analysis; CFA, confirmatory factor analysis; CR, cardiac rehabilitation; CER, cardiac exercise rehabilitation; EBBS, exercise benefits/barriers scale; NYHA, New York Heart Association; HBM, health belief model; CVI, content validity index; KMO, Kaiser Meyer Olkin; PCA, principal component analysis; χ^2/df, chi-square fit statistics/degree of freedom; NFI, normed fix index; RFI, relative fit index; CFI, comparative fit index;

RMSEA, root mean squared error of approximation; ICC, intraclass correlation co-efficient; Kendall's W, Kendall's coefficient of concordance W; CV, coefficient of variation; S-CVI, scale content validity index; I-CVI, items content validity indices.

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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. All authors took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and have agreed to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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