REVIEW

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Home versus centre-based pulmonary rehabilitation for patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis

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Highlights

The meta-analysis systematically evaluate the effects of home versus centre-based pulmonary rehabilitation on exercise capacity, quality of life, and dyspnoea scores in patients with chronic obstructive pulmonary disease. A total of 9 articles were included. Meta-analysis results indicated that home and centre-based pulmonary rehabilitation has no difference on exercise capacity, quality of life, and dyspnoea scores in individuals with chronic obstructive pulmonary disease. Home-based pulmonary rehabilitation has the potential to be an alternative to centre-based pulmonary rehabilitation. However, limited by the quantity and quality of the included studies, the above conclusions need to be verified by more high-quality studies.

Abstract

Background: To evaluate the effects of home versus centre-based pulmonary rehabilitation on exercise capacity, quality of life, and dyspnoea scores in patients with chronic obstructive pulmonary disease by meta-analysis. **Methods:** We searched the Cochrane library, Embase, PubMed and CINAHL (EBSCO) up to April 2020 without language restriction to collect randomized controlled trials of home versus centre-based pulmonary rehabilitation for patients with chronic obstructive pulmonary disease. Literatures screening, risk of bias assessment and data extraction for the included studies were conducted by two reviewers independently. The data analysis was carried out by RevMan 5.3 software. **Results:** A total of 9 studies, which comprised a total of 859 participants were included in the meta-analysis. Centre and home-based pulmonary rehabilitation were equally effective at improving exercise capacity (MD = −2.30, 95% CI: −12.02 to 7.42, $P > 0.05$) and dyspnoea scores (MD = −0.15, 95% CI: −0.46 to 0.17, $P > 0.05$). They were also equally effective at improving health-related quality of life on the chronic respiratory questionnaire (dyspnea: MD = −0.08, 95% CI: −0.30 to 0.13, $P > 0.05$; fatigue: MD = −0.19, 95% CI: −0.45 to 0.07, $P > 0.05$; emotional function: MD = −0.18, 95% CI, −0.40 to 0.40, $P > 0.05$ and mastery: MD = −0.13, 95% CI: −0.38 to 0.11, $P > 0.05$), and on the St George's respiratory questionnaire (MD = −1.77, 95% CI: −4.54 to 0.99, $P > 0.05$). **Conclusion:** Home and centre-based pulmonary rehabilitation has similar effects on exercise capacity, quality of life, and dyspnoea scores in individuals with chronic obstructive pulmonary disease. Home-based pulmonary rehabilitation has the potential to be an alternative to centre-based pulmonary rehabilitation.

Key words: Chronic obstructive pulmonary disease, Home-based pulmonary rehabilitation, Centre-based pulmonary rehabilitation, Meta-analysis

Abbreviations:

COPD, chronic obstructive pulmonary disease; PR, pulmonary rehabilitation; EWST, endurance shuttle walk test; SGRQ, Saint George's respiratory questionnaire; CI, confidence intervals; RCTs, randomized controlled trials; MWT, minute walk test; CRQ, chronic respiratory questionnaire.

***Competing interests*:**

The authors declare that they have no conflict of interest.

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Background

Chronic obstructive pulmonary disease (COPD) is a respiratory disease characterized by continuous airflow limitation with the characteristics of high incidence, high disability rate and high case fatality rate. In 2020, COPD has become the third cause of death globally and the fifth cause of disability, ranking fifth in the world's disease burden [2]. Patients with COPD will suffer from problems such as progressive decline of respiratory function and daily activity ability, decrease of quality of life and so on [1].

Pulmonary rehabilitation (PR) is a key component of non-drug therapy in patients with COPD. The American Thoracic Society and the European Respiratory Society [3, 4] define it as: "PR is a comprehensive intervention on the basis of thorough evaluation of patients. Its core treatment measures are exercise training, education and behavior changes, which aims to improve the physical and mental condition and to promote long-term adherence to promote healthy behaviors of COPD patients". Studies have shown that PR can improve patients' symptoms of dyspnea, improve patients' quality of life and exercise capacity and reduce the number of admissions [5, 6].

Although PR is at the core of the treatment of COPD and is strongly recommended in clinical guidelines, only very few patients have participated in PR. Traditional PR is achieved through the face-to-face meeting of the patient and the rehabilitation teacher in a center to complete at least six weeks of personalized sports and education program treatment [3]. Center-based PR has some problems, such as inconvenience, time conflict, and high cost, which lead to poor adherence. [7]. Therefore, it is urgent to develop an alternative mode of traditional PR to benefit more patients.

Home-based PR has been proved to have effects to improve the patients' quality of life and exercise capacity and reduce the number of admissions [7]. However, whether home-based PR can be used as an alternative to centre-based PR has not been confirmed. In order to make it clear that home-based PR rehabilitation can be used as an alternative to centre-based PR, the purpose of this study is to compare the application effects of home-based PR and centre-based PR.

Methods

Inclusion and exclusion criteria

Inclusion criteria ① Research type: randomised controlled trial of home versus centre-based PR, whether or not blind and assigned concealment, without language restrictions. ② Research object: adults ≥ 18 years old stable patients in accordance with the global strategy for the diagnosis of COPD [8]. ③ Intervention measures: in the experimental group, home-based PR is the main intervention and it is clearly described. The main forms include remote supervision through the Internet, telephone, video conference, television and self-supervision such as pedometer and exercise diary. ④ In the control group centre-based PR is the main intervention and it is clearly described. The main forms are supervised group-based face to face programme undertaken in a centre setting. Home or centre-based PR included in the study must include exercise training and self management education.

Exclusion criteria ① Search for research with only titles, abstracts and no access to the full text. ② Animal experiment research. ③ The presentation was repeated. ④ Major outcome indicators were not match.

Outcome indicator ① Exercise capacity: 6-minute walk test (MWT), under the standardized encouragement and guidance of doctors, patients walked as fast as possible along the 30 m-long ward corridor within 6 min until 6 min stopped [9]; endurance shuttle walk test (EWST), the patient walks along a 10-meter-long walkway separated by a cone at both ends. Patients are asked to bypass the boundary cone at both ends, and the speed at which they walk is controlled by a series of pre-recorded audio signals. Patients walk until they are out of breath, too tired or can no longer maintain speed [10]. ② Health-related quality of life: Saint George's respiratory questionnaire (SGRQ), SGRQ has a total of 54 items and three dimensions, which are including symptom score, impact score, activity score and total score. The total score ranged from 0 to 100, and the higher the score, the more the quality of life was affected by the disease [11]; chronic respiratory questionnaire (CRQ) has a total of 20 items, involving four dimensions of dyspnea, fatigue, emotional function and mastery [12]. ③ Dyspnoea scores: modified Medical Research Council dyspnoea scale: the degree of dyspnea was evaluated, and the severity of symptoms was divided into 0–5 grades, 0 as mild, 1 as moderate, 2 as severe, and 3–4 as extremely severe [13].

Search methods

We searched the following electronic databases from inception to April 2020: the Cochrane library, Embase, PubMed and CINAHL (EBSCO). In addition, manual searches were made in the references of the studies found on this research topic. The following search terms were employed: "chronic obstructive pulmonary disease", "COPD", "pulmonary rehabilitation", "hospital-based", "rehabilitation", "centers rehabilitation", "Internet", "interactive web-based", "home care services", "home-based", "traditional", "face to face", "randomized controlled trial". Literature retrieval is in the form of mesh combined

with free words. Taking Pubmed as an example, the retrieval strategy is as follows.
#1 pulmonary disease, chronic obstructive [mesh]
#2 COPD OR chronic obstructive pulmonary disease
#3 #1 OR #2
#4 rehabilitation [mesh]
#5 pulmonary rehabilitation OR PR OR physiotherapy
#6 #4 OR #5
#7 hospitals, rehabilitation [mesh]
#8 rehabilitation hospitals OR centers, rehabilitation OR centre-based OR traditional OR supervised OR hospital-based OR face to face
#9 Internet [mesh] OR telemedicine [mesh] OR home care services, hospital-based [mesh] OR telerehabilitation [mesh]
#10 mobile health OR telehealth OR hospital based home cares OR online OR web-based OR unsupervised
#11 #7 #8 OR #9 #10
#12 randomized controlled trials [mesh]
#13 clinical trials OR randomized trials OR random allocation OR blind method OR RCT
#14 #13 OR #14
#3 AND #6 AND #11 AND #14

Risk of bias assessment

The risk of bias in the included studies was assessed by 2 researchers using the Cochrane collaboration risk of bias tool, for risk assessment of bias in randomized controlled trials (RCTs). Seven items were included: generation of random order, concealment of random scheme allocation, blind method for research objects and intervention implementors, blind method for outcome evaluators, integrity of outcome indicator data, possibility of selective reporting of results, and other sources of bias. The evaluator should make a low bias risk, high bias risk and unclear judgment for each project.

Statistical analysis

RevMan 5.3 statistical software was used for data analysis. Because the outcome indicators were all continuous variables, the mean difference (MD) or standardized MD was used. For the included studies, only the mean and 95% confidence intervals (CI) were mentioned, and the combined analysis was conducted after conversion according to the formula. The heterogeneity of the included studies was analyzed using the X^2 test. When $P \geq 0.10$ and $I^2 \leq 50\%$, the fixed-effect model was used for meta-analysis; otherwise, the random-effect model was used for meta-analysis and the study results were interpreted with caution. If the data cannot be combined, perform a descriptive analysis.

Results

Search results

We identified 885 records. After duplicate removal, 735 records were screened by title/abstract and 18 by full-text. Further reading excluded 9 articles that did not meet the criteria and could not extract data, of which 3 were non-RCT articles, 4 were not comprehensive PR, and 2 were unable to obtain the full text. Finally, 9 studies [14–22] met the eligibility criteria and were included in this review. The flow chart of study selection is shown in Figure 1.

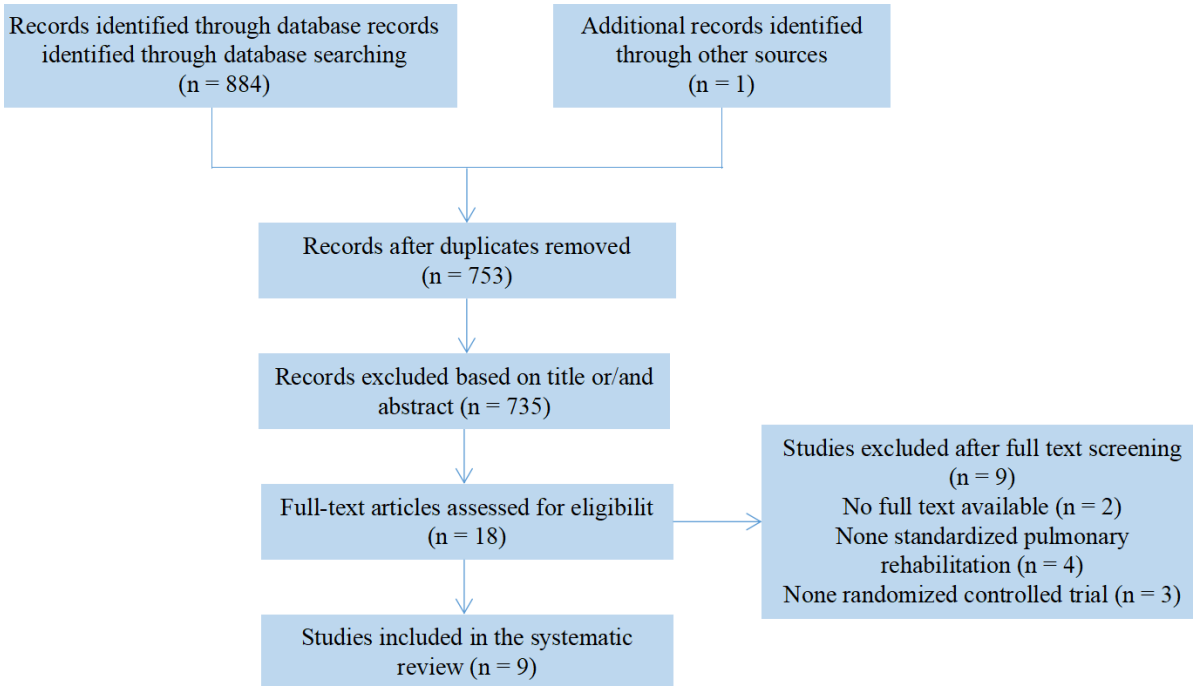

Figure 1 Flow chart of the study

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Description of the subjects and bias assessment

The basic characteristics of the literature included are shown in Table 1. A total of 859 patients with COPD were included. The included studies are mainly in UK (n = 3) [15–17], Canada (n = 2) [19, 21], Australia (n = 2) [14, 22], Spain (n = 1) [20], Denmark (n = 1) [18].

All patients received the core components of PR, include resistance training aerobic, exercise training and self-management education. The duration ranged from 6 weeks to 3 months. The session frequency varied from daily to three times a week. The bias risks of the included studies are shown in Figure 2.

Intervention group. All the interventions evaluated in this system are home-based PR, but there are some differences in the specific implementation plans of home-based PR in different studies.

Three of the nine included studies [15, 16, 18] were web-based PR. Henrik et al. [18] implements standardized home-based PR through a videoconferencing software system. Four to eight patients were divided into a group, monitored remotely by professional physiotherapists and nurses and communicated through the network. Chaplin et al. [15] peformed PR through an interactive website. The website consists of individualised webpages containing the patient's PR action plan. Patients are asked to fill in exercise diaries online, and rehabilitation experts review patients' progress online and contact patients weekly via email or standardized phone calls. Bourne et al. [16] performed an online PR programme (my PR). Patients can exercise according to the exercise videos on the screen and watch three educational videos a week.

Six of the nine included studies [14, 17, 19–22] were self-monitored home-based PR. Most PR begins with an introductory meeting in the hospital or a home visit by a physiotherapist. Rehabilitation experts work with patients to establish specific exercise goals, evaluate inhalation techniques, supervise and guide patients for the first exercise, and ensure that patients can complete the PR program correctly and independently. Patients may asked to keep a diary of each completed training session or recorded the distance walked using a pedometer. Also during the period each patient was further supported by motivational telephone calls, in oder to ask how the participant was progressing with their exercise, detect problems, clarify questions, reinforce the importance of the rehabilitation and help promote self-management.

Control group. In the study, the main intervention measures in the control group were conventional group-based, supervised and standardised centre-based pulmonary programme.

Table1 Characteristics of the included studies

Study	Sample size (T/C)	Age (T/C)	FEV1 % (T/C)	Interventions (T vs C)	Outcome	Duration
Bourne et al. 2017 UK	64/26	T: 69.1 ± 7.9 C: 71.4 ± 8.6	T: 58 ± 23.6 C: 60.5 ± 20.1	Home-based vs centre-based	HRQoL: SGRQ Exercise capacity: 6WMT Dyspnoea scores: mMRC	6 weeks
Holland et al. 2017 Australia	72/76	T: 69 ± 13 C: 69 ± 10	T: 52 ± 19 C: 49 ± 19	Home-based vs centre-based	HRQoL: CRQ Exercise capacity: 6WMT Dyspnoea scores: mMRC	8 weeks
Chaplin et al. 2017 UK	51/52	T: 66.4 ± 10.1 C: 66.1 ± 8.1	T: 58.7 ± 29.1 C: 55 ± 20.5	Home-based vs centre-based	HRQoL: CRQ-D Exercise capacity: ESWT	6–8 weeks
Güell et al. 2008 Spain	23/28	T: 66 ± 5.8 C: 63.2 ± 6.6	T: 39.0 ± 7.6 C: 37.5 ± 7.1	Home-based vs centre-based	HRQoL: CRQ Exercise capacity: 6WMT	9 Weeks
Mendes de Oliviere et al. 2010 Canada	33/23	T: 66.4 ± 9.5 C: 71.3 ± 6.7	T: 68.7 ± 30.2 C: 79.1 ± 30.0	Home-based vs centre-based	Exercise capacity: 6WMT	12 Weeks
Maltais et al. 2008 Canada	119/114	T: 66 ± 9 C: 66 ± 9	T: 46 ± 13 C: 43 ± 13	Home-based vs centre-based	HRQoL: CRQ; SGRQ Exercise capacity: 6WMT	12 Weeks
Burge et al. 2019 Australia	77/82	T: 71 ± 9 C: 69 ± 9	T: 53 ± 18 C: 49 ± 20	Home-based vs centre-based	Exercise capacity: 6WMT	8 weeks
Henrik et al. 2019 Denmark	67/67	T: 68.4 ± 8.7 C: 68.2 ± 9.4	T: 32.6 ± 10.3 C: 33.7 ± 8.4	Home-based vs centre-based	Exercise capacity: 6WMT	10 weeks

T, experimental group; C, control group; HRQoL, Health-related quality of life; 6WMT, 6-minute walk test; EWST, endurance shuttle walk test; SGRQ, Saint George's respiratory questionnaire; CRQ, chronic respiratory questionnaire; mMRC, modified Medical Research Council dyspnoea scale.

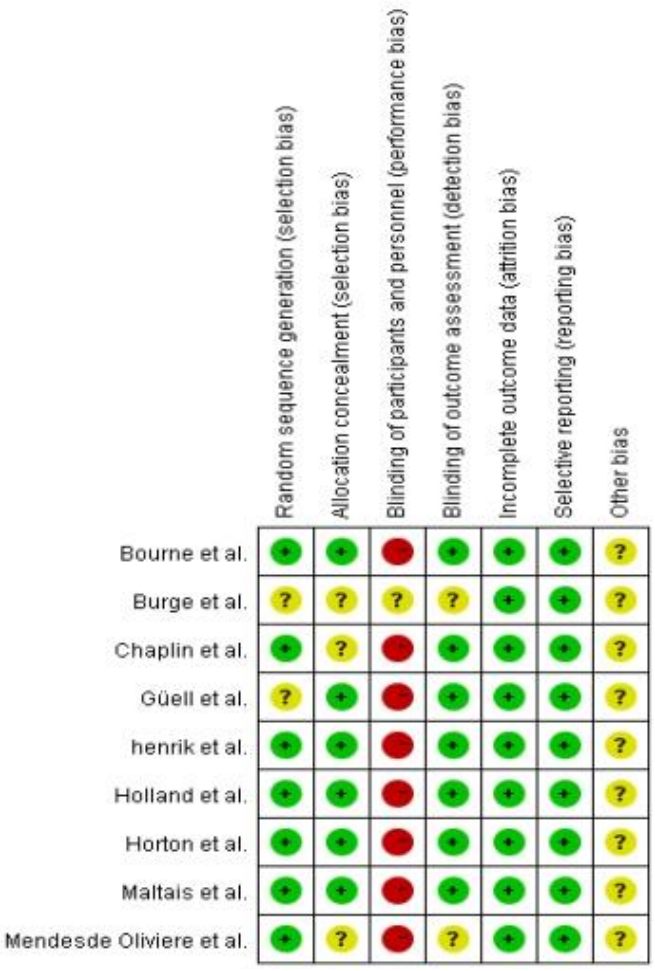

Figure 2 Risk of bias summary

Effects of interventions

Exercise capacity. Total ten studies assessed exercise capacity. Pooled analysis showed no significant difference in exercise capacity between home-based and centre-based PR (MD = −2.30, 95% CI (−12.02, 7.42), *P* > 0.05). Seven studies [14, 16, 18–22] assessed exercise capacity with the 6 MWT and 2 studies [15, 17] used the EWST. The subgroup analysis for different scales were conducted, the results showed no significant difference in the 6 MWT (MD = −1.64, 95% CI (−11.42, 8.15), *P* > 0.05), and also no significant difference in the EWST (MD = −51.95, 95% CI (−136.83, 32.94), *P* > 0.05) (Figure 3).

Health-related quality of life. Two studies [16, 19] assessed quality of life with SGRQ, and 5 [15, 17, 19, 20, 22] with CRQ. The results showed that patients who received the intervention showed no significant difference in the four quality of life domains assessed by CRQ, namely dyspnea (MD = −0.08, 95% CI (−0.30, 0.13), *P* > 0.05), fatigue (MD = −0.19, 95% CI (−0.45, 0.07), *P* > 0.05), emotional function (MD = −0.18, 95% CI (−0.40, 0.40), *P* > 0.05), and mastery (MD = −0.13, 95% CI (−0.38, 0.11), *P* > 0.05) (Figure 4). Similarly, when compared to controls, patients who received home-based PR also showed significant difference assessed by SGRQ (MD = −1.77, 95% CI (−4.54, 0.99), *P* > 0.05) (Figure 5).

Dyspnoea scores. Two articles reported dyspnoea scores with modified Medical Research Council dyspnoea scale. Meta-analysis found no evidence of a difference between the home-based and centre-based groups in terms of dyspnoea scores (MD = −0.15, 95% CI (−0.46, 0.17), *P* >0.05) (Figure 6).

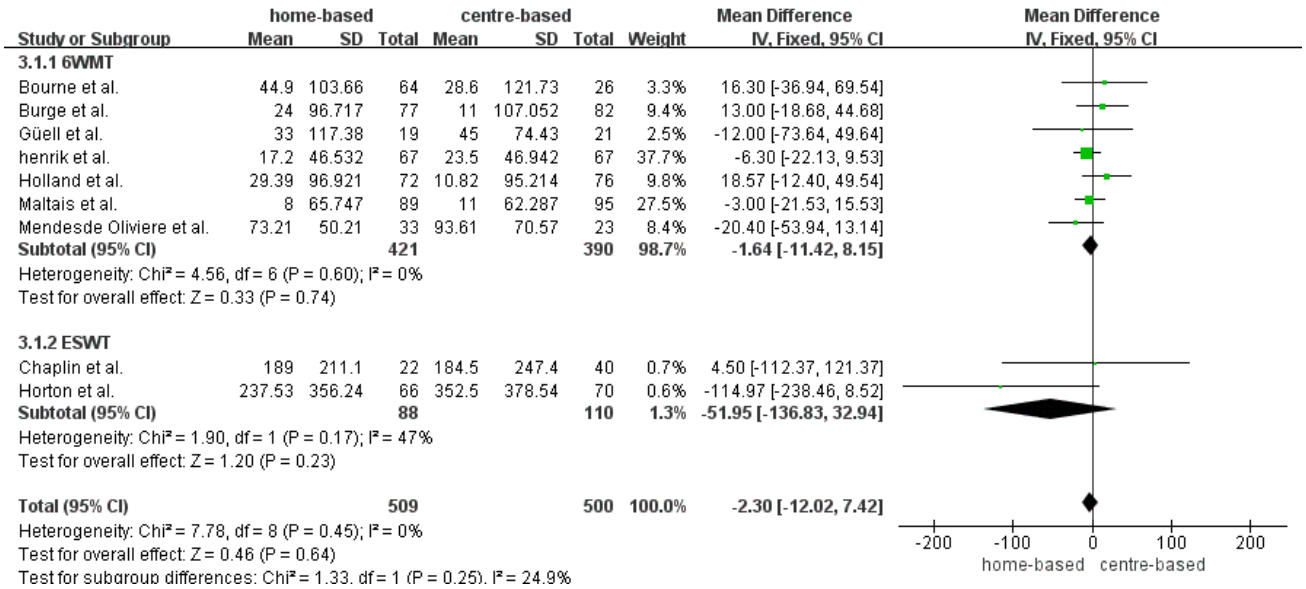

Figure 3 Forest plot for exercise capacity. 6WMT, 6-minute walk test; EWST, endurance shuttle walk test; SD, standard deviation; CI, confidence interval.

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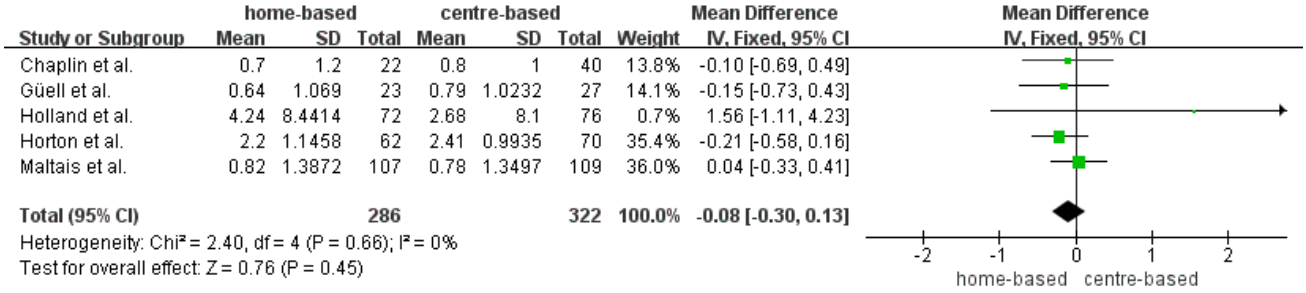
(a)



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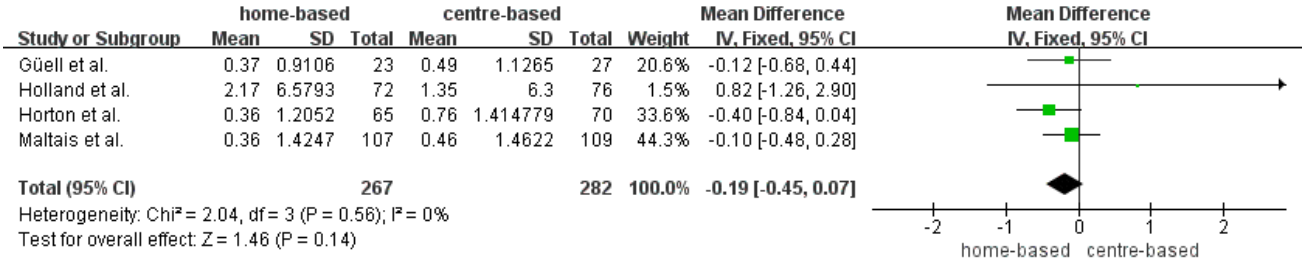

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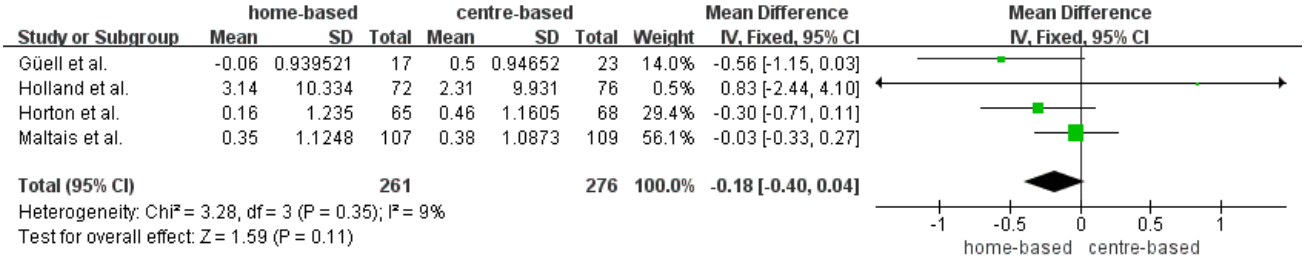

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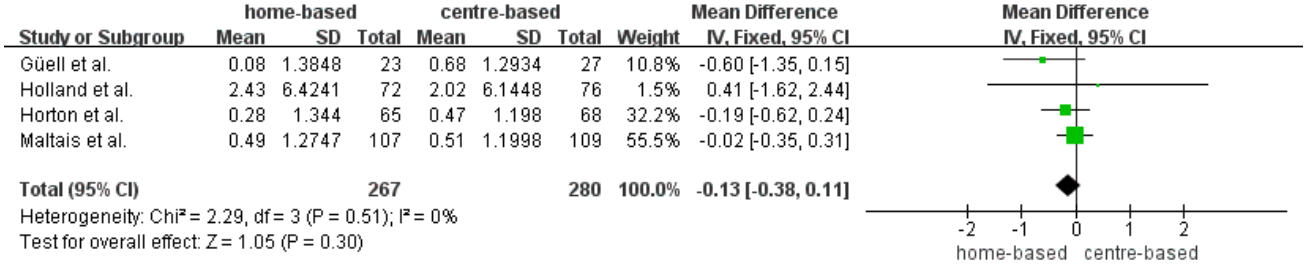

Figure 4 Forest plot for CRQ on health-related quality of life. (a) CRQ-dyspnea; (b) CRQ-fatigue; (c) CRQ-emotional function; (d) CRQ-mastery; CRQ, chronic respiratory questionnaire; SD, standard deviation; CI, confidence interval.

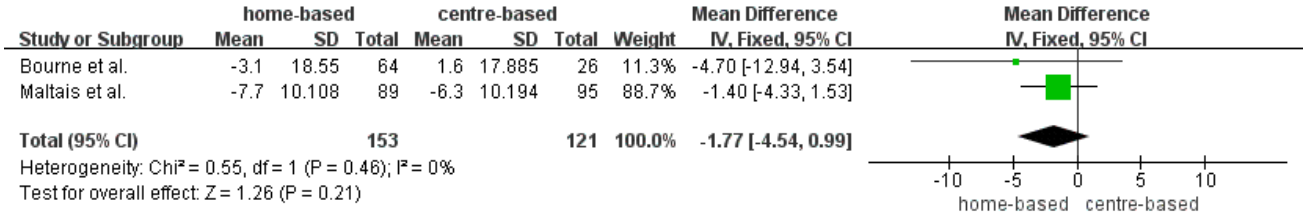

Figure 5 Forest plot for SGRQ on health-related quality of life. SGRQ, Saint George's respiratory questionnaire; SD, standard deviation; CI, confidence interval.

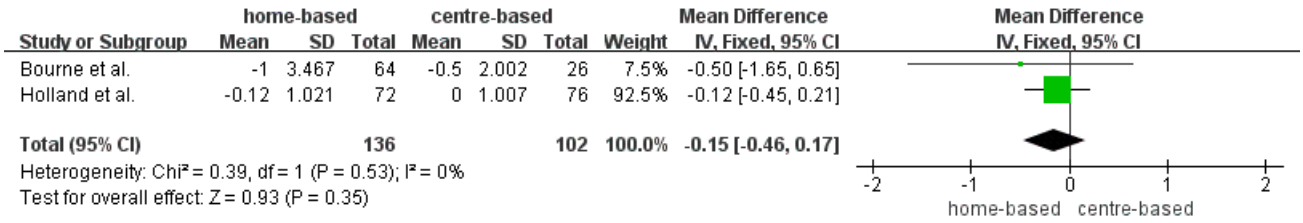

Figure 6 Forest plot for modified Medical Research Council dyspnoea scales. SD, standard deviation; CI, confidence interval.

Discussion

At present, COPD has become the fourth leading cause of death worldwide, with 600 million patients suffering from COPD each year, and it has become one of the most important public health issues in the world [23]. The main clinical symptoms of patients with COPD are persistent airflow limitation, decreased pulmonary function, varying degrees of dyspnea, and decreased quality of life. PR is a standard treatment method for patients with chronic and symptomatic pulmonary diseases [24]. It can improve patients' exercise capacity, quality of life and alleviate symptoms of dyspnea. The availability of PR is limited, particularly in rural areas. In addition, the implementation of PR is also faced with traffic, cost, time and other problems [7].

Home-based PR is not be limited by time and space. Also it can save patients' valuable time, avoid patients' long-distance travel and facilitate the communication between medical staff and patients, making the two more closely linked [25]. In order to ensure the effectiveness of home-based PR, key components of traditional central-based PR must exist, including appropriate personalized exercise prescriptions, self-management education, outcome measurement and patient support [26]. Home-based PR strives to provide patients with the most simple and accessible medical services can be divided into two categories: self-supervision and remote supervision. Home-based PR in the form of self-supervision is mainly treated through exercise diary, pedometer, regular contact with rehabilitation specialist, structured PR manual and so on. Remote supervision of PR is generally carried out by means of mobile phone, tablet, network and so on. The effectiveness of home-based PR has been proved, but the real question is whether home-based PR can produce the same effect as centre-based PR, thus becoming an alternative to central PR.

This systematic evaluation is the first study to directly compare the effect of home-based PR with centre-based PR. The research system compared the effect of centre-based PR on exercise capacity, dyspnea score and quality of life with home-based PR in patients with COPD. This study showed that the effects of home-based PR and centre-based PR were similar in terms of exercise ability, dyspnea score and quality of life in patients with COPD, and the differences were not statistically significant.

To sum up, home-based PR has similar effects with centre-based PR, which can be a substitute for centre-based PR, and is a new trend in the future development of PR.

The study found that most of the studies did not implement blinding, which may lead to potential implementation bias; different forms of home-based PR included in the study may have certain clinical heterogeneity, which has a certain impact on the results of the study. The above reasons affect the argumentation intensity of the results to a certain extent. In the future, a large number of high-quality, large-sample and multi-traditional RCT are still needed to verify the above conclusions. At the same time, the economic benefits and costs of home-based PR, the best implementation model of home-based PR and the comparison of long-term effects need to be further studied.

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