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Effect of Home-based Cardiac Rehabilitation for Patients with Heart Failure: A Systematic Review and Meta-Analysis

Rehabilitación para Pacientes con Insuficiencia Cardíaca: Una Revisión Sistemática y Metanálisis

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SUMMARY: This study is to investigate the effect of home-based cardiac rehabilitation (HBCR) on quality of life, functional capacity, and readmission rates in patients with heart failure. Randomized controlled trials (RCTs) were screened from Cochrane Library, CINAHL, EMBASE, and MEDLINE. The intervention group received a standardized HBCR or a comprehensive rehabilitation strategy that included HBCR. The participants in the control group received CR at a medical center or usual care without CR intervention. The main outcome measurements included quality of life, exercise capacity, mortality and re-hospitalization. This meta-analysis included 20 RCTs, in which 16 studies compared HBCR with usual care, and 4 studies compared HBCR with center-based CR. In comparison with the usual care, HBCR improved the total quality of life score [MD=-5.85, 95 % CI (-9.76, -1.94), P=0.003, I2=75 %]. Patients with HBCR and usual care were significantly different in VO_2max [MD=1.05 mL/kg/min, 95 % CI (0.35, 1.75), P=0.003, I2=46 %]. However, VO_2max of patients with HBCR was not significantly different from those with center-based CR [MD=0.08 mL/kg/min, 95 % CI (-1.29, 1.44), P=0.91, I2=0 %]. There was statistically significant difference in the 6-min Walk Distance between usual care and HBCR (for distance [MD=11.84, 95 % CI (7.41, 16.28), P<0.00001, I2=0 %]; and for feet [MD=98.93, 95 % CI (26.79, 171.08), P=0.007, I2=56 %]). However, there was no significant difference in 6-min Walk Distance between patients with HBCR and center-based CR [MD=12.45, 95 % CI (-9.81, 34.72), P=0.27, I2=0 %] , or in anxiety and depression between patients with usual care and HBCR (for anxiety, [MD=-0.25, 95 % CI (-0.56, 0.05), P=0.11, I2=0 %]; for depression, [MD=-0.18, 95 % CI (-0.51, 0.16), P=0.30, I2=0 %] . No significant difference was found in death number [RR=1.04, 95 % CI (0.55, 1.98), P=0.90, I2=0 %] or in the number of re-hospitalization [RR=0.88, 95 % CI (0.66, 1.18), P=0.40, I2=0 %] between usual care and HBCR. For patients with heart failure, compare with usual care and center-based CR, HBCR can improve the total quality of life. Compare with usual care, HBCR can improve VO2max and 6-min Walk Distance, but compare with center-based CR, there are no differences in mortality, re-hospitalization rate or incidence of anxiety and depression. Additionally, center-based CR and HBCR showed similar outcomes and medical costs.

KEY WORDS: Heart failure; Exercise training; Meta-analysis; Cardiac rehabilitation; Systematic review.

INTRODUCTION

Heart failure (HF) is a disease with high mortality (Global Burden of Disease Study 2013 Collaborators, 2015). It is estimated that more than 23 % of HF re-hospitalization occurs within 60 to 90 days after discharge, and less than 50 % of patients with HF will survive for more than 5 years (Chriss *et al*., 2004; Jackevicius *et al*., 2015; Mozaffarian *et al*., 2015). The enormous medical costs of HF place a heavy financial burden on the patients' family and health care system. It is reported that some of the symptoms of HF, including fatigue and difficulty in

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breathing during exercise, make the daily activities of patients with HF unbearable (Fini & de Almeida Lopes Monteiro da Cruz, 2009). In addition, aggravation of HF can lead to depression, anxiety and a decline in the quality of life of patients (Hooley *et al*., 2005; Rutledge *et al*., 2006; Shimizu *et al*., 2014). The results of many clinical trials have confirmed the benefits of center-based rehabilitation for patients with HF (Maiorana *et al*., 2000; Selig *et al*., 2004; O'Connor *et al*., 2009). The goal of treatment for HF is to avoid any exacerbations, improve HRQoL (health-related quality of life), and reduce medical costs (Franzén *et al*., 2007; Chien *et al*., 2008).

Based on current evidence on clinical outcomes and medical costs, the national and international guidelines on the management of HF, including those of the American College of Cardiology/American Heart Association, the European Society of Cardiology, and the National Institute for Health and Care Excellence (NICE) in the UK, have consistently recommended group- or center-based cardiac rehabilitation (CR) as an effective and safe intervention for HF patients with preserved ejection fraction (Yancy *et al*., 2013; Ponikowski *et al*., 2016; National Institute for Health and Care Excellence, 2018). Despite the benefits, many patients are unable to receive center-based CR due to the distance, cost and poor health. It is reported that less than 10 % of HF patients in the United States and less than 20 % in the Europe received CR (Bjarnason-Wehrens *et al*., 2010; Golwala *et al*., 2015). Recently, a new CR pattern, home-based cardiac rehabilitation (HBCR) has been explored in HF patients due to its accessibility and convenience (Yancy *et al*., 2013). HBCR may be an acceptable alternative for patients. Compared to telemedicine, traditional outpatient CR has many shortcomings, such as high costs. Home-based remote health rehabilitation helps overcome these obstacles and improves CR compliance because of its convenience and accessibility. Telehealth rehabilitation has a positive impact on the health outcomes of patients with HF (Clark *et al*., 2007; Piotrowicz *et al*., 2010; Golwala *et al*., 2015). For example, Piotrowicz *et al*. demonstrated that both home telehealth CR and standard center-based CR significantly improved quality of life, but home telehealth CR had better compliance than standard CR (Piotrowicz *et al*., 2010). Therefore, whether HBCR is superior to center-based CR needs to be analyzed in depth. However, home-based rehabilitation programs have not been extensively studied and their training effects remains unclear (Chien *et al*., 2008; Jolly *et al*., 2009; O'Connor *et al*., 2009).

Herein, we assessed the impact of HBCR on functional capacity, quality of life and readmission rates in patients with HF.

MATERIAL AND METHOD

Data sources and search strategy. Literature retrieval was conducted in PubMed, MEDLINE, EMBASE and Cochrane library until 31th January 2021. Meanwhile, a manual search of randomized controlled trials (RCTs) on CR in patients with HF was performed. The language of the literature was: Chinese and English. The keywords for literature retrieval were as follows: Cardiovascular, heart failure, cardiac rehabilitation, exercise training, and home-based rehabilitation.

Study selection. The inclusion criteria were: 1) RCTs; 2) HF patients were with age ≥18 years; 3) the intervention group included a home-based standardized CR or a comprehensive rehabilitation strategy that included HBCR and the control group was treated with CR or routine care at a hospital rehabilitation center; 4) the clinical outcomes included assessment of patient quality of life, exercise capacity, mortality, re-hospitalization and costs. The exclusion criteria included: 1) reviews or dissertations; 2) articles with incomplete data; 3) duplicate articles; and 4) the patient underwent any form of CR before enrollment.

Data extraction and evaluation. The extracted data included: 1) basic information; 2) study design, baseline information of participants, type of intervention, frequency, duration and intensity, and follow-up time and clinical outcomes. Cochrane Handbook for Systematic Reviews of Interventions 5.1.0 (Higgins & Green, 2011) was used to evaluate study quality (Table I). The outcome measurements included quality of life, exercise capacity, mortality and re-hospitalization. Data were extracted by 2 independent investigators. Discussion was performed or a third investigator was consulted to resolve disagreement.

Statistical analysis. Meta-analysis was performed with RevMan 5.6. The Minnesota Living with Heart Failure, maximum oxygen uptake (VO2max) and, 6-minute walk distance and mental condition were represented by MD (mean differences) and 95 % CI (confidence interval). RR (relative risk) and 95 % CI represented quantitative data. Heterogeneity was analyzed with Chi square test. Fixed effects model analyzed data of non-heterogeneity ($P > 0.1$, $I2 < 50$ %); otherwise, subgroup analysis was performed according to the factors with high heterogeneity ($P \leq 0.1$, $I2 \geq 50$ %). Random effect model analyzed data of heterogeneity (statistical or method heterogeneity). Descriptive analysis was performed for significant heterogeneity ($I2 \geq 75$ %) or data with un-identified data source. Publication bias was analyzed with Egger tests and Funnel plots (Egger *et al*., 1997; Higgins & Green, 2011). A $P < 0.05$ was considered as statistically significant.

Table I. Quality evaluation form.

Study	Randomization method	Concealment	Blinding			Data integrity	Reporting integrity	Other bias
			Patients	Investigators	Evaluators			
Brubaker-2009 (Brubaker PH, Moore JB, Stewart KP, Wesley DJ and Kitzman DW, 2009)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Chen-2018 (Chen YW, Wang CY, Lai YH, *et al*, 2018)	Not mentioned	Not mentioned	No	N/A	Yes	Yes	Yes	N/A
Chien-2011 (Chien CL, Lee CM, Wu YW and Wu YT, 2011)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Coats-1992 (Coats AJ, Adamopoulos S, Radaelli A, *et al*, 1992)	Not mentioned	Not mentioned	No	Yes	Yes	Yes	Yes	N/A
Corvera-Tindel-2004 (Corvera-Tindel T, Doering LV, Woo MA, Khan S and Dracup K, 2004)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Cowie-2011 (Cowie A, Thow MK, Granat MH and Mitchell SL, 2012)	Not mentioned	concealed envelopes	No	N/A	N/A	Yes	Yes	N/A
Dalal-2019 (Dalal HM, Taylor RS, Jolly K, *et al*, 2019)	Computer generated	Not mentioned	No	Yes	Yes	Yes	Yes	N/A
Daskapan-2005 (Daskapan A, Arikan H, Caglar N, Tunali N and Ataman S, 2005)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Davey-1992 (Davey P, Meyer T, Coats A, *et al*, 1992)	Not mentioned	Not mentioned	No	Yes	Yes	Yes	Yes	N/A
Dracup-2007 (Dracup K, Evangelista LS, Hamilton MA, *et al*, 2007)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Gary-2004 (Gary RA, Sueta CA, Dougherty M, *et al*, 2004)	Random numbers	Stratified sampling plan	No	N/A	N/A	Yes	Yes	N/A
Gary-2011 (Gary RA, Cress ME, Higgins MK, Smith AL and Dunbar SB, 2011)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Jolly-2009 (Jolly K, Taylor RS, Lip GY, *et al*, 2009)	Computerized programme	Not mentioned	No	Yes	Yes	Yes	Yes	N/A
Karapolat-2009 (Karapolat H, Demir E, Bozkaya YT, *et al*, 2009)	Not mentioned	concealed envelopes	No	N/A	N/A	Yes	Yes	N/A
Oka-2000 (Oka RK, De Marco T, Haskell WL, *et al*, 2000)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Passino-2006 (Passino C, Severino S, Poletti R, *et al*, 2006)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Peng-2018 (Peng X, Su Y, Hu Z, *et al*, 2018)	Computerized programme	concealed envelopes	No	Yes	Yes	Yes	Yes	N/A
Piotrowicz-2010 (Piotrowicz E, Baranowski R, Bilinska M, *et al*, 2010)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Piotrowicz-2015 (Piotrowicz E, Buchner T, Piotrowski W and Piotrowicz R, 2015)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A
Wall-2010 (Wall HK, Ballard J, Troped P, Njike VY and Katz DL, 2010)	Not mentioned	Not mentioned	No	N/A	N/A	Yes	Yes	N/A

RESULTS

Study selection

The study flowchart was shown in Figure 1. A total of 3493 articles were identified, and 3299 records were retained after removing duplicates. After excluding the studies that did not meet the inclusion criteria, 20 studies (1465 patients) (Coats *et al*., 1992; Davey *et al*., 1992; Oka *et al*., 2000; Corvera-Tindel *et al*., 2004; Gary *et al*., 2004; Daskapan *et al*., 2005; Passino *et al*., 2006; Dracup *et al*., 2007; Brubaker *et al*., 2009; Jolly *et al*., 2009; Karapolat *et al*., 2009; Piotrowicz *et al*., 2010; Wall *et al*., 2010; Chien *et al*., 2011; Gary *et al*., 2011; Cowie *et al*., 2012; Piotrowicz *et al*., 2015; Chen *et al*., 2018; Peng *et al*., 2018; Dalal *et al*., 2019) were finally included.

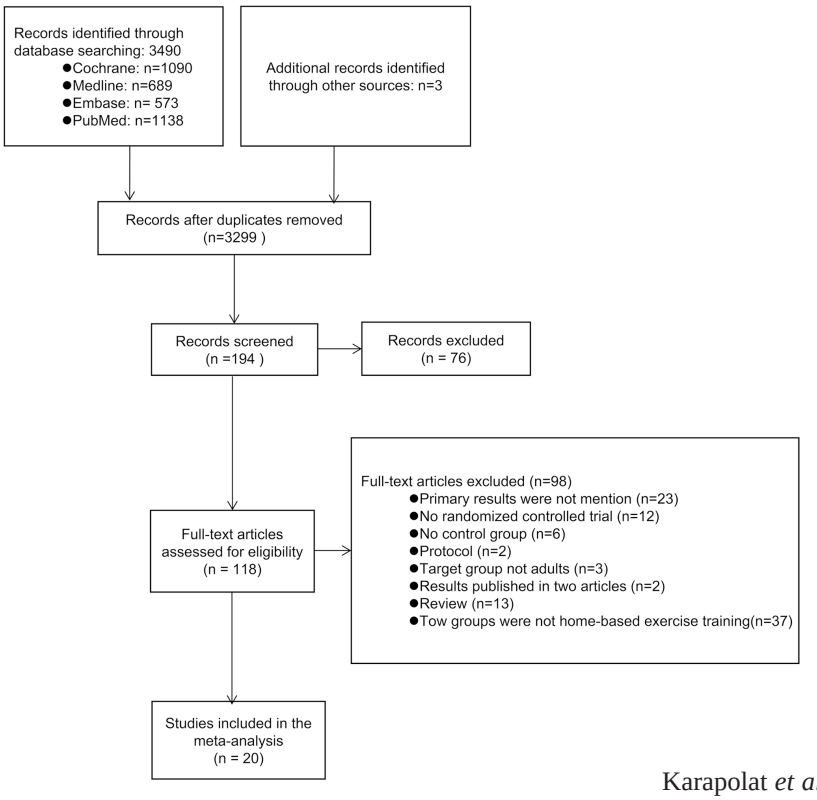

Fig. 1. Flowchart of literature screening.

Characteristics of included studies

Among the 20 studies, 16 studies (Coats *et al*., 1992; Davey *et al*., 1992; Oka *et al*., 2000; Corvera-Tindel *et al*., 2004; Gary *et al*., 2004; Passino *et al*., 2006; Dracup *et al*., 2007; Brubaker *et al*., 2009; Jolly *et al*., 2009; Wall *et al*., 2010; Chien *et al*., 2011; Gary *et al*., 2011; Cowie *et al*., 2012; Chen *et al*., 2018; Peng *et al*., 2018, Dalal *et al*., 2019) focused on the comparison of the efficacy between usual care and HBCR; and, 4 studies (Daskapan *et al*., 2005; Karapolat *et al*., 2009; Piotrowicz *et al*., 2010; Cowie *et al*., 2012) were comparative studies of HBCR and center-based CR. Among them, the study by Cowie *et al*. (2012) compared usual care or center-based rehabilitation versus HBCR. Five studies included aerobic exercise and resistance training. Aerobic exercise had a wide range, lasting for 8 weeks to 12 months with 2-5 times a week and 10-60 minutes each time. The target intensity was 40 %-80 % of the maximum heart rate. The re-hospitalization rate, and quality of life of the patients were used to evaluate the effects of rehabilitation. The subjective factors for the evaluation of therapeutic efficacy in the original study were based on the Borg table. The patients included in the study and the basic information was shown in Table II.

Effects of interventions

Quality of life. Ten studies (Gary *et al*., 2004; Dracup *et al*., 2007; Brubaker *et al*., 2009; Jolly *et al*., 2009; Chien *et al*., 2011; Gary *et al*., 2011; Cowie *et al*., 2012; Chen *et al*., 2018; Peng *et al*., 2018; Dalal *et al*., 2019) assessed the quality of life of patients. These studies reported the total score of the Minnesota Heart Failure Quality of Life Scale. Despite the heterogeneity of outcome measures and reported methods, this meta-analysis still evaluated the quality of life. The results of random effects model showed that the quality of life of patients with HBCR was statistically different from that of patients with usual care [MD=-5.85, 95 % CI (- 9.76, -1.94), P=0.003, I2=75 %] (Fig. 2).

Exercise capacity. There were 13 studies (Coats *et al*., 1992; Davey *et al*., 1992; Oka *et al*., 2000; Corvera-Tindel *et al*., 2004; Daskapan *et al*., 2005; Passino *et al*., 2006; Dracup *et al*., 2007; Brubaker *et al*., 2009; Karapolat *et al*., 2009; Piotrowicz *et al*., 2010; Wall *et al*., 2010; Piotrowicz *et al*., 2015; Chen *et al*., 2018) that reported the patients' exercise capacity with VO_2max as the outcome measurement. VO_2max of patients with HBCR was not significantly different from those with center-based CR [MD=0.08 mL/kg/min, 95 % CI (-1.29, 1.44), P=0.91, I2=0 %] (Fig. 3A). However, patients with HBCR and usual care was significantly different in VO_2max [MD=1.05 mL/kg/min, 95 % CI (0.35, 1.75), P=0.003, I2=46 %] (Fig. 3B).

Some studies (Karapolat *et al*., 2009; Piotrowicz *et al*., 2010; Chien *et al*., 2011; Peng *et al*., 2018) reported the incremental shuttle walk test or the 6-Minute Walk Distance. There was no significant difference in 6-min Walk Distance between patients with HBCR and center-based CR [MD=12.45, 95 % CI (-9.81, 34.72), P=0.27, I2=0 %] (Fig. 4A). However, there was a statistically significant difference in the 6-min Walk Distance between usual care and HBCR (for distance [MD=11.84, 95 % CI (7.41, 16.28), P<0.00001, I2=0 %]; and for feet [MD=98.93, 95 % CI (26.79, 171.08), P=0.007, I2=56 %]) (Fig. 4B).

Anxiety and stress. Three studies (Chien *et al*., 2011; Peng *et al*., 2018; Dalal *et al*., 2019) reported the effects of rehabilitation on anxiety and stress in patients. The results of this meta-analysis showed no statistically significant differences between anxiety and depression in patients of usual care and HBCR (for anxiety, [MD=-0.25, 95 % CI (-0.56, 0.05), P=0.11, I2=0 %]; for depression, [MD=-0.18,

Table II. Basic information of the included articles.

Participants (number and diagnosis)	Age (years old)	Sex	NYHA class	Interventions	Follow-up	Outcomes	Costs	Reference
59 HF patients	Mean age of 70 ± 5	Male: 39 Female: 20	II/III/IV	Home-based rehabilitation *vs* usual care	16-week	Peak VO_{2max}, 6-minute walk Distance	no mention	(Brubaker PH, Moore JB, Stewart KP, Wesley DJ and Kitzman DW, 2009)
37 HF patients	Intervention: 61±11 Control: 60±16	Male: 31 Female: 6	II/III	Home-based rehabilitation *vs* usual care	3-month	Peak VO_{2max}, maximal 6-Minute Walking Distance, QOL	no mention	(Zhao Y, Yan M, Chen C, *et al*, 2018)
51 HF patients	Mean age of 58±16	Male: 38 Female: 13	I/II/III	Home-based rehabilitation *vs* usual care	8-week	MHFQ, 6MWT, HADS anxiety, HADS depression	no mention	(Chien CL, Lee CM, Wu YW and Wu YT, 2011)
17 HF patients	Intervention: 65.1±1.8 Control: 61.1±2.5	Male: 17 Female: 0	II/III	Home-based rehabilitation *vs* usual care	3-month	Peak VO_{2max}, peak heart rate, Resting heart rate, etc.	no mention	(Coats AJ, Adamopoulos S, Radaelli A, *et al*, 1992)
79 HF patients	Intervention: 63.8 ± 10.1 Control: 61.3±11.1	Male:78 Female:1	II/III/IV	Home-based rehabilitation *vs* usual care	12-week	peak oxygen consumption via cardiopulmonary exercise testing, 6-minute walk test, the Heart Failure Functional Status Inventory and symptoms	no mention	(Corvera-Tindel T, Doering LV, Woo MA, Khan S and Dracup K, 2004)
60 HF patients	Mean age: 65.8	Male: 51 Female: 9	II/III	Home-based rehabilitation *vs* center-based rehabilitation *vs* usual care	8-week	Exercise capacity (shuttle walk test), HFQoL (SF-36 and MLHFQ)	£197/patient and £222/patient respectively	(Cowie A, Thow MK, Granat MH and Mitchell SL, 2012)
216 HF patients	Intervention: 69.7±10.9 Control: 69.9±11	Male: 169 Female: 47	I/II/III/IV	Home-based rehabilitation *vs* usual care	12-month	Primary: quality of life (Mac New questionnaire), total cholesterol Secondary: exercise capacity (METs), self-reported smoking, cardiovascular morbidity, mortality, secondary prevention medication use	The Mean cost of the REACH-HF intervention was £418 per participant	(Dalal HM, Taylor RS, Jolly K, *et al*, 2019)
22 HF patients	Home-based rehabilitation :49±11 center-base: 52±8	Male: 16 Female: 6	II/III	Home-based rehabilitation *vs* center-based rehabilitation	12-week	Exercise capacity (mL/kg/min), resting blood pressure, systolic and diastolic blood pressure, adherence, dropouts, mortality	no mention	(Daskapan A, Arikan H, Caglar N, Tunali N and Ataman S, 2005)
22 HF patients	Mean age 64	Male: 22 Female: 0	II/III	Home-based rehabilitation *vs* usual care	8-week	Peak VO_{2max}	no mention	(Davey P, Meyer T, Coats A, *et al*, 1992)
173 HF patients	Intervention: 53.3±12.7 Control: 54.6±12.5	Male: 124 Female: 79	II/III	Home-based rehabilitation *vs* usual care	3-month, 6-month, 12-month	all-cause hospitalizations, emergency department admissions, urgent transplantation, and death. Functional performance (as assessed by cardiopulmonary exercise testing and the 6-minute walk test), quality of life, and psychological states	no mention	(Dracup K, Evangelista LS, Hamilton MA, *et al*, 2007)
32 HF patients	Intervention: 67±11 Control: 69±11	Male: 0 Female: 32	II/III	Home-based rehabilitation *vs* usual care	3-month	MHFQ, 6MWT, and the Geriatric Depression Scale	no mention	(Gary RA, Sueta CA, Dougherty M, *et al*, 2004)
24 HF patients	Intervention: 59±11 Control: 61±10	Male: 12 Female: 12	II/III	Home-based rehabilitation *vs* usual care	12-week	MHFQ, 6MWT, CS-PFP10 total score	no mention	(Gary RA, Cress ME, Higgins MK, Smith AL and Dunbar SB, 2011)
169 HF patients	Intervention: 65.9±12.5 Control: 70±12.5	Male: 126 Female: 43	II/III	Home-based rehabilitation (Heart Manual) *vs* center-based rehabilitation	6-month, 12-month	Primary: serum cholesterol, total cholesterol, HDL cholesterol, blood pressure, exercise capacity (ISWT), smoking Secondary: quality of life, health service usage (hospital readmissions, primary care visits, medication), mortality, cardiovascular events, costs	no mention	(Jolly K, Taylor RS, Lip GY, *et al*, 2009)
68 HF patients	Home-based rehabilitation: 44.05±11.49 center-base: 45.16±13.58	Male: 43 Female: 25	II/III	Home-based rehabilitation *vs* center-based rehabilitation	8 weeks	Exercise capacity, quality of life (SF-36)	no mention	(Karapolat H, Demir E, Bozkaya YT, *et al*, 2009)
40 HF patients	aged 30 to 76 years	Male: 31 Female: 9	II/III	Home-based rehabilitation *vs* usual care	3-month	Peak VO_{2max}, QOL.	no mention	(Oka RK, De Marco T, Haskell WL, *et al*, 2000)
85 HF patients	Intervention: 60±2 Control: 61±2	Male: 74 Female: 11	II/III	Home-based rehabilitation *vs* usual care	3-month, 9-month	Peak VO_{2max}	no mention	(Passino C, Severino S, Poletti R, *et al*, 2006)
98 HF patients	Mean age: 66.3±10.5	Male: 58 Female: 40	II/III	Home-based rehabilitation *vs* usual care	8-week	QOL, 6-minute walking distance (6MWD), resting heart rate (HR), Hospital Anxiety and Depression Scale, left ventricular ejection fraction (LVEF), and the New York Heart Association (NYHA) classification	no mention	(Peng X, Su Y, Hu Z, *et al*, 2018)
131 HF patients	Mean age: 58.1±10.2	Male: 117 Female: 14	II/III	Home-based rehabilitation (tele-monitored) *vs* center-based rehabilitation (outpatient)	8-week	Exercise capacity (6MWT), quality of life (SF-36), mortality, hospitalization	no mention	(Piotrowicz E, Baranowski R, Bilinska M, *et al*, 2010)
51 HF patients	Intervention: 52.6±10.12 Control: 61.4±13.2	Male: 46 Female: 5	II/III	Home-based rehabilitation *vs* usual care	8-week	peak VO_2, heart rate variability (HRV) and heart rate turbulence (HRT)	no mention	(Piotrowicz E, Buchner T, Piotrowski W and Piotrowicz R, 2015)
19 patients with HF	Intervention: 69±4.44 Control: 70±4.05	Male: 11 Female: 8	II/III	Home-based rehabilitation *vs* usual care	6-month, 12-month	Exercise capacity-Peak VO_{2max}	no mention	(Wall HK, Ballard J, Troped P, Njike VY and Katz DL, 2010)

95 % CI (-0.51, 0.16), P=0.30, I2=0 %] (Fig. 5).

Mortality. Eight original studies (Coats *et al*., 1992; Corvera-Tindel *et al*.; 2004, Dracup *et al*., 2007; Brubaker *et al*., 2009; Jolly *et al*., 2009; Wall *et al*., 2010; Chen *et al*., 2018; Dalal *et al*., 2019) reported 40 deaths, while the usual care group reported only 4 HF-related deaths were reported. Only 4 studies (Corvera-Tindel *et al*.; 2004, Jolly *et al*., 2009; Wall *et al*., 2010; Dalal *et al*., 2019) reported the number of all-cause deaths. The death number was not significantly different between usual care and HBCR [RR=1.04, 95 % CI (0.55, 1.98), P=0.90, I2=0 %] (Fig. 6).

Re-hospitalization. Three studies (Corvera-Tindel *et al*., 2004; Dracup *et al*., 2007; Dalal *et al*., 2019) reported the rate of re-hospitalization, and our results showed no statistically significant difference in the number of re-hospitalization between usual care and HBCR [RR=0.88, 95 % CI (0.66, 1.18), P=0.40, I2=0 %] (Fig. 7).

Cost. Two studies reported the costs. One study (Cowie *et al*., 2012) showed that the average cost for 8 weeks of HBCR was similar to that of usual care (£197/patient vs. £222/patient). Another study (Daskapan *et al*., 2005) showed that the mean total cost for delivery of the Rehabilitation Enablement in Chronic Heart Failure (REACH-HF) intervention was estimated at £418.39 per participant.

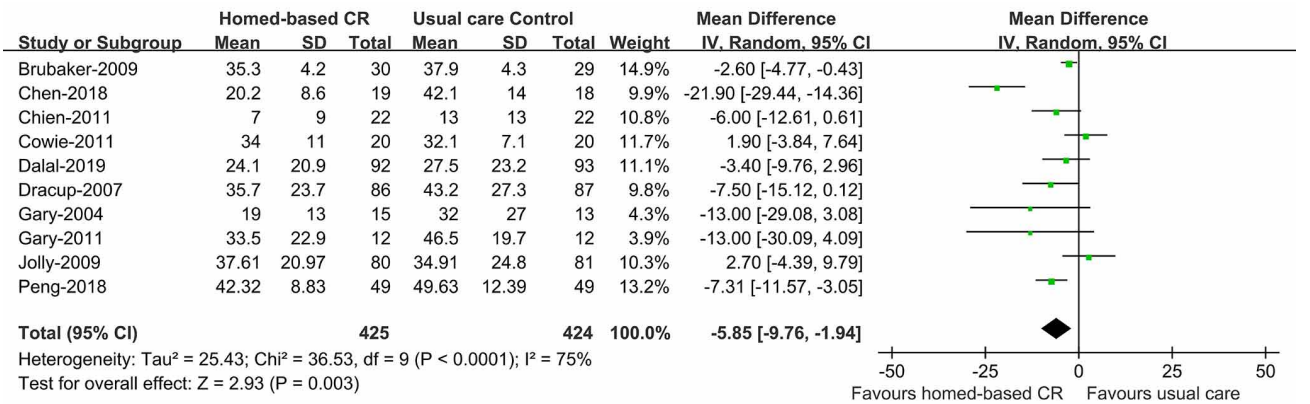

Fig. 2. Health-related quality of life. The total score of the Minnesota Heart Failure Quality of Life Scale was compared.

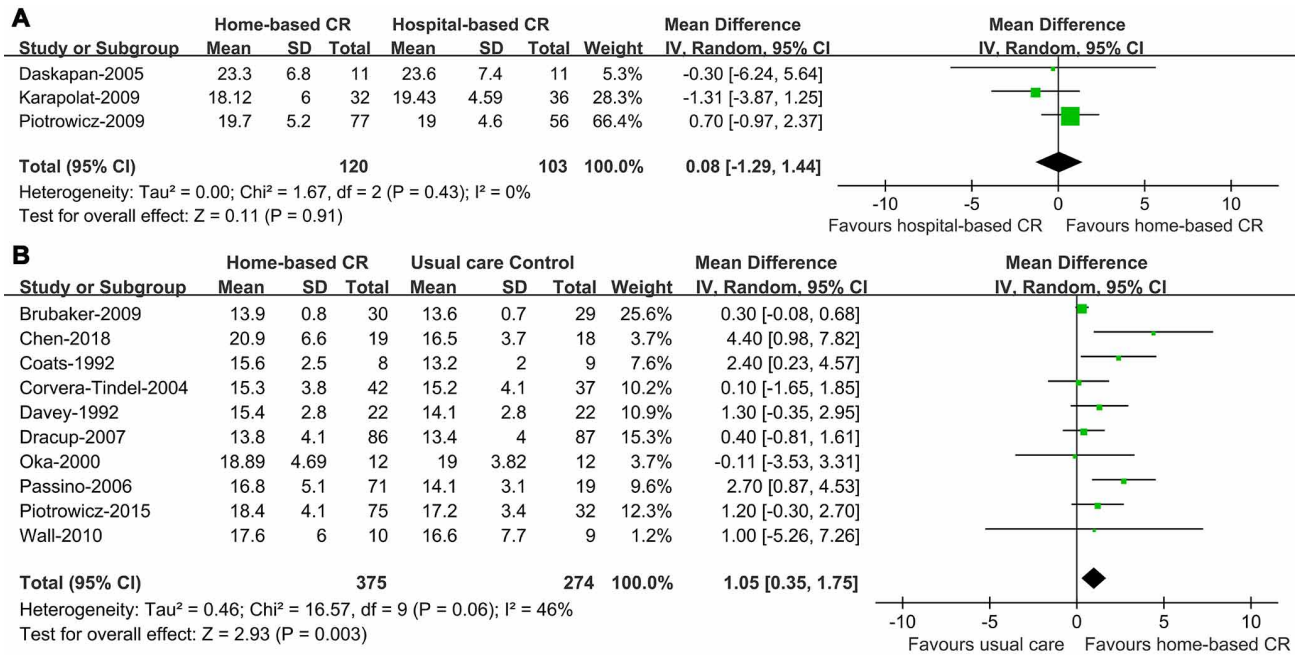

Fig. 3. Exercise Capacity-Peak VO_2max. (A) Comparison of HBCR and center-based CR control; (b) Comparison of HBCR and usual care control.

DISCUSSION

At present, the treatment of HF mainly uses drug therapy to relieve symptoms and improve physical signs. However, the early rehabilitation of HF patients after discharge is always ignored. Thus, the recurrence rate and re-hospitalization rate of HF patients are high, which not only increases the economic burden of patients, reduces their quality of life, but also greatly occupies social resources. Currently, there is no unified medical treatment norm and expert consensus for the home-based rehabilitation treatment program. Therefore, this study systematically evaluated the effects of HBCR, so as to provide guidance for clinical decision-making.

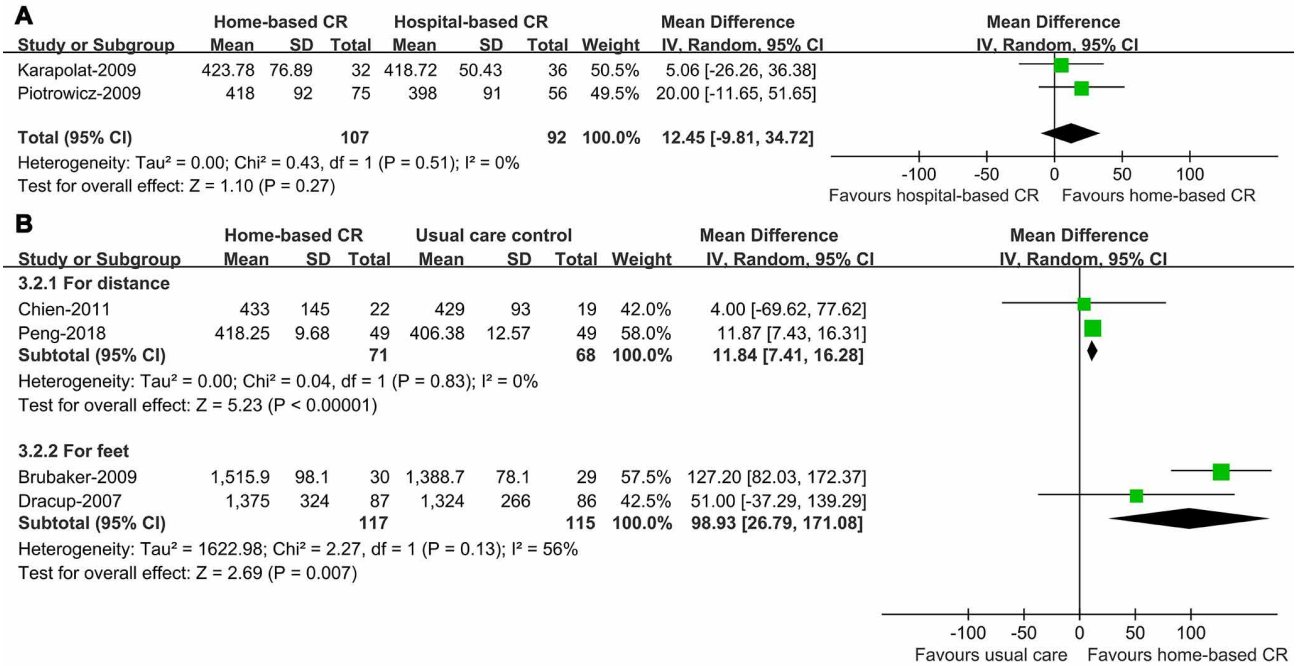

Fig. 4. 6-min Walk Distance (6MWD). (A) Comparison of HBCR and center-based CR control; (b) Comparison of HBCR and usual care control.

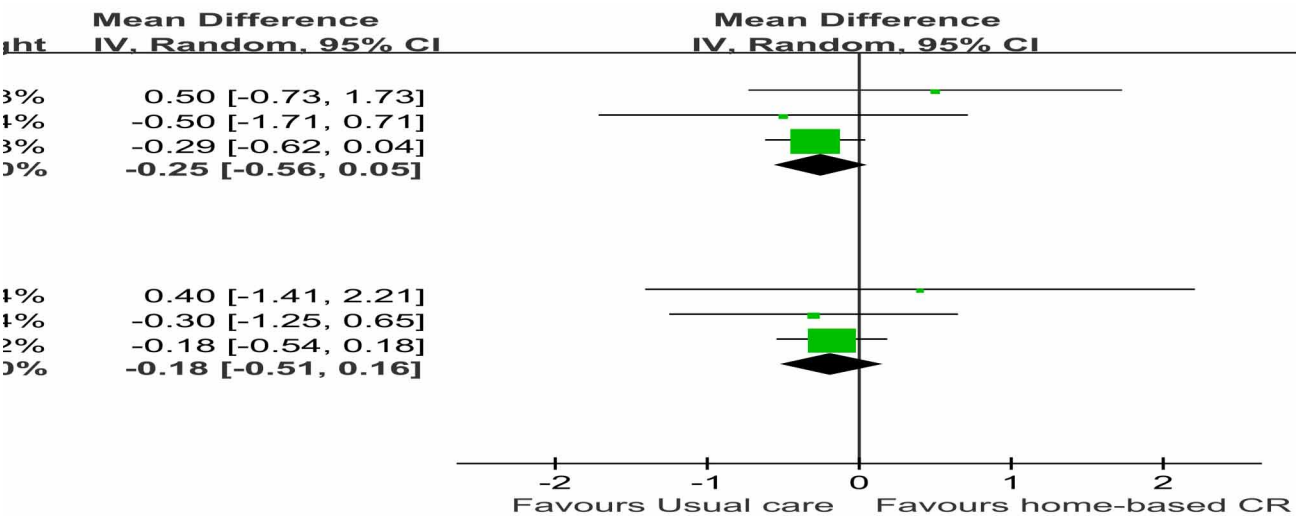

Fig. 5. Assessment of anxiety and stress using Hospital Anxiety and Depression Scale (HADS).

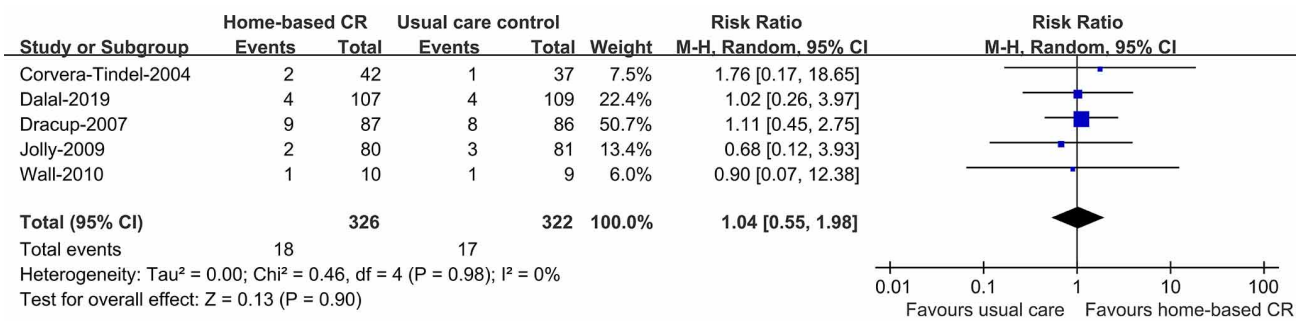

Fig. 6. Comparison of mortality.

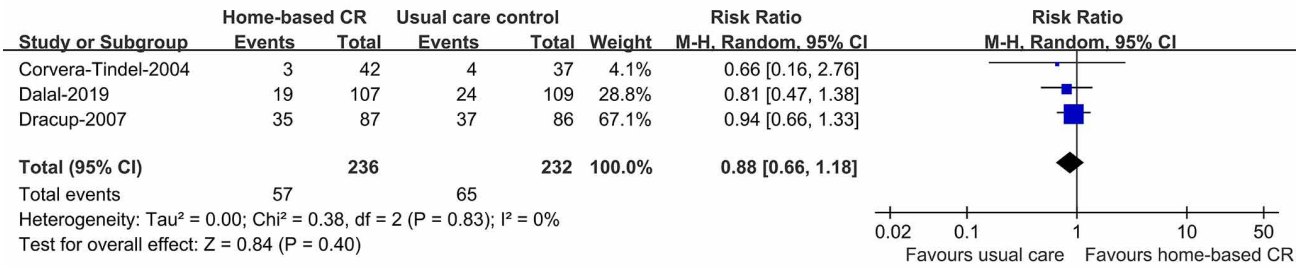

Fig. 7. Comparison of re-hospitalizations.

Although CR is highly recommended (Chien *et al*.; 2008; Balady *et al*., 2011; McMurray *et al*., 2012; National Institute for Health and Care Excellence, 2013; Piepoli *et al*., 2014), CR application rate is not high (Menezes *et al*., 2014, Forman *et al*., 2015, Jelinek *et al*., 2015). Alternative ways, such as HBCR, may help to improve CR application (Wingham *et al*., 2006; Lavie *et al*., 2016). In this analysis, the effectiveness and safety of HBCR for HF were demonstrated by comparing to center-based CR or usual care (non-CR). Patient characteristics at baseline were well balanced between patients in the CR and Control groups. All trials evaluated an aerobic exercise intervention, which was most commonly delivered in either an exclusively center-based setting or a center-based setting in combination with some home exercise sessions. The HF-ACTION (O'Connor *et al*., 2009) investigators reported no significant interaction effect of exercise training intervention on their composite primary outcomes (i.e. all-cause mortality or hospitalization) and subgroups of age (≤ 70 vs. > 70 years), sex, race (white vs. non-white), HF aetiology (ischemic vs. non-ischemic), ejection fraction (≤ 25 % vs. > 25 %) or New York heart association (NHYA) class (II vs. III/IV). Our study suggested that compared with usual care and center-based CR, HBCR could improve the total quality of life. Compared with usual care, HBCR could improve VO2max and 6-min Walk Distance. However, there were no differences in mortality, re-hospitalization rate or incidence of anxiety and depression between HBCR and center-based CR. Center-based CR and HBCR showed similar outcomes and medical costs.

The Minnesota Heart Failure Quality of Life Scale is widely used to evaluate the quality of life in patients with HF. In this study, ten studies (Gary *et al*., 2004; Dracup *et al*., 2007; Brubaker *et al*., 2009; Jolly *et al*., 2009; Chien *et al*., 2011; Gary *et al*., 2011; Cowie *et al*., 2012; Chen *et al*., 2018; Peng *et al*., 2018; Dalal *et al*., 2019) reported the total score of the Minnesota Heart Failure Quality of Life Scale. Only three (Brubaker *et al*., 2009; Chen *et al*., 2018 Peng *et al*., 2018) studies showed that there was a difference in the total scores between usual care and HBCR, while there were no differences between the two groups in the other seven studies. However, this meta-analysis found that the quality of life of patients with HBCR was superior to that of the usual care group. As for the results of the patient's exercise capacity, there was no difference in the VO_2max between center-based CR and HBCR, but the VO_2max of the patients in the HBCR group was better than the usual care group, indicating that the exercise capacity of the HF patients can be better improved by HBCR.

In this study, the data on patient cost was limited, with only two RCT reports showing no difference of health care costs. Our analysis confirmed that HBCR was of great benefit to HF patients. However, this study found that the anxiety, re-hospitalization rates and mortality of patients who received HBCR had no significant improvement compared to usual care. Further study is needed.

Through our research, we found that the quality of life and motor function of patients after HBCR and center-based rehabilitation could be improved compared with conventional care. HBCR was not significantly different from center-based CR in re-hospitalization rate, mortality, and anxiety symptoms, indicating that HBCR is applicable for HF patients with relatively easy accessibility and high compliance, especially during the COVID-19 epidemic. Furthermore, HBCR may be a lower-cost alternative in the healthcare economy compared to more traditional center-based approaches. Further large-sample clinical studies are needed to confirm the need for HBCR.

There are some limitations in this paper. First, the consistency in the assessment of the results of the included studies was lacking to some extent. Although we learned the details of each study by contacting the authors of the included studies, it was found that the assessment of the results yet failed to keep consistency, which may lead to weakened final results. Second, the sample size was relatively small. Third, the "excessive" data at the patient level were not obtained (i.e., to determine the persistence of individual patients based on the time, frequency and

intensity of exercise training). Four, there was a high degree of statistical heterogeneity in both excise capacity and quality of life scores. This heterogeneity is likely caused by the differences in the interventions of the original researches. Further studies are warranted.

In conclusions, this study demonstrates that HBCR is safe and effective for HF patients, which should be promoted to improve their quality of life and exercise capacity. Through this study, the benefits of HBCR for HF patients are confirmed. More patients may benefit from HBCR through the results of this study.

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YE, Y.; MA, J.; ZHANG, L.; FU, X.; AIKEMU, A.; FAN, P. & TANG, B. Rehabilitación para pacientes con insuficiencia cardíaca: una revisión sistemática y metanálisis. *Int. J. Morphol., 41(1)*:246-256, 2023.

RESUMEN: El objetivo de este estudio fue investigar el efecto de la rehabilitación cardíaca domiciliaria (HBCR) sobre la calidad de vida, la capacidad funcional y las tasas de reingreso en pacientes con insuficiencia cardíaca. Se seleccionaron ensayos controlados aleatorios (ECA) de la Biblioteca Cochrane, CINAHL, EMBASE y MEDLINE. El grupo de intervención recibió un HBCR estandarizado o una estrategia de rehabilitación integral que incluía HBCR. Los participantes del grupo de control recibieron RC en un centro médico o atención habitual sin intervención de RC. Las principales medidas de resultado incluyeron la calidad de vida, la capacidad de ejercicio, la mortalidad y la rehospitalización. Este metanálisis incluyó 20 ECA, en los que 16 estudios compararon HBCR con la atención habitual y 4 estudios compararon que mejoró la puntuación total de calidad de vida [DM=-5,85, IC del 95 % (-9,76, -1,94), P=0,003, I2=75 %]. Los pacientes con HBCR y atención habitual fueron significativamente diferentes en el VO_2máx [DM = 1,05 ml/kg/min, IC del 95 % (0,35, 1,75), P = 0,003, I2 = 46 %]. Sin embargo, el VO_2max de los pacientes con HBCR no fue significativamente diferente de aquellos con CR basada en el centro [DM = 0,08 ml/kg/min, IC del 95 % (-1,29, 1,44), P = 0,91, I2 = 0 %]. Hubo una diferencia estadísticamente significativa en la distancia de caminata de 6 minutos entre la atención habitual y HBCR (para la distancia [DM=11,84, IC del 95 % (7,41, 16,28), P<0,00001, I2=0 %]; y para los pies [DM= 98,93, IC 95 % (26,79, 171,08), P=0,007, I2=56 %]). Sin embargo, no hubo una diferencia significativa en la distancia de caminata de 6 minutos entre los pacientes con HBCR y CR basada en el centro [DM = 12,45, IC del 95 % (-9,81, 34,72), P = 0,27, I2 = 0 %], o en la ansiedad y depresión entre pacientes con atención habitual y HBCR (para ansiedad, [DM=-0,25, IC del 95 % (-0,56, 0,05), P=0,11, I2=0 %]; para depresión, [DM=-0,18, 95 % IC (-0,51, 0,16), P=0,30, I2=0 %] No se encontraron diferencias significativas en el número de muertes [RR=1,04, IC del 95 % (0,55, 1,98), P=0,90, I2=0 %] o en el número de reingresos [RR=0,88, IC 95 % (0,66, 1,18), P=0,40, I2=0 %] entre atención habitual y HBCR. Para los pacientes con insuficiencia cardíaca, en comparación con la atención habitual y la CR en un centro, la HBCR puede mejorar la calidad de vida total. En comparación con la atención habitual, la HBCR puede mejorar el VO_2máx y la distancia recorrida en 6 minutos, pero en comparación con la CR basada en un centro, no hay diferencias en la mortalidad, la tasa de rehospitalización o la incidencia de ansiedad y depresión. Además, CR y HBCR basados en el centro mostraron resultados y costos médicos similares.

PALABRAS CLAVE: Insuficiencia cardíaca; Entrenamiento físico; Metanálisis; Rehabilitación cardíaca; Revisión sistemática.

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