A meta-analysis of the efficacy of home cardiac rehabilitation in patients with heart failure

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Introduction. This article systematically evaluates the efficacy of home cardiac rehabilitation (HBCR) in patients with heart failure (CHF).
Methods. The randomized controlled trials of HBCR in patients with heart failure were searched through PubMed, The Cochrane library, EMBASE, Web of science, CNKI, Wanfang Database and VIP Chinese Science and technology journals. The retrieval time was from the establishment of the database to December 2022. According to inclusion and exclusion criteria, literature was screened, data were extracted and methodological quality of included studies was evaluated. HBCR patients were selected as observation group and routine care group as control group. Quality of life, activity endurance and heart function were compared. Meta-analysis was performed using RevMan 5.3 software.
Results. A total of 11 randomized controlled clinical trials at home and abroad were included, involving 3341 patients. The observation group was superior to the control group in the improvement of 6 min walking distance (6MWD), peak oxygen uptake in cardiopulmonary exercise test and left ventricular ejection fraction (all $P < 0.05$), and there was no statistical significance in the improvement of MLHF score between the two groups ($P > 0.05$). Compared with the control group, only the combination of aerobic exercise and impedance exercise could improve 6MWD in the observation group. HBCR could significantly reduce the MLHF score of patients with heart failure, and the difference was statistically significant ($P < 0.01$).
Conclusion. HBCR can improve movement ability, heart function and quality of life in patients with heart failure.

1 INTRODUCTION

Cardiovascular disease is the main cause of death in the world, and the prevalence rate in China has continued to rise in recent years, and the incidence trend is younger [1-2]. Heart failure (HF), referred to as heart failure, is a group of syndroes in which various cardiac structural or functional diseases lead to ventricular filling and/or ejection function impairment, cardiac output can not meet the metabolic needs of body tissues, and pulmonary circulation and/or systemic circulation congestion and organ tissue blood perfusion insufficiency are clinical manifestations. Heart failure has now been defined as a global pandemic, with more than 64 million people affected worldwide, and efforts to reduce its social and economic burden have become a major global public health priority. According to a survey of 15,518 people from 20 cities and rural areas in 10 provinces and cities in China in the "China Cardiovascular Health and Disease Report 2021" [3], the prevalence of chronic heart failure among people aged 35-74 in China in 2000 was 0.9%, so it is conservatively estimated that

there were about 4 million patients with chronic heart failure in China at that time. The prevalence rate of male was slightly higher than that of female (60.8%), which was similar to the results of the epidemiological study of heart failure carried out by Fan Rong, Refukaiti Abduhalic and Chen Kangyu in Xi 'an, Xinjiang and Anhui. A retrospective cross-sectional study investigated 50 million people over 25 years old who participated in the national basic medical insurance for urban workers in 6 provinces in China from 2013 to 2017, and the results showed that the prevalence rate of people over 25 years old in China was 1.18%, so it was estimated that there were about 12.1 million people over 25 years old in China with central force failure [4]. As an important part of secondary prevention of cardiovascular disease, Cardiac rehabilitation (CR) refers to the comprehensive medical measures using drugs, exercise, nutrition, psychopsychological and behavioral intervention, to provide patients with cardiovascular disease in the whole life cycle of biological, psychological and social comprehensive medical intervention and risk control [5]. Although CR started slowly in our country, its development is particularly rapid. In the 1960s, with the gradual maturity of cardiac rehabilitation training for rheumatic heart disease, the cardiac rehabilitation of patients with chronic coronary heart disease also gradually opened, and gradually extended to the cardiac rehabilitation of patients with acute cardiovascular disease. In 2012, the CR five prescriptions proposed by Professor Hu Dayi made China's CR move to a new level. In 2012, the number of hospitals carrying out CR in China was only more than 30. However, in the following five years, more than 400 hospitals carried out CR, an increase of more than 10 times, fully demonstrating that China's cardiovascular experts have formed a new understanding of cardiac rehabilitation. Although CR has been rapidly developed in China in recent years, CR has greatly improved the clinical outcome of HF patients, and has also played a positive impact on improving the quality of life of HF patients and reducing the mortality rate of HF patients. However, the existing traditional cardiac rehabilitation model based on hospitals, outpatient clinics or cardiac rehabilitation centers is limited by time and place, and the participation and compliance of patients are not optimistic [6-7]. The study [8] reported that 30% of European people joined cardiac rehabilitation programs, and 20% to 30% in the United States. However, less than 10% of departments in China have carried out cardiac rehabilitation work, and only 25% to 50% of cardiovascular patients have participated in cardiac rehabilitation programs. Although central CR can provide specific clinical benefits for HF patients, unfortunately, low participation rates and poor dependence have become important obstacles to the implementation of central CR, so a new CR model, family CR, has emerged. In recent years, Home-Based Cardiac Rehabilitation (HBCR) has been gradually applied in the rehabilitation of cardiovascular patients due to its convenience, safety and effectiveness. The emergence of HBCR can significantly improve the participation rate and compliance of CR in the center, but the benefit of HBCR for HF patients has been questioned. The studies [9-10] concluded that home cardiac rehabilitation and the traditional cardiac rehabilitation center model had similar benefits in terms of patient death,

cardiovascular events, exercise endurance, and correctable risk factors, as well as increased participation and adherence in cardiac rehabilitation, playing an important role in improving health outcomes for more cardiovascular patients. Compared with foreign countries, China has a large population base, a large number of cardiovascular diseases, and a serious aging population, resulting in a relative lack of medical resources (lack of a sound referral system for cardiac rehabilitation, the professional capacity of medical personnel for cardiac rehabilitation, and the degree of medical personnel to popularize the knowledge of cardiac rehabilitation to patients). As a result, the problem of poor CR dependence and low participation rate in China is more prominent. HBCR is more flexible and aims to increase the participation of all patients who should have CR. HBCR may be a more appropriate cardiac rehabilitation model in our country. A large number of literatures have confirmed that HBCR can benefit HF patients. The purpose of this study was to investigate the impact of HBCR on HF patients, in order to provide evidence-based evidence for the majority of medical personnel to promote family cardiac rehabilitation and secondary prevention of coronary heart disease.

1 MATERIALS AND METHODS

1.1 Retrieval Strategy

Chinese and English literature published from the establishment of the relevant database to December 2022 were searched, excluding unpublished grey literature. The search takes the way of combining subject words and free words. Search terms include: home-based cardiac rehabilitation、remote cardiac rehabilitation、telerehabilitation、heart failure、cardiac failure, etc.

1.2 References Inclusion and Exclusion Criteria

Inclusion criteria: RCT study comparing and analyzing the effect of HBCR and conventional care on patients with stable heart failure. The diagnostic criteria of included cases were in accordance with the Chinese Guidelines for the Diagnosis and Treatment of Heart Failure 2018 [11]. Exclusion criteria: Duplicate publications; The intervention measures are biased; There is a high degree of bias (such as the test design is not rigorous, the subject information is incomplete, etc.); Full text and raw data are not available.

1.3 Information Extraction and Quality Evaluation

Two researchers independently evaluated the included literature, and when there was disagreement, a third made a decision. The contents of literature data extraction include: first author, publication time, follow-up time, research method, characteristics of research objects, intervention measures, outcome indicators, etc. Finally, a formal information extraction table is formed after the two people reach an agreement. The methodological quality of included studies was evaluated by 2 trained researchers using the Cochrane Handbook for Systemetic Review of Interventions 5.1.0 bias assessment tool. The evaluation included: random allocation method, allocation scheme hiding, blind method, result data integrity, selective result reporting, and other bias. The general characteristics of the included studies are shown in Table

1.

Table 1 General features included in the study

Authors	Time	Country of publication	Number of cases		Baseline LVEF (%)		Interventions for HBCR	HBCR model	Follow-up methods	Recovery time (month)	Outcome index
			Observation group	Control group	Observation group	Control group					
Mckelvie et al.[12]	2002	Canada	91	90	28.2±0.8	27.7±0.9	Aerobic exercise and resistance exercise	Exercise prescription	Unknown	9	①④
Chen et al.[13]	2018	China	35	40	36.0±9.0	32.0±11.0	Aerobic exercise	Combination prescription	Traditional follow-up	3	①②④
Dalal et al.[14]	2019	Britain	92	93	32.8±10.5	32.3±7.4	Aerobic exercise	Exercise prescription	Teaching manual	12	④
O'connor et al.[15]	2009	The United States, Canada and France	1172	1159	24.9±7.4	25.0±7.6	Aerobic exercise	Exercise prescription	Traditional follow-up	30	①②
Oka et al.[16]	2000	The United States	20	20	24.9±8.7	22.3±5.8	Aerobic exercise	Exercise prescription	Traditional follow-up	3	②
Peng et al.[17]	2018	China	49	49	34.0±6.6	34.1±6.7	Aerobic exercise and resistance exercise	Combination prescription	Internet follow-up	2	①③④
Piotrowicz et al.[18]	2015	Poland	77	34	30.0±8.0	34.0±6.0	Aerobic exercise	Exercise prescription	Internet follow-up	2	①②
Safiyari-Hafizi et al.[19]	2016	Canada	20	20	Unknown	Unknown	Aerobic exercise	Exercise prescription	Unknown	3	②

Shi Feifei[20]	2020	China	75	75	41.8±4.8	41.9±4.9	Unknown	Combination prescription	Community follow-up	12	①③
Xu Dexing et al.[21]	2018	China	45	45	35.6±1.5	35.9±1.4	Aerobic exercise	Combination prescription	Traditional follow-up	2	②③
Yang Weiwei et al.[22]	2021	China	30	30	36.0±5.0	36.5±5.9	Aerobic exercise and resistance exercise	Combination prescription	Unknown	Unknown	①③

1.4 Primary outcome measure

(1) Exercise ability was evaluated by 6-minute walk test distance (6MWD) and cardiopulmonary exercise test with peak oxygen uptake (VO_2 peak). (2) Cardiac function was evaluated using left ventricular ejection fraction (LVEF). (3) The quality of life was evaluated using the Minnesota living with heart failure (MLHF) score.

1.5 Subgroup Analysis

(1) According to different follow-up methods, evaluate the advantages and disadvantages of main outcome indicators between traditional follow-up methods (telephone follow-up mainly, face-to-face follow-up as a supplement) and Internet follow-up methods (wechat, QQ and other instant messaging tools or remote interactive courses). (2) According to different exercise modes of HBCR, the main outcome indexes were evaluated between aerobic exercise and aerobic exercise + resistance exercise (including weight-bearing exercise, apparatus exercise or limb exercise, etc.). (3) According to different prescription combinations of HBCR, the main outcome indicators between ≥2 prescription combinations (including exercise prescription, drug prescription, smoking cessation prescription, nutrition prescription and psychological prescription) and exercise prescription were analyzed.

1.6 Statistical Method

Meta-analysis of data was performed using Revman5.3 software. standardized mean difference, MD, or weighted mean difference, WMD, or standardized mean difference, Standardized mean Difference, SMD) is an effect index. The heterogeneity among studies was determined by Q test. When $I^2 \geq 50\%$ and $P<0.1$, subgroup analysis or sensitivity analysis was used to determine the source of heterogeneity, or only descriptive analysis was performed. If heterogeneity could not be eliminated, random effects model was used to combine effect sizes. When $I^2<50\%$ and $P>0.1$, no heterogeneity can be considered and fixed effect model is used for analysis.

2 RESULTS

2.1 Literature Screening Process and Results

At first screening, 208 literatures were obtained. After layer by layer screening, 11 RCT studies were eventually included, with a total of 3341 patients. The literature

screening process and results are shown in Figure 1.

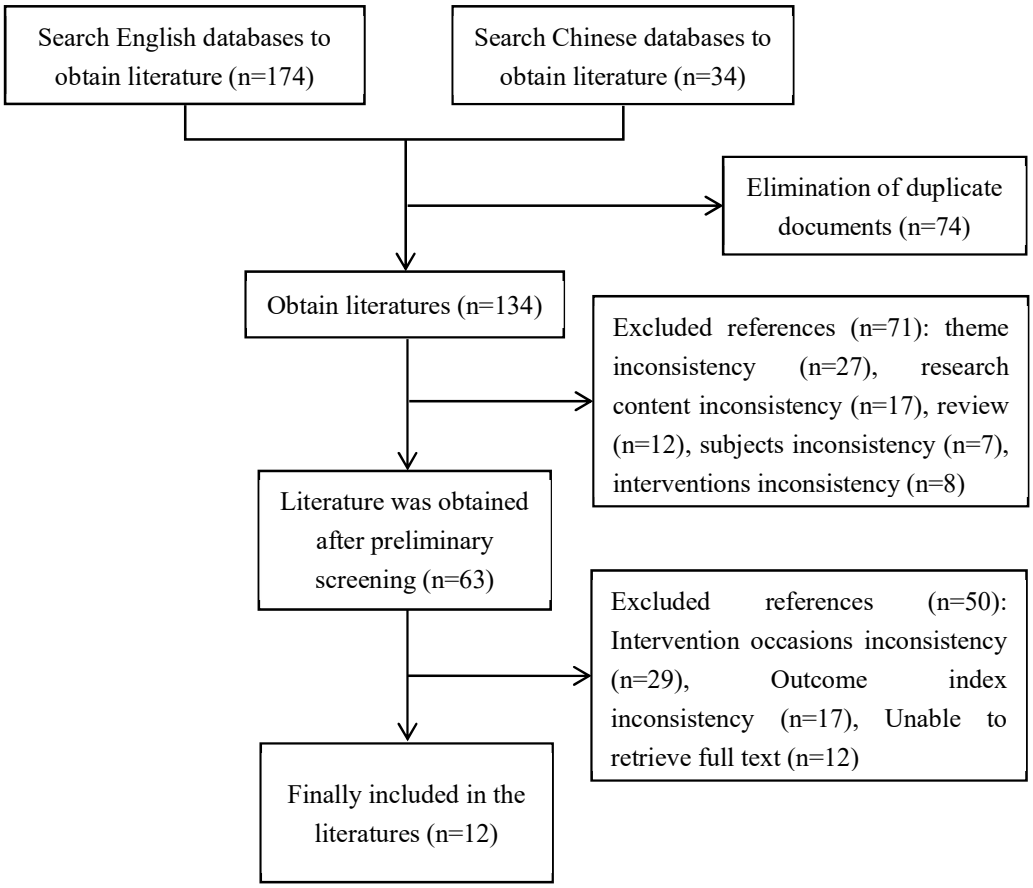


Figure 1 Document screening flow chart

2.2 Quality Evaluation

The results of bias risk assessment for 11 studies are shown in Table 2.

Table 2 Bias risk assessment results from 11 studies

Authors	Time	Random allocation methods	Allocation scheme hiding	Blind methods	Result data integrity	Selective result reporting	Other bias
Mckelvie et al.	2002	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias
Chen et al.	2018	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias
Dalal et al.	2019	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias

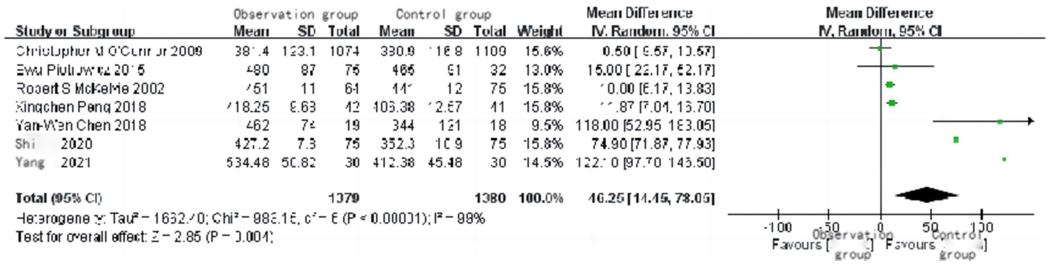
O'connor et al.	2009	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias
Oka et al.	2000	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias
Peng et al.	2018	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias
Piotrowicz et al.	2015	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias
Safiyari-Hafizi et al.	2016	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias
Shi Feifei	2020	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias
Xu Dexing et al.	2018	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias
Yang Weiwei et al.	2021	Low risk of bias	Low risk of bias	Unknown	Low risk of bias	Low risk of bias	Low risk of bias

2.3 Meta-analysis Results

2.3.1 Athletic Ability

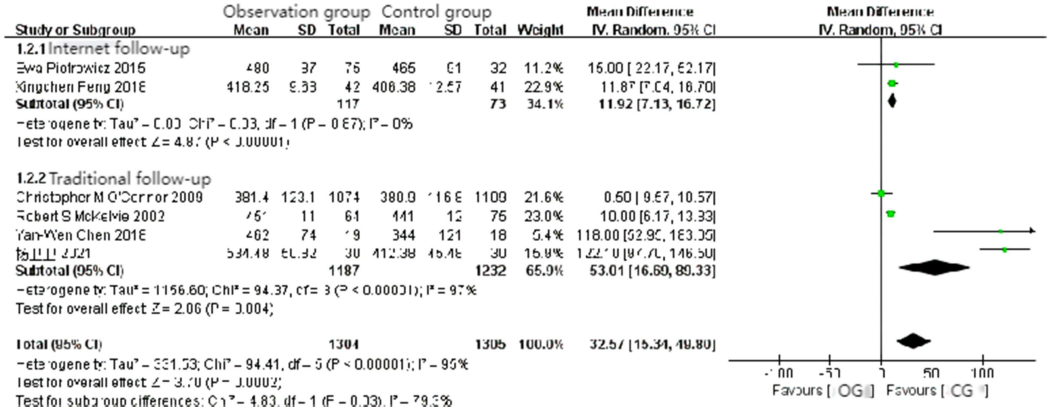
(1) The outcome indicators included a total of 7 studies with 6WMD [12, 13, 15, 17-18, 20, 22], including 2759 patients with $I^2 > 50\%$, using a random effects model. The results showed that 6MWD in the observation group was higher than that in the control group, with statistical significance (MD=46.25, 95%CI: 14.45-78.05, $P < 0.01$), and the results were stable, as shown in Figure 2. (2) Subgroup analysis: Subgroup analysis according to different follow-up methods showed that compared with Internet follow-up (MD=11.92, 95%CI: 7.13-16.73, $P < 0.01$), 6MWD with traditional follow-up improved more significantly, and the difference was statistically significant (MD=53.01, 95%CI: 16.69 ~ 89.34, $P < 0.01$), as shown in Figure 3. Subgroup analysis according to different exercise methods showed that 6MWD in the observation group that chose aerobic exercise + resistance exercise was higher than that in the control group, the difference was statistically significant (MD=40.09, 95%CI: 17.21 ~ 62.96, $P < 0.01$), while there was no statistically significant difference in pure aerobic exercise between the two groups (MD=34.31, 95%CI: -15.70 ~ 84.31, $P > 0.05$), as shown in Figure 4. Subgroup analysis according to different prescription combinations showed that compared with exercise prescription

alone (MD=7.28, 95%CI: 0.30-14.27, P < 0.01), 6MWD of ≥2 prescription combinations increased more significantly, and the difference was statistically significant (MD=77.36, 95%CI: 30.93 ~ 123.79, P < 0.05), as shown in Figure 5. (3) The outcome indicators included a total of 6 studies with VO_2 peak [13, 15-16, 18-19, 21], including 2482 patients with I^2 > 50%, using a random effects model. The results showed that the VO_2peak in the observation group was higher than that in the control group, and the difference was statistically significant (MD=1.19, 95%CI: 0.32-2.06, P < 0.01), as shown in Figure 6.



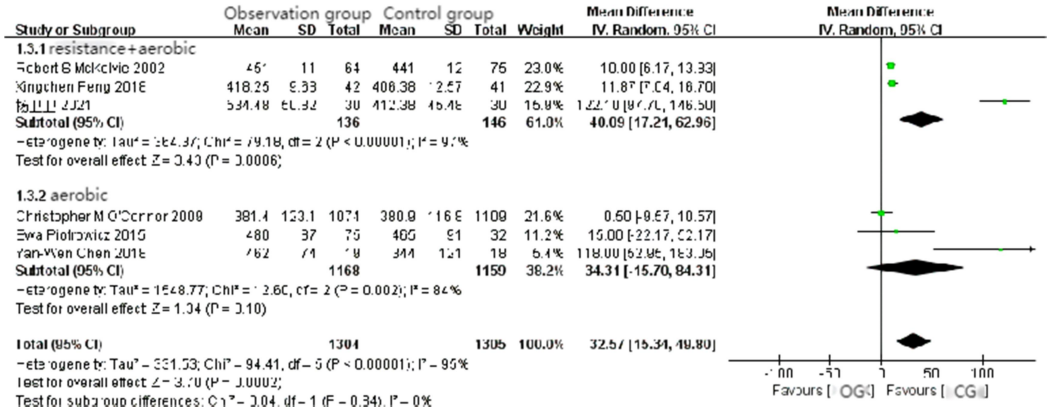
Note: 6MWD is 6 min walking distance

Figure 2 Meta-analysis of 6 MWD comparison between two groups of patients



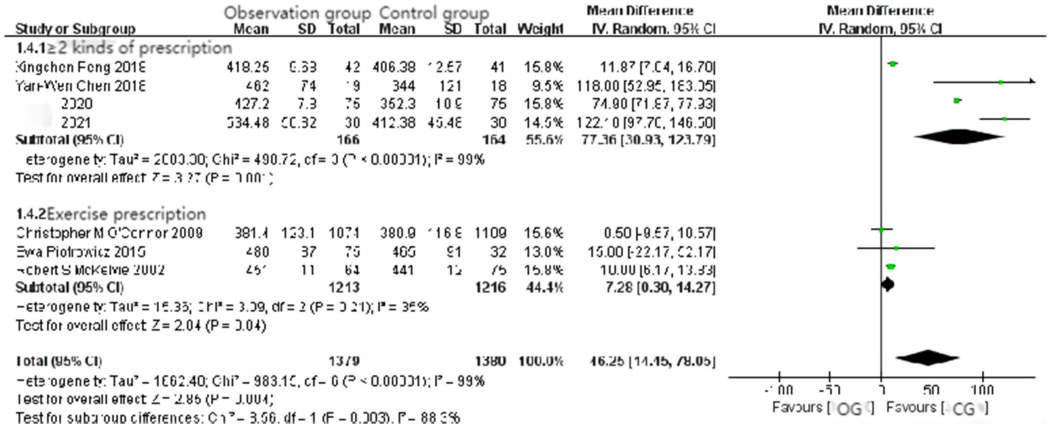
Note: 6MWD is 6 min walking distance

Figure 3 Meta-subgroup analysis of 6MWD between two groups of patients with different follow-up modalities



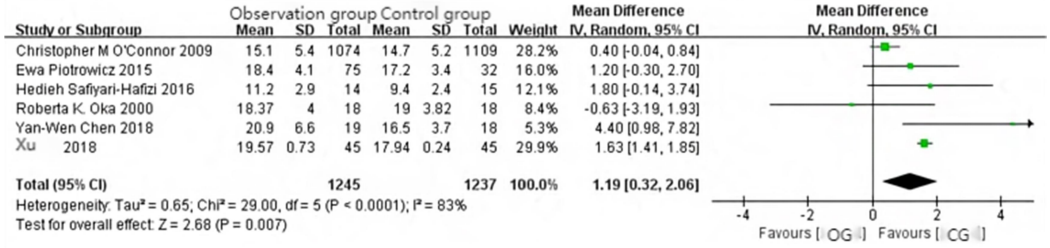
Note: 6MWD is 6 min walking distance

Figure 4 Meta subgroup analysis of 6 MWD between two groups of patients with different exercise modes



Note: 6MWD is 6 min walking distance

Figure 5 Meta subgroup analysis of 6MWD between two groups of patients with different prescription combinations



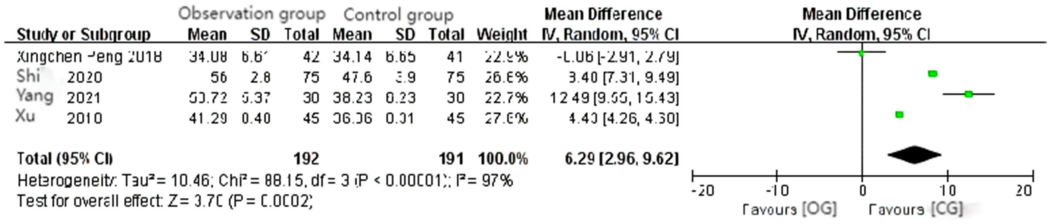
Note: VO_2 peak is the peak oxygen uptake

Figure 6 Meta-analysis comparing VO_2 peak between two groups

2.3.2 Cardiac function

Outcome indicators included LVEF in 4 studies [17, 20-22], including 383 patients with $I^2 > 50\%$, using a random effects model. The results showed that LVEF in the

observation group was higher than that in the control group, with statistical significance (MD=6.29, 95%CI: 2.96-9.62, P < 0.01), and the results were stable, as shown in Figure 7.

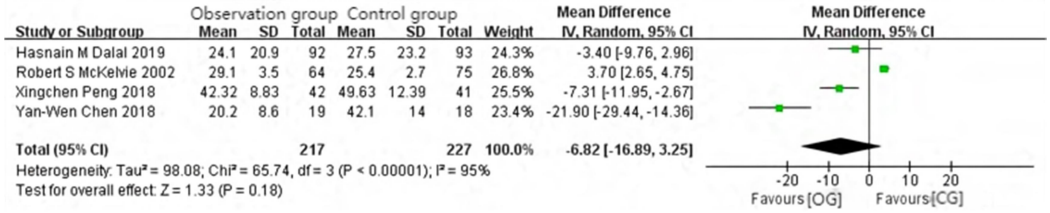


Note: LEVF is left ventricular ejection fraction

Figure 7 Meta-analysis of LVEF comparison between two groups of patients

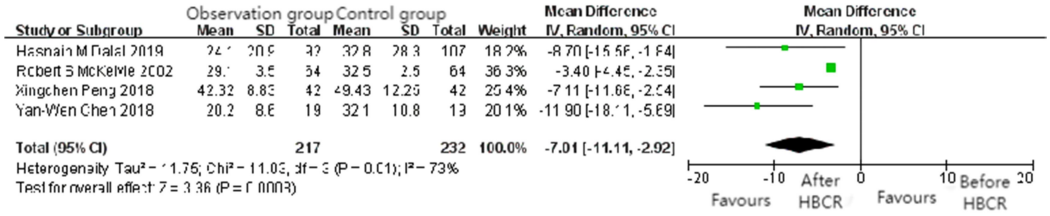
2.3.3 Living quality

Outcome indicators included MLHF score in 4 studies [12, 13-14, 17], including 444 patients with I^2 > 50%, using random effects model. The results showed that there was no significant difference in MLHF scores between the observation group and the control group (MD=-6.82, 95%CI: -16.89-3.52, P > 0.05), as shown in Figure 8. The results of the observation group before and after rehabilitation showed that I^2 was > 50%, and the random effects model was adopted. HBCR could reduce MLHF scores in patients with heart failure, and the difference was statistically significant (MD=-7.01, 95%CI: -11.11 ~ -2.92, P < 0.01), and the results were stable, as shown in Figure 9.



Note: MLHF is the Minnesota Heart Failure Quality of Life Scale

Figure 8 Meta-analysis of MLHF score comparison between two groups



Note: MLHF is the Minnesota Heart Failure Quality of Life Scale

Figure 9 Meta-analysis of MLHF scores before and after rehabilitation in observation group

3 DISCUSSION

The main outcome indicators used in this study were 6MWD and VO2 peak

quantitative evaluation of exercise ability, LVEF evaluation of cardiac function, and MLHF score to reflect quality of life. This study mainly analyzed the effectiveness of HBCR in patients with heart failure and the ways in which cardiac rehabilitation is more effective. As for the results of HBCR, consistent with the results of this study, Zwisler et al. [23] included 19 RCT studies, a total of 1,290 patients with heart failure, and selected HBCR patients as the observation group and CBCR or conventional care as the control group. The results showed that the VO_2 peak increased significantly in the observation group, but the MLHF score did not change significantly. A meta-analysis reported by Long et al. [24] found that a total of 44 RCT studies involving 5,783 patients with heart failure were included, with exercise rehabilitation as the observation group and conventional care as the control group. The results showed that exercise rehabilitation could significantly reduce the MLHF score of patients, which was different from the results of this study. Among the 11 studies in this study, 7 studies could not clearly measure risk, that is, it was uncertain whether the analyst knew the grouping of subjects, which would affect the results of the study to a certain extent and might bias the outcome indicators. However, through sensitivity analysis, the results of the included studies in this study were stable. Therefore, there is no case that the deviation of the results of one article will affect the overall results.

6MWD is often used as a predictor of mortality and hospitalization rate of patients with heart failure, and can sensitively reflect the clinical prognosis of patients with heart failure [25]. In this study, 6MWD was used as the main outcome index for subgroup analysis. Subgroup analysis showed that traditional follow-up provided more clinical benefits than Internet follow-up, which may be related to the advantages of traditional follow-up such as certainty, controllability, and adequate interaction. In the subgroup analysis of exercise modes of HBCR, it is recommended to combine aerobic exercise with resistance exercise in exercise rehabilitation. Muscle atrophy is one of the main causes of exercise intolerance and low ventilation efficiency in patients with heart failure, which is easy to promote the aggravation of clinical symptoms and the decline of quality of life, and is associated with the increase of patients' re-hospitalization rate, the extension of hospital stay and the deterioration of clinical prognosis [26].

In cardiac rehabilitation, it is especially necessary to pay attention to the combined effect of the five major prescriptions (exercise prescription, drug prescription, smoking cessation prescription, nutrition prescription and psychological prescription). Unreasonable diet, insufficient physical activity and excessive emotional stress can easily cause inflammation, oxidative stress and sympathetic overexcitation, exacerbate obesity, further induce or aggravate hypertension, diabetes, dyslipidemia and sleep-disbreathing, which lead to left ventricular remodeling, atherosclerosis and ultimately heart failure. However, healthy diet, physical exercise and psychological support can delay these pathological processes [27]. Compared with a single prescription, the combination of reasonable diet under the guidance of nutrition prescription and exercise rehabilitation under the guidance of exercise

prescription can significantly improve the exercise ability of patients [28]. At the same time, anxiety, depression and other emotions of patients with heart failure are also related to adverse outcomes of patients, which can lead to reduced treatment compliance, increased hospitalization rate and increased mortality [29]. HBCR can be implemented through the organic combination of five major prescriptions to correct the adverse lifestyle of patients with heart failure as a whole, improve peripheral blood circulation and endothelial function, improve skeletal muscle oxidative metabolism, enhance skeletal muscle tolerance and function, reduce cardiac load, and thus improve left ventricular function and increase exercise endurance [30].

For the daily management of patients with heart failure, more attention should be paid to the improvement of patients' quality of life. In this study, MLHF scale was used as the main outcome index. Although the observation group could not significantly change the MLHF score of patients with heart failure compared with the control group, HBCR could reduce the MLHF score of patients with heart failure before and after. Long et al. [24] conducted a meta-analysis of 26 RCT studies with a total of 3,833 patients, using a combination of various scales as the main outcome indicator, and found that 12-month cardiac rehabilitation could significantly improve the quality of life score of patients with heart failure. HBCR may reduce stress or anxiety, improve physical activity rhythm, improve exercise ability and sleep quality, etc. [21]. Although this study is based on the meta-analysis of previous RCT studies, there are certain defects, such as the heterogeneity of HBCR model selected in the original literature, the relatively short intervention and follow-up time of patients in the observation group, and the lack of data on the readmission rate, mortality rate and cardiovascular end-point event rate of patients in the observation group. However, HBCR can still bring clinical benefits to patients with heart failure [31] and can effectively save family and social medical expenses. Data show that HBCR can not only save about US $6163.7 per patient per year in medical costs [32], but also improve the prevalence of cardiac rehabilitation, patient compliance and satisfaction [33]. In view of HBCR's incomparable advantages over CBCR, this study believes that HBCR has broad clinical application prospects.

In summary, HBCR can significantly improve patients' exercise endurance, improve heart function and improve quality of life in patients with heart failure, and is worthy of clinical promotion and application.

REFERENCES

[1] Hu Shengshou, Wang Zengwu.Overview of China Cardiovascular Health and Disease Report 2022[J].Chinese Journal of Cardiovascular Review,2023,21(07):577-600.

[2] Nagata JM, Vittinghoff E, Gabriel KP, et al. Physical activity from young adulthood to middle age and premature cardiovascular disease events: a 30-year population-based cohort study[J]. Int J Behav Nutr Phys Act, 2022, 19(1):123.

[3] Mao Yiheng, Su Min, Yuan Peng. Comparison of efficacy and safety of different intensity exercise rehabilitation training in patients with chronic heart failure [J]. Chinese Journal of Rehabilitation, 2020, 35 (01): 7-11.

[4] Interpretation of Key Points in the Chinese Cardiovascular Health and Disease Report 2022 [J]. Chinese Journal of Cardiovascular Medicine, 2023, 28 (04): 297-312.

[5] Zhang Jian, Zhang Yuhui, Zhou Lei. National Heart Failure Guidelines 2023 (Lite)[J]. Chinese Circulation Journal, 2023, 38 (12): 1207-1238.

[6] Huang Ping, Shen Qianqian, Zhu Meihong et al. Application of planned behavior theory in home remote cardiac rehabilitation of patients with chronic heart failure [J]. Chinese Journal of Rehabilitation Medicine, 2022, 37 (10): 1395-1399.

[7] Su JJ, Yu DSF, Paguio JT. Effect of eHealth cardiac rehabilitation on health outcomes of coronary heart disease patients: A systematic review and meta-analysis[J]. Journal of Advanced Nursing,2020,76(3):754-772.

[8] Liu Xinrui, Li Zhengzheng, Fan Xiaoyu.Effect of home self-directed cardiac exercise rehabilitation after PCI and its effect on cardiopulmonary reserve function[J].Chinese Journal of Evidence-Based Cardiovascular Medicine,2023,15(12):1346-1349.

[9] Fang J, Huang B, Xu D, Li J, Au WW. Innovative Application of a Home-Based and Remote Sensing Cardiac Rehabilitation Protocol in Chinese Patients After Percutaneous Coronary Intervention[J]. Telemed J E Health,2019,25(4):288-293.

[10] Noites A, Freitas CP, Pinto J, et al. Effects of a Phase IV Home-Based Cardiac Rehabilitation Program on Cardiorespiratory Fitness and Physical Activity[J].2017,26(5):455-462.

[11] [Chinese guidelines for the diagnosis and treatment of heart failure 2018]. [J]. Zhonghua xin xue guan bing za zhi, 2018, 46 (10): 760-789.

[12] McKelvie RS, Teo KK, Roberts R, et al. Effects of exercise training in patients with heart failure: the Exercise Rehabilitation Trial (EXERT)[J].Am Heart J. 2002;144(1):23-30. doi:10.1067/mhj.2002.123310

[13] Chen Y W , Wang C Y , Lai Y H ,et al.Home-based cardiac rehabilitation improves quality of life, aerobic capacity, and readmission rates in patients with chronic heart failure[J].Medicine, 2018, 97(4):e9629.DOI:10.1097/MD.0000000000009629.

[14] Dalal HM, Taylor RS, Jolly K, et al. The effects and costs of home-based rehabilitation for heart failure with reduced ejection fraction: The REACH-HF multicentre randomized controlled trial [published correction appears in Eur J Prev Cardiol. 2020 Dec;27(18):NP17][J]. Eur J Prev Cardiol. 2019;26(3):262-272. doi:10.1177/2047487318806358

[15] O'Connor CM, Whellan DJ, Lee KL, et al. Efficacy and safety of exercise training in patients with chronic heart failure: HF-ACTION randomized controlled trial[J].JAMA,2009,301(14):1439-1450.DOI:10.1001/jama.2009.454.

[16] Oka RK, De Marco T, Haskell WL, et al. Impact of a home-based walking and resistance training program on quality of life in patients with heart failure[J]. Am J Cardiol. 2000;85(3):365-369. doi:10.1016/s0002-9149(99)00748-1

[17] Peng X, Su Y, Hu Z, et al. Home-based telehealth exercise training program in Chinese patients with heart failure: A randomized controlled trial. Medicine (Baltimore)[J]. 2018;97(35):e12069. doi:10.1097/MD.0000000000012069

[18] Piotrowicz E, Zieliński T, Bodalski R, et al. Home-based telemonitored Nordic walking training is well accepted, safe, effective and has high adherence among heart failure patients, including those with cardiovascular implantable electronic devices: a randomised controlled study[J]. Eur J Prev Cardiol. 2015;22(11):1368-1377. doi:10.1177/2047487314551537

[19] Safiyari-Hafizi H, Taunton J, Ignaszewski A, Warburton DE. The Health Benefits of a 12-Week Home-Based Interval Training Cardiac Rehabilitation Program in Patients With Heart Failure[J]. Can J Cardiol. 2016;32(4):561-567. doi:10.1016/j.cjca.2016.01.031

[20] Shi Feifei. Clinical study of continuous nursing management model of cardiac rehabilitation in patients with heart failure in tertiary hospital, community and home [J]. Digest World Latest Med Inf , 2019, 19 (65): 298+300. DOI:10.19613/j.cnki.1671-3141.2019.65.180.

[21] Xu Dexing, Dai Ruozhu, Zeng Weijun et al. Application effect analysis of home self-help cardiac rehabilitation training in patients with chronic stable left heart failure [J]. Chinese modern doctor, 2018, 56 (34): 104-106.

[22] Yang Weiwei, Shen Wenlin, Zhang Min. Effect of family cardiac rehabilitation program with exercise as the core on patients with chronic heart failure [J]. Clinical Medicine, 2021, 41 (03): 77-79. DOI:10.19528/j.issn.1003-3548.2021.03.033.

[23] Zwisler AD, Norton RJ, Dean SG, et al. Home-based cardiac rehabilitation for people with heart failure: A systematic review and meta-analysis[J]. Int J Cardiol. 2016;221:963-969. doi:10.1016/j.ijcard.2016.06.207

[24] Long L, Mordi IR, Bridges C, et al. Exercise-based cardiac rehabilitation for adults with heart failure[J]. Cochrane Database Syst Rev. 2019;1(1):CD003331. Published 2019 Jan 29. doi:10.1002/14651858.CD003331.pub5

[25] Ingle L, Cleland JG, Clark AL. The relation between repeated 6-minute walk test performance and outcome in patients with chronic heart failure[J]. Ann Phys Rehabil Med. 2014;57(4):244-253. doi:10.1016/j.rehab.2014.03.004

[26] Lena A, Anker MS, Springer J. Muscle Wasting and Sarcopenia in Heart Failure-The Current State of Science[J]. Int J Mol Sci. 2020;21(18):6549. Published 2020 Sep 8. doi:10.3390/ijms21186549

[27] Aggarwal M, Bozkurt B, Panjrath G, et al. Lifestyle Modifications for Preventing and Treating Heart Failure[J]. J Am Coll Cardiol. 2018;72(19):2391-2405. doi:10.1016/j.jacc.2018.08.2160

[28] Kitzman DW, Brubaker P, Morgan T, et al. Effect of Caloric Restriction or Aerobic Exercise Training on Peak Oxygen Consumption and Quality of Life in Obese Older Patients With Heart Failure With Preserved Ejection Fraction: A Randomized Clinical Trial[J]. JAMA. 2016;315(1):36-46. doi:10.1001/jama.2015.17346

[29] Celano CM, Villegas AC, Albanese AM, Gaggin HK, Huffman JC. Depression and Anxiety in Heart Failure: A Review[J]. Harv Rev Psychiatry. 2018;26(4):175-184. doi:10.1097/HRP.0000000000000162

[30] Carubelli V, Castrini AI, Lazzarini V, Gheorghiade M, Metra M, Lombardi C. Amino acids and derivatives, a new treatment of chronic heart failure?[J]. Heart Fail Rev. 2015;20(1):39-51. doi:10.1007/s10741-014-9436-9

[31] Anderson L, Sharp GA, Norton RJ, et al. Home-based versus centre-based cardiac rehabilitation[J]. Cochrane Database Syst Rev. 2017;6(6):CD007130. Published 2017 Jun 30. doi:10.1002/14651858.CD007130.pub4

[32] Taylor RS, Watt A, Dalal HM, et al. Home-based cardiac rehabilitation versus hospital-based rehabilitation: a cost effectiveness analysis[J]. Int J Cardiol. 2007;119(2):196-201. doi:10.1016/j.ijcard.2006.07.218

[33] Subedi N, Rawstorn JC, Gao L, Koorts H, Maddison R. Implementation of Telerehabilitation Interventions for the Self-Management of Cardiovascular Disease: Systematic Review[J]. JMIR

Mhealth Uhealth. 2020;8(11):e17957. Published 2020 Nov 27. doi:10.2196/17957

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