

# Self-management of health care behaviors for COPD: a systematic review and meta-analysis

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**Purpose:** This systematic review aimed to identify the most effective components of interventions to facilitate self-management of health care behaviors for patients with COPD. PROSPERO registration number CRD42011001588.

**Methods:** We used standard review methods with a systematic search to May 2012 for randomized controlled trials of self-management interventions reporting hospital admissions or health-related quality of life (HRQoL). Mean differences (MD), hazard ratios, and 95% confidence intervals (CIs) were calculated and pooled using random-effects meta-analyses. Effects among different subgroups of interventions were explored including single/multiple components and multicomponent interventions with/without exercise.

**Results:** One hundred and seventy-three randomized controlled trials were identified. Self-management interventions had a minimal effect on hospital admission rates. Multicomponent interventions improved HRQoL (studies with follow-up >6 months St George's Respiratory Questionnaire (MD 2.40, 95% CI 0.75–4.04,  $I^2$  57.9). Exercise was an effective individual component (St George's Respiratory Questionnaire at 3 months MD 4.87, 95% CI 3.96–5.79,  $I^2$  0%).

**Conclusion:** While many self-management interventions increased HRQoL, little effect was seen on hospital admissions. More trials should report admissions and follow-up participants beyond the end of the intervention.

**Keywords:** COPD, self-management, systematic review, meta-analysis

## Background

“Self-management” has been defined as “the ability of a patient to deal with all that a chronic disease entails, including symptoms, treatment, physical and social consequences and lifestyle changes”.<sup>1</sup> Within COPD, self-management interventions are very varied in delivery and content. Interventions are often multicomponent, commonly include exercise or physical activity support, disease education, recognition and management of exacerbations, respiratory muscle training, management of breathlessness, medication adherence, inhaler technique, smoking cessation, and relaxation.<sup>2</sup> Different behavioral change techniques underpin interventions.

An important driver for self-management is potential savings in health care costs from reducing hospital admissions. Patients with COPD have high rates of emergency department visits and hospital admissions and are costly to health services.<sup>3,4</sup> The huge diversity of potential self-management interventions makes it difficult for commissioners and providers of health services to select the most effective model of self-management support for people with COPD. To address this, we undertook a wide systematic review of interventions which included supported self-management for COPD to explore the effectiveness of various configurations on all-cause hospital admissions and health-related quality of life (HRQoL).

## Methods

### Study design

Systematic review of the effectiveness of COPD self-management interventions on hospital admissions and HRQoL measured by the St George's Respiratory Questionnaire (SGRQ) and Chronic Respiratory Disease Questionnaire (CRQ) total scores and reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses. This was part of a larger review registered in PROSPERO (CRD42011001588). The aim was to identify which individual or combination of components was most effective. No ethical approval was required for this review as it used secondary published data.

### Definition of self-management for this review

Self-management interventions were defined as those which involve collaboration between health care professional and patient so the patient acquires and demonstrates knowledge and skills required to manage their medical regimens, change their health behavior, improve control of their disease, and improve their well-being.<sup>5</sup> Guided by our patient participation group, a list of interventions/components was drawn up which were considered as self-management for this review (Table S1). Given the absence of a universally agreed definition of self-management, we took a very broad definition of self-management as it is known that there is a spectrum of interventions.<sup>6</sup> We excluded trials where the intervention was largely done to the patient by a professional such as a physiotherapy intervention involving handling of a patient; hospital-at-home or disease-management interventions were only included if they described a self-management component.

### Literature search and inclusion criteria

Potentially relevant citations were identified through comprehensive electronic searches from inception of the following bibliographic databases to May 2012: MEDLINE, MEDLINE In Process and EMBASE via Ovid, Cochrane (Wiley) Central Register of Controlled Trials (CENTRAL) and Science Citation Index (ISI), PEDro, PsycINFO (Ovid), and Cochrane Airways specialized register; (eg, search strategy in Supplementary materials). Reference lists of retrieved articles and relevant reviews were manually searched. Additional literature was identified through contacts with experts in the field.

To be included, trials had to have used randomization to create the study groups; required at least 90% of the

population to have COPD; reported a self-management intervention; reported hospital admissions or HRQoL; and were not solely smoking cessation.

No language restrictions were applied. Inclusion and exclusion criteria were applied to all citations and full texts of potentially relevant papers by two reviewers independently. Co-reviewers were consulted where there was uncertainty.

### Data extraction and risk of bias assessment

Data were extracted directly into tables; key characteristics (number of participants, duration of intervention, and follow-up) were all double checked and 20% of outcome data checked. To ensure consistency, one person (SM) categorized intervention components in all trials after the research team had each mapped 30 studies and discussed discrepancies and component definitions/criteria. Risk of bias was assessed according to methods in the Cochrane Handbook, assessing sequence generation, allocation concealment, blinding of personnel and participants (by outcome), incomplete outcome data (by outcome), selective outcome reporting and other potential threats to validity.<sup>7</sup>

### Data synthesis

For effect estimates of admissions over follow-up, hazard ratios (HR) were used. Only first admissions were used as it was not possible to combine different types of measures without making assumptions. Where HR were not directly reported, methods of Parmar et al<sup>8</sup> or Pernerger were used.<sup>9</sup> Where there were zero cells, a continuity correction (1/sample size of the opposite group) was added to each cell.<sup>10</sup>

For HRQoL, reported mean difference (MD) estimates and 95% confidence intervals (CIs) calculated from an analysis of covariance were preferred. Otherwise, MD reported from an analysis of change scores, an analysis of final scores or change value were used (preferred in that order). The SGRQ MD results were multiplied by -1 to ensure that all estimates related to the same direction of effect. Where data were missing they were not imputed, nor were authors contacted due to the large volume of papers.

In order to explore the effectiveness of different self-management components (or groups of components), a series of analyses was planned prior to collation of the data and followed two main objectives: i) to explore clinically relevant subgroups; ii) to avoid repeating any recent high-quality systematic review. We explored effectiveness of any single-component interventions delivered alone or where the only difference between the two arms was this single component.

A multicomponent self-management package was defined as including three or more relevant components.

A random-effects meta-analysis model was used to synthesize effect estimates across trials<sup>11</sup> to account for between-trial heterogeneity in intervention effects, and was estimated using methods of moments.<sup>11</sup> MD were pooled on the original scale, and HR pooled on the log<sub>e</sub> scale. Heterogeneity across studies was summarized using  $I^2$  statistic.<sup>12</sup> Trials reporting the SGRQ and CRQ were not combined because they report different domains (SGRQ: symptoms, activity, and impact; CRQ: dyspnea, fatigue, emotional functioning, and mastery).

Where two or more interventions from the same study contributed to the same meta-analysis, as they shared the same control group, the standard errors of their effect estimates were inflated, essentially by dividing the sample size in the control group by number of comparisons it contributed to within the meta-analysis.<sup>13</sup> For meta-analyses containing ten or more studies, small study effects (potential publication bias) were investigated by examining asymmetry on a funnel plot and calculating Egger's test, with  $P < 0.1$  taken as statistically significant. Potential causes of heterogeneity, such as number of components, duration of intervention, and follow-up were explored visually through Forest plots and by subgroup analyses.

## Results

From 13,355 identified titles, 836 full papers were obtained, 283 papers were included, and 173 randomized controlled trials from 193 papers reported one of the two primary outcomes: HRQoL and hospital admissions/readmissions (Figure 1). Within the 173 trials, several studies had multiple arms, thus there were 226 randomized comparisons of interventions compared to usual care, control or another active intervention.

## Populations and settings

The 173 trials were set in 31 countries with most from high-income countries, 33 (19.1%) from the USA and 21 (12.1%) from the UK (Table 1). Sample sizes ranged from 10 to 743, median 53 (interquartile range [IQR] 38, 100). Trials were generally small with 81 (46.8%) including less than 50 participants. The participant characteristics reported were frequently only of those who completed the trial, rather than all those randomized.

The mean age of participants was between 52 and 80 years; males tended to be in the majority. Mean FEV<sub>1</sub>% predicted of trial participants ranged from 26.3% to 69%. Approximately 20% of trials did not report the mean FEV<sub>1</sub>%

predicted, reporting other measures of lung function. These were consistent with moderate to severe COPD. More than half of trials had a population mean in the 30%–59% range, equivalent to GOLD stage 3, severe COPD. Recruitment of participants was mainly from secondary care or pulmonary rehabilitation programs.

## Trial design

Length of follow-up was frequently short, in 78 (45.1%) 3 months or less, and 106 (61.3%) of trials only reported follow-up data at the end of the intervention period (Table 1).

## The interventions

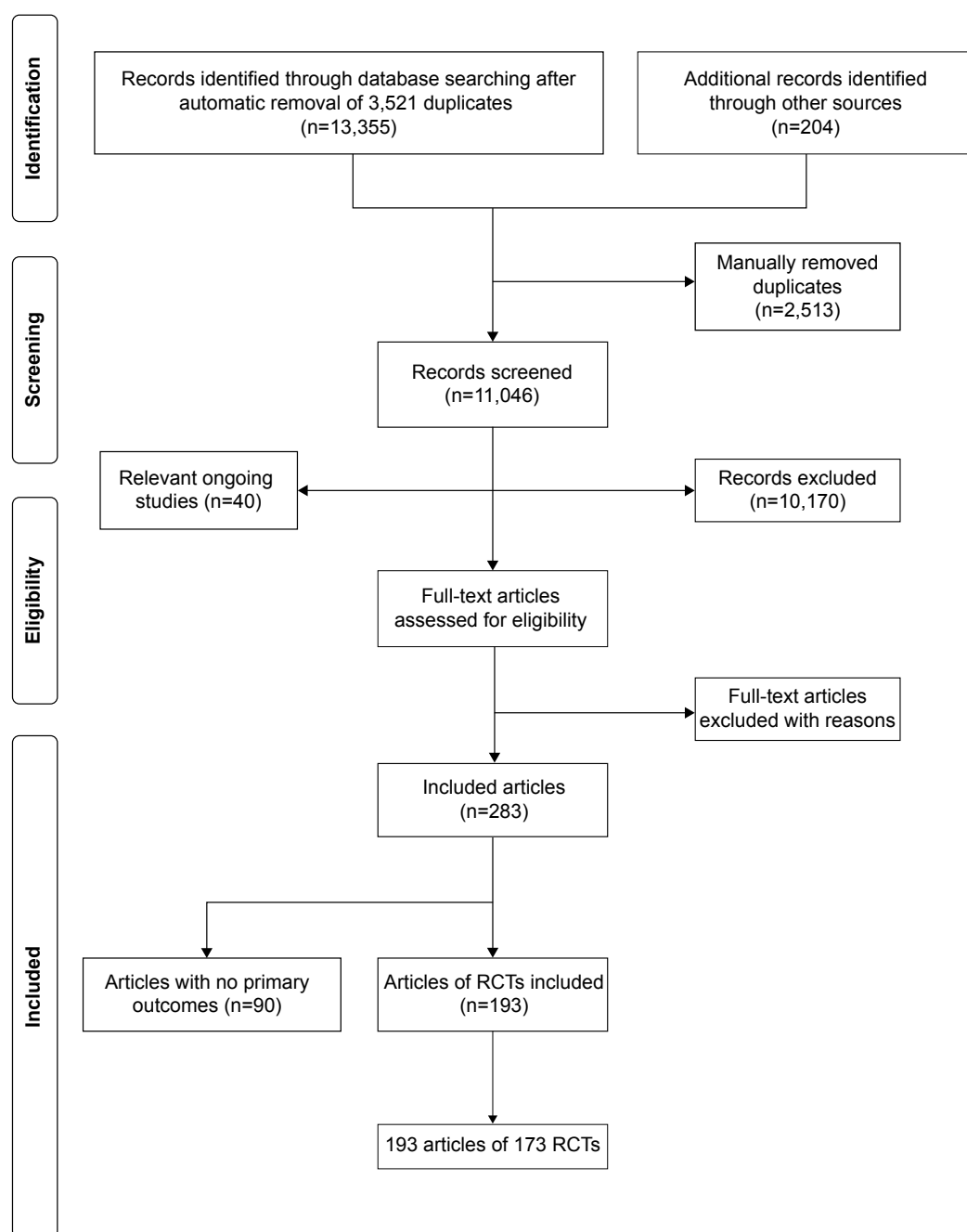
The interventions were very heterogeneous. They included structured group-based pulmonary rehabilitation programs (which aim to teach self-management skills); more limited one-to-one educational self-management interventions delivered in an outpatient setting or at a patient's home, sometimes with telephone follow-up; integrated disease management with multidisciplinary input and often some element of monitoring by health professionals; exercise-only interventions (with some dyspnea management) and respiratory muscle training using threshold devices. Within these various broad categories, there were a range of individual self-management components.

We categorized 15 types of components. Exercise was the most commonly reported component (77.9%) in interventions, followed by breathing techniques and management of dyspnea (64.6%) and general education about COPD and its management (47.8%) (Table S2). Up to 13 different self-management components were included in any one of the intervention arms with 73 (32.3%) having six or more components. Thirty-seven (16.4%) were single-component interventions with the vast majority of these being exercise-only (mixture of supervised and unsupervised exercise). The behavioral change elements were rarely reported in sufficient detail for categorization beyond information giving and other techniques.

The duration and mode of interventions are in Table 1; 113 trials (65.3%) reported interventions of 3 months duration or less; most were delivered by nurses and respiratory physiotherapists and half had a group-based component.

## Comparator arms

There were 139 comparisons (from 126 trials) of an intervention compared with usual care or control group that was not an active intervention. The usual care arm was frequently not described; in other cases, it was standard primary and/or secondary care for people with COPD.



**Figure 1** Flow diagram summarizing the study selection process.

**Abbreviation:** RCT, randomized controlled trial.

## Outcome measures

Most trials (163, 94.2%) reported HRQoL and only 42 (24.3%) reported hospital admissions or readmissions.

## Risk of bias of included studies

Table 2 summarizes risk of bias. Few trials provided an adequate description of sequence generation or allocation concealment; and due to trials being unblinded, there was a high risk of bias for HRQoL outcomes.

## The effect of individual components of self-management interventions

The effectiveness of individual components was established from interventions with only one component or where there was one additional component in the intervention compared to control. Only three trials of single components (exercise and action plans), two at a high risk of bias reported hospital admission rates, none reporting a significant effect (Table 3). In two trials of high risk of bias, breathing techniques (such

**Table 1** Characteristics of the trials and their populations

Characteristic	n	(%)
Setting		
North America	41	23.7
Europe	82	47.4
Australasia	18	10.4
Asia	22	12.7
Other	10	5.8
Sample size		
<50	81	46.8
50–99	46	27.2
100+	46	26.2
Age (mean/years)		
50–59	11	6.3
60–69	111	63.8
70–79	29	16.7
80+	1	0.6
Not reported as mean age	21	12.1
Males (n, %)		
1%–25%	4	2.3
26%–50%	36	20.8
51%–75%	62	35.8
75%–100%	51	29.5
Not reported	20	11.6
FEV <sub>1</sub> % predicted (mean)		
50–79	44	25.4
30–49	90	50.0
<30	5	2.9
Not reported as mean FEV <sub>1</sub> % predicted	34	19.6
Recruited from:		
Secondary care in-patient	15	8.7
Secondary care outpatient/unspecified	82	47.4
Emergency department	1	0.6
Pulmonary rehabilitation program/referral	21	12.1
Primary care	9	5.2
Primary and secondary care	3	1.7
Community	3	1.7
Primary or secondary care and advertisement	18	10.4
Not reported/unclear	21	12.1
Duration of intervention (weeks)		
≤13	118	65.3
14–26	28	16.2
27+	26	15.0
Unclear	6	3.5
Mode of intervention delivery		
Group	62	35.8
Individual	63	36.4
Mixed group and one-to-one	24	13.9
Remote	4	2.3
Unclear	20	11.6
Time to last follow-up (weeks)		
≤13	78	45.0
14–26	42	24.3
27–52	43	24.8
>52	8	4.6
Unclear	2	1.2
Time from end of intervention to last follow-up (weeks)		
0	106	61.3
≤13	27	15.6
14–26	16	9.2
27–52	16	8.7
>52	3	1.7
Unclear	6	3.5

**Note:** n refers to number of studies.

as yogic and diaphragmatic breathing) were associated with a significant and clinically important improvement in the SGRQ (MD 5.0, 95% CI 4.06–5.94,  $I^2$  0%), as was advice about fortification of food with milk powder (10.10, 95% CI 1.70–18.50). Single-component exercise interventions showed a significant and clinically important improvement in HRQoL at 3 months follow-up (SGRQ 4.87, 95% CI 3.96–5.79,  $I^2$  0%) although no significant effect was seen at later time points or when exercise was added to a self-management package. No benefits were observed for action plans or any other single component (Table 3; Figures S1–S3).

## The effectiveness of multicomponent self-management interventions

There were many different multicomponent interventions and they were too diverse to create meaningful groups. Overall, multicomponent interventions did not result in reduction in hospital admissions (Table 4; Figure S4), but were on average associated with improvements in HRQoL at all-time points (Table 5 and Figure 2; Figure S5), although there was high between-study heterogeneity in effect.

A group of multicomponent interventions which contained supervised exercise resulted in significant effects on HRQoL up to 6 months follow-up, but were not sustained and heterogeneity was very high (Figures S6 and S7). Significant effects on HRQoL were also observed for multicomponent interventions containing more limited exercise counseling, but those without any exercise support or counseling demonstrated no improvement in HRQoL (Figures S8–S10).

**Table 2** Summary of risk of bias

Risk of bias	Low	High	Unclear	Total
	n %	n %	n %	
Sequence generation	66 38.2	0 0	107 62.8	173
Allocation concealment	27 15.6	1 0.6	145 83.8	173
Blinding of HRQoL outcome	33 19.1	117 67.6	23 13.3	173
Blinding of admission outcome	44 97.8	0 0	1 2.2	45
Incomplete outcome data	46 26.6	82 50.0	45 26.0	173
Selective outcome reporting	54 31.2	2 1.2	117 67.6	173
Other biases	44 25.4	86 49.7	43 24.9	173

**Notes:** n refers to number of studies. Other biases include: only presenting the baseline characteristics of participants who completed follow-up; baseline differences between study groups; limited baseline characteristics reported.

**Abbreviation:** HRQoL, health-related quality of life.

**Table 3** Effect of single components on HRQoL and hospital admissions

Intervention and timing of study follow-up	HRQoL			Hospital admissions		
	Number of studies (comparisons)	Number of participants	Summary MD <sup>a</sup> (95% CIs)	I <sup>2</sup> (%)	Number of studies (comparisons)	Number of participants
Exercise only						
SGRQ at <3 m	4 (5)	320	4.87 (3.96–5.79)*	0.0	1 (2)	207
SGRQ at >6 m	1	19	8.50 (–2.29 to 19.29)	n/a		
CRQ at <3 m	2	106	0.70 (–0.07 to 1.47)	68.6		
CRQ at >3 to ≤6 m	2	146	1.17 (–0.35 to 2.69)	92.5		
Exercise in addition						
SGRQ at 3–12 m	2	75	8.20 (–2.28 to 18.67)	41.1	–	–
CRQ at 3–12 m	3	156	0.71 (–0.30 to 1.73)	82.4		
Action plans						
SGRQ at 6–12 m	4	587	0.43 (–1.69 to 2.54)	0.0	1 (12 m) 1 (6 m)	154 216
Breathing techniques						
SGRQ at <3 m	2	78	5.00 (4.06–5.94)*	0.0	–	–
CRQ at <3 m	1	43	0.17 (0.09–0.43)	n/a		
DAS						
SGRQ at <3 m	1	24	–1.20 (–12.01 to 9.61)	n/a	–	–
Food fortification						
SGRQ at 12 m	1	66	10.10 (1.70–18.50)*	n/a	–	–
Patient support groups						
SGRQ at 12 m	1	85	1.40 (–4.14 to 6.94)	n/a	–	–

**Notes:** \* $P < 0.05$ . <sup>a</sup>Positive MD represents an improvement for SGRQ and CRQ. – indicates no data.

**Abbreviations:** CIs, confidence intervals; CRQ, chronic respiratory disease questionnaire; DAS, distraction auditory therapy during exercise; HRQoL, health-related quality of life; HR, hazard ratio; MD, mean difference; n/a, not applicable; SGRQ, St George's respiratory questionnaire; m, months.



**Table 4** Effect of different multicomponent self-management intervention compared to usual care on hospital admissions

Intervention	Follow-up at ≤3 months			Follow-up at >3 to ≤6 months			Follow-up at >6 months		
	Number of studies (participants)	Summary HR (95% CIs)	I <sup>2</sup> (%)	Number of studies (participants)	Summary HR (95% CIs)	I <sup>2</sup> (%)	Number of studies	Summary HR (95% CIs)	I <sup>2</sup> (%)
Multicomponent	8 (879)	0.94 (0.73–1.20)	0.0	4 (353)	0.56 (0.22–1.42)	77.8	8 (1,810)	0.79 (0.60–1.05)	62.6
Multicomponent with supervised exercise	4 (321)	0.78 (0.54–1.14)	0.0	1 (46)	0.55 (0.25–1.18)	n/a	2 (86)	0.47 (0.08–2.60)	83.8
Multicomponent with structured, unsupervised exercise	–	–	–	–	–	–	1 (191)	0.55 (0.35–0.87)*	n/a
Multicomponent with exercise counseling only	2 (296)	1.40 (0.93–2.11)	0.0	3 (307)	0.52 (0.13–2.09)	81.0	3 (994)	0.79 (0.50–1.26)	67.9
Multicomponent without exercise advice or support	1 (40)	0.32 (0.03–3.03)	n/a	–	–	–	2 (539)	0.99 (0.76–1.30)	0.0

**Notes:** – indicates no data. \* $p < 0.05$ .

**Abbreviations:** CIs, confidence interval; HR, hazard ratio; n/a, not applicable.

## Publication bias

The four funnel plots of meta-analyses with at least ten studies show very strong evidence of publication bias consistent with an absence of smaller studies with negative outcomes.

## Discussion

This systematic review explored the components and delivery of self-management interventions to try to identify optimal mode of delivery and make-up of such interventions on hospital admission and HRQoL. Few interventions reduced hospital admissions, with only one analysis of one trial having a significant effect. Many different interventions improved HRQoL, particularly in the shorter term. It was unfortunately not possible to describe a package of effective elements, although exercise and dyspnea management seem important. This is supported by recent systematic reviews which report an association between physical activity and exacerbations, mortality and HRQoL,<sup>14</sup> and similar HRQoL outcomes in exercise-only and multicomponent pulmonary rehabilitation.<sup>15</sup>

## Comparison with the existing literature

Through mapping self-management interventions and their individual components, we were able to show the range of interventions, with differing components, delivered in a variety of ways. Almost all multicomponent interventions included exercise, and this was also the most common element in single-/two-component interventions.

Education is an important element of COPD self-management interventions; it was included in almost half the studies in this review. However, education is generally not effective by itself,<sup>16</sup> it requires combination with active, behavioral strategies, but it was frequently unclear to what extent these techniques were used. The use of a taxonomy of behavior change to describe the self-management interventions would enable their relative contributions to be ascertained.<sup>17</sup>

There were few studies which evaluated either individual components compared with usual care, or addition of an individual component to a wider package of care. Exploration of single-component interventions is important, as it may be easier for participants to focus on a single behavioral change rather than multiple.

We identified no significant effect on admissions or HRQoL with action plans, which supports previous evidence.<sup>18</sup>

We have reported the effects of exercise-only/exercise with dyspnea management interventions compared to usual care.

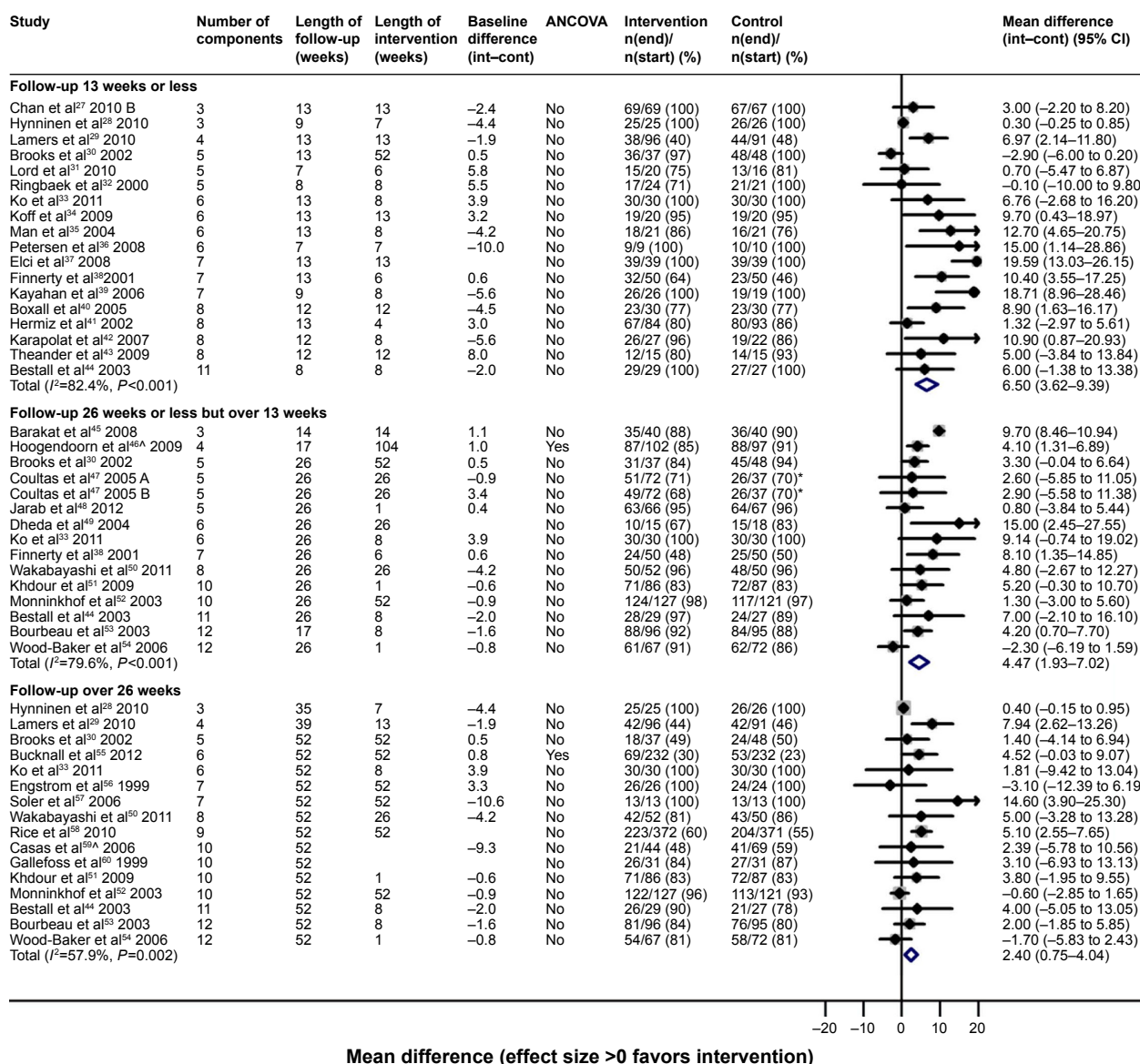
**Table 5** Effect of different multicomponent self-management intervention compared to usual care on HRQoL

Intervention	Follow-up at ≤ 3 months			Follow-up at > 3 to ≤ 6 months			Follow-up at > 6 months		
	Number of studies (participants)	Summary MD (95% CIs)	I <sup>2</sup> (%)	Number of studies (participants)	Summary MD (95% CIs)	I <sup>2</sup> (%)	Number of studies (participants)	Summary MD (95% CIs)	I <sup>2</sup> (%)
Multicomponent									
SGRQ	18 (1,296)	6.50 (3.62–9.39)*	82.4	14 <sup>a</sup> (1,905)	4.47 (1.93–7.02)*	79.6	16 (2,816)	2.40 (0.75–4.04)*	57.9
CRQ	7 (430)	0.40 (0.01–0.79)*	75.7	5 (360)	1.02 (0.05–1.98)*	93.2	3 (272)	1.21 (–0.47 to 2.88)	96.2
Multicomponent with supervised exercise									
SGRQ	14 (841)	7.75 (3.49–12.01)*	80.1	6 (580)	6.57 (3.24–9.90)*	77.6	4 (251)	1.13 (–2.81 to 5.08)	0.0
CRQ	7 (416)	0.43 (0.03–0.83)*	77.8	6 (380)	1.02 (0.19–1.86)*	92.0	3 (272)	1.21 (–0.47 to 2.88)	95.2
Multicomponent with structured, unsupervised exercise									
SGRQ	–	–	–	–	3.59 (1.28 to 5.91)*	0.0	5 (776)	0.80 (–1.03 to 2.63)	2.3
CRQ	1 (34)	0.61 (–0.18 to 1.41)	n/a	4 (714)	–	–	–	–	–
Multicomponent with exercise counseling only									
SGRQ	1 (177)	1.32 (–2.97 to 5.61)	n/a	3 (305)	1.87 (–4.43 to 8.18)	71.2	4 (1,021)	3.88 (–1.39 to 9.14)	74.6
CRQ	–	–	–	–	–	–	–	–	–
Multicomponent without exercise advice or support									
SGRQ	3 (278)	4.65 (–1.45 to 10.74)	82.0	2 (218)	2.75 (–3.24 to 8.74)	0.0	3 (702)	3.73 (–0.99 to 8.44)	81.1
CRQ	–	–	–	–	–	–	–	–	–

**Notes:** Positive MD represents an improvement for SGRQ and CRQ. \* $P < 0.05$ . <sup>a</sup>15 comparisons. – indicates no data.

**Abbreviations:** CIs, confidence interval; CRQ, chronic respiratory disease questionnaire; HRQoL, health-related quality of life; MD, mean difference; SGRQ, St George's respiratory questionnaire; n/a, not applicable.





**Figure 2** HRQoL (SGRQ) outcomes for multicomponent self-management intervention versus usual care.

**Notes:** \*Indicates that several papers are represented by this lead publication. A = nurse-assisted collaborative management vs UC. B = nurse-assisted medical management vs UC.

**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; Int, intervention group; Cont, control group; SGRQ, St George's respiratory questionnaire; UC, usual care.

In trials with follow-up at 3 months or less, there was a clinically and statistically significantly higher HRQoL in the self-management group, but due to few trials reporting admissions or HRQoL with longer follow-up, we have no evidence of an effect after this short period.

Our meta-analysis indicates that on average multicomponent, self-management interventions have a positive effect on HRQoL. Our summary estimates were larger than the minimal clinically important difference for SGRQ at follow-up to 6 months for multicomponent interventions and at all follow-up points for the CRQ.<sup>19</sup> However, we did find considerable heterogeneity, making it unclear which particular interventions and settings work best.

A recent Cochrane review reported significantly fewer hospital admissions (OR 0.60; 95% CI 0.40-0.89, six studies) and better HRQoL (MD in SGRQ -3.51, 95% CI -5.37 to -1.65, ten studies) in patients allocated to self-management, but excluding pulmonary rehabilitation.<sup>20</sup> This effect was larger than seen in a previous review of limited self-management education alone.<sup>21</sup> It is consistent with the effects of the more supported interventions in our review.

Several systematic reviews have addressed effectiveness of disease management.<sup>22,23</sup> A Cochrane review of integrated care reported a difference of 3.71 points on the SGRQ (95% CI 1.6, 5.8) favoring the intervention group

and reduction in respiratory admissions (OR 0.68, 95% CI 0.47, 0.99).<sup>22</sup> Given this recent report, we did not repeat this analysis.

Our analysis of self-management interventions with supervised exercise is similar to that of pulmonary rehabilitation programs.<sup>15</sup> The McCarthy review found a similar effect size at our follow-up points up to 6 months, but only provided one follow-up point. We report an attenuated effect after 1 year. We had higher heterogeneity, which may reflect our wider inclusion criteria and have been able to extend their review by reporting hospital admissions. Our study differs from many other systematic reviews<sup>14,20,22</sup> in reporting follow-up at three time points. Our findings of a possibly attenuation of effect are important and highlight the need for follow-up to 1 year or more and for interventions to include behavioral change strategies that will lead to long-term behavior change.

All our included trials delivered self-management to patients in groups or one-to-one. A large UK-based cluster randomized trial, published after our search was completed, supported primary care practitioners to embed self-management support into everyday practice,<sup>24</sup> but did not find statistically significant improvements in self-efficacy, HRQoL or shared decision-making (see additional Supplementary materials).

Our findings suggest that self-management support improves HRQoL in people with COPD. The mechanism of action of this improvement is likely to be due to a reduction in dyspnea and distress from dyspnea as a result of exercise and breathing techniques, reduced fatigue, improved mental health from increased physical activity, an altered perception about limitations in daily activities, and an increased confidence in management of their condition.<sup>25</sup> These may also lead to increased confidence in taking part in social activities.

## Strengths and limitations

This is the largest systematic review of self-management for COPD; searching was systematic with no exclusions by language or publication date. We used an extensive data extraction form to extract directly and, where not reported, indirectly calculate statistical results for intervention effects of interest. This allowed us to incorporate a larger number of studies in meta-analysis than previous reviews. Heterogeneity was apparent in most meta-analyses in this study, but none of the possible causes we explored were explained. Possible causes of heterogeneity include the usual care received by the control groups, severity of COPD, intervention differences

in terms of components, duration, intensity, setting, mode of delivery, and professional backgrounds of the people delivering the intervention.

Limitations result from heterogeneity of both the interventions and comparison groups, and general poor standard of reporting and conduct of many identified trials. As many trials used a “usual care” comparator, participants were generally not blinded to their allocation. This may have led to an attention effect, where participants in the active intervention arm have a more positive experience and often more social support through group-based activities. The heterogeneity meant that we were unable to perform indirect comparisons, which had been our intention. We included trials with any self-management components, which resulted in 16% of included trials being of a single self-management component. There is no agreed definition of self-management, but previous reviews have required self-management interventions to be multicomponent for inclusion.<sup>20</sup> Given that the focus of this review was to try to identify the most effective components of interventions to facilitate self-management of health care behaviors, it was important to include single-component self-management interventions in this review. We also found strong evidence of possible publication bias. The publication bias is a concern; however, the asymmetry may be due to systematic associations between sample size and other characteristics that impact on outcome, such as proactive support or group-based provision. The search was completed in 2012, so more recent literature may have been published. In addition, “usual care” has improved in recent years, with most hospitals in the UK now offering education as standard care; this may diminish the observed effect of self-management in more recent trials. Furthermore, due to the large literature identified we confined our outcomes to HRQoL reported using the SGRQ and CRQ and all-cause hospital admissions. This will have led to a potential loss of subtlety in the findings and interpretation as we can only comment on all-cause admissions. It may be that certain intervention components may have a greater effect on respiratory admissions, for example, pulmonary rehabilitation leads to a reduction in respiratory admissions.<sup>26</sup>

We planned to undertake full independent double data extraction on all papers, but due to the large number of eligible papers only one person extracted the characteristics and outcomes, with a 20% check of the outcome data and 100% check for key characteristics. To ensure consistency, the same person categorized the components in all trials. In extracting HRQoL outcome data, we focused on disease-specific measures (SGRQ and CRQ), and have not reported

the generic HRQoL outcomes as a wide variety of these were reported in a small number of trials.

Hospital admissions were reported in several different ways. We chose the rate of first admission because there were more data available; however, it is not clear how the effect of interventions would vary if all admissions could be considered. We were unable to separate out all-cause and respiratory admissions in many cases, so have reported all-cause admissions, which may be less amenable to change as a result of self-management interventions.

Included trials were set in 21 countries, suggesting that our findings can be generalized across a range of different health care settings. We did not explore the effect of the standard level of COPD care as potential cause of heterogeneity as it was often poorly described, but it may be an important factor. Most trial participants were recruited from secondary care, and participants generally had moderate/severe COPD, thus our findings may not be generalized well to populations with milder COPD managed in primary care. In addition, trials may recruit participants who are more affluent or have a higher educational level than the general population. Given the fundamental role of self-efficacy in many self-management interventions, the participant representativeness is key.

## Implications for future research or clinical practice

While overall self-management support for COPD appears to be associated with improvements in HRQoL, there is only evidence for an effect on hospital admissions in the most supported subgroup. The considerable inconsistency in outcomes requires additional research, but future trials need to be larger, better designed and reported, with longer follow-up after the end of the intervention and clearer descriptions of the interventions describing the behavioral change components employed. Future evidence syntheses would be greatly aided by consistent reporting of hospital admissions and the use of a single patient-reported outcome for HRQoL. An individual patient data meta-analysis of high-quality trials might shed more light on which individual components of self-management are most effective.

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## Author contributions

KJ and REJ conceived the study, KJ, REJ, RDR, PA, DAF, and DJM contributed to the protocol, SEB advised on and performed search strategies, KJ, SM, REJ, NRH, DJM, PA, and AMT contributed to study selection, SM led the development of a risk of bias and data extraction tools, SM, NRH, and EJB extracted results, SM, EJB, NRH, DJM, and KJ undertook the risk of bias assessment, SM, MJP, and RDR coordinated and undertook some data extraction and/or calculation of effect estimates, RDR advised on statistical and reviewing methods and supervised statistical analyses, AJS undertook the statistical analyses, KJ oversaw the analyses, SJS, DAF, and AMT provided clinical input, KJ with input from REJ and RDR wrote and edited the paper. All authors contributed to the paper and commented on the final version.

## Disclosure

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## Supplementary materials

**Table S1** Definitions of components of self-management

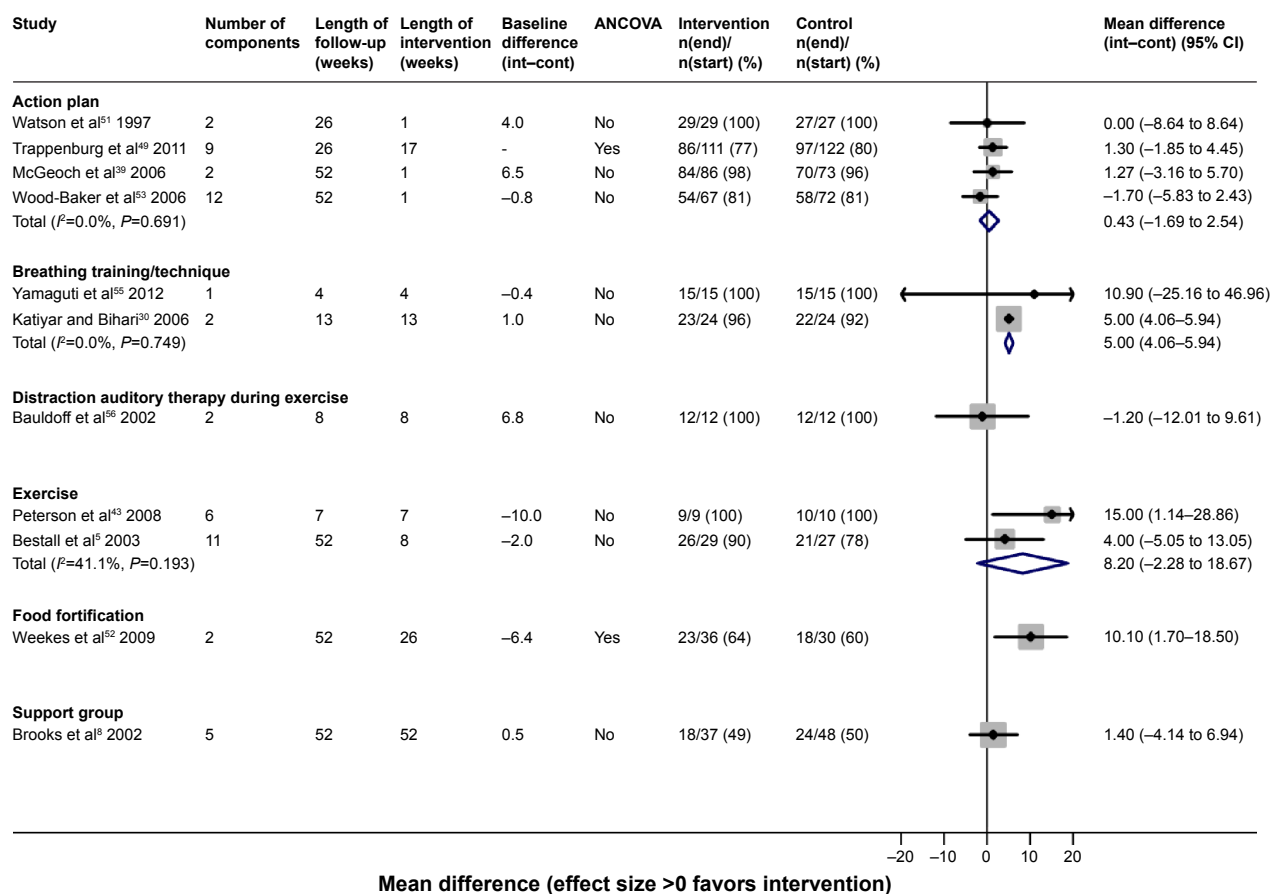
Component	Broad inclusion/definition
Disease knowledge	Education about disease, disease management, treatments, self-management, chronic illness, activities of daily life, end of life, self-care tips, travel, and COPD
Self-management unspecified	Self-management education/skills
Respiratory muscle training	Inspiratory muscle training, expiratory muscle training (pressure, threshold, and resistance devices)
Action planning	Managing exacerbations, coping plan, management of COPD symptoms, recognizing when to call a doctor
Breathing management and techniques	Breathing exercises, breathing retraining, respiratory biofeedback, managing breathlessness and coping with triggers for breathlessness, tai chi, vocal exercises
Smoking cessation	Advice, counseling, groups, interventions to help reduce/quit smoking as required
Medication/adherence	Information about medication and adherence, promoting adherence (pharmacological or nonpharmacological)
Bronchial hygiene techniques	Postural drainage/coughing technique
Nutrition	Advice, counseling, groups, supplements as required
Psychological intervention	Psychosocial support, cognitive behavioral therapy, cognitive training, relaxation (including exercises, eg, progressive muscle relaxation), stress management, general goal setting, mood disturbance, handling emotions (how to cope with the disease), psychosocial problems associated with respiratory disability, self-talk and panic control, health qigong
Preventative	Avoiding exacerbations, pollution and environmental hazards, managing infections, and personal hygiene
Inhaler technique and use	Assessing inhaler technique, teaching correct use, and handling of inhalers
Energy conservation	Pacing and good posture, home modifications and activities of daily living, work simplification
Support groups/patient empowerment	Peer support self-help groups/networks, eg, Breathe Easy, developing confidence to negotiate with clinicians
Exercise – strength	Upper limb, lower limb strength/resistance exercises
Exercise – aerobic	Cycling, walking, stair climbing as aerobic/endurance exercises
Exercise – other	Flexibility and balance exercises, sham training, unspecified exercises
Enhanced access/care	Access to health professionals, access to call center/hotline, health professional home visits and/or telephone support
Other	Any miscellaneous uncommon components, eg, sleep or other symptom control
Usual care	Usual medications and visits to general practitioner or routine secondary care



**Table S2** Content of interventions by the number of components within the self-management package

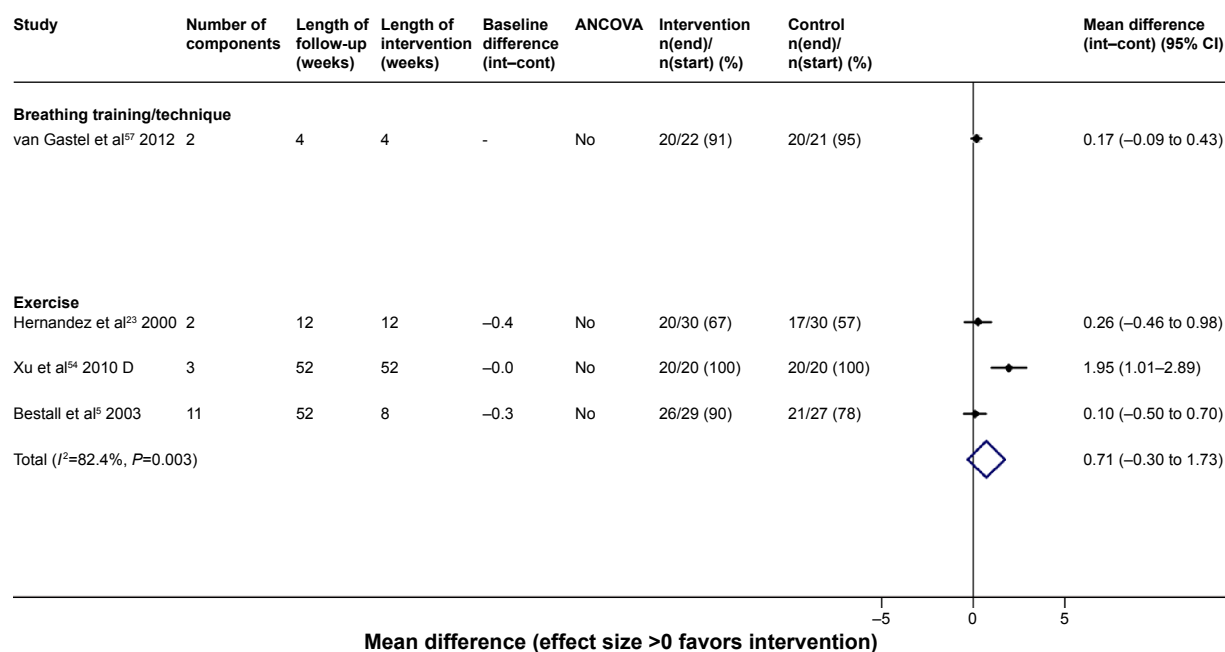
	Number of self-management components in intervention													Total number of interventions (% of comparisons <sup>a</sup> )
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Action planning for self-treating exacerbations	0	3	2	2	4	2	7	6	4	7	3	3	1	43 (19.0)
Breathing techniques/dyspnea management	2	37	16	15	10	18	16	12	5	7	5	24	1	146 (64.6)
Bronchial hygiene/secretion clearance techniques	0	0	0	4	2	3	5	4	1	3	5	2	1	30 (13.3)
Disease knowledge	0	8	11	10	14	17	16	13	4	7	5	2	1	108 (47.8)
Energy conservation	0	0	0	2	0	3	1	8	1	2	4	1	0	22 (9.7)
Enhanced access	0	4	6	3	6	4	8	7	3	4	3	1	1	50 (22.1)
Exercise	25	37	21	14	10	18	17	14	5	7	5	2	1	176 (77.9)
Inhaler technique	0	0	0	1	2	4	8	7	4	5	2	2	1	36 (15.9)
Medication advice	0	1	6	3	7	16	13	13	5	6	5	1	1	77 (34.1)
Nutrition advice	0	2	3	1	4	8	10	6	4	5	5	2	1	51 (22.6)
Preventative measures to avoid infection	0	0	3	0	0	2	2	3	2	2	2	1	1	18 (8.0)
Psychological including relaxation and stress management	1	3	8	14	8	14	8	7	2	4	5	2	1	77 (34.0)
Respiratory muscle training	9	7	7	1	0	3	4	0	0	0	1	0	0	32 (14.2)
Smoking cessation advice/support	0	0	0	1	5	6	9	8	4	5	3	2	1	44 (19.5)
COPD support groups	0	0	0	0	1	2	1	1	0	1	0	1	0	7 (3.1)
Unspecified	0	0	1	4	3	6	0	3	0	4	1	1	1	24 (10.6)
Other	0	6	3	1	4	0	1	0	1	1	1	0	0	18 (7.7)

**Note:** <sup>a</sup>n=226 comparison groups.



**Figure S1** HRQoL (SGRQ) at final follow-up for comparisons assessing the effects of one additional component of self-management.

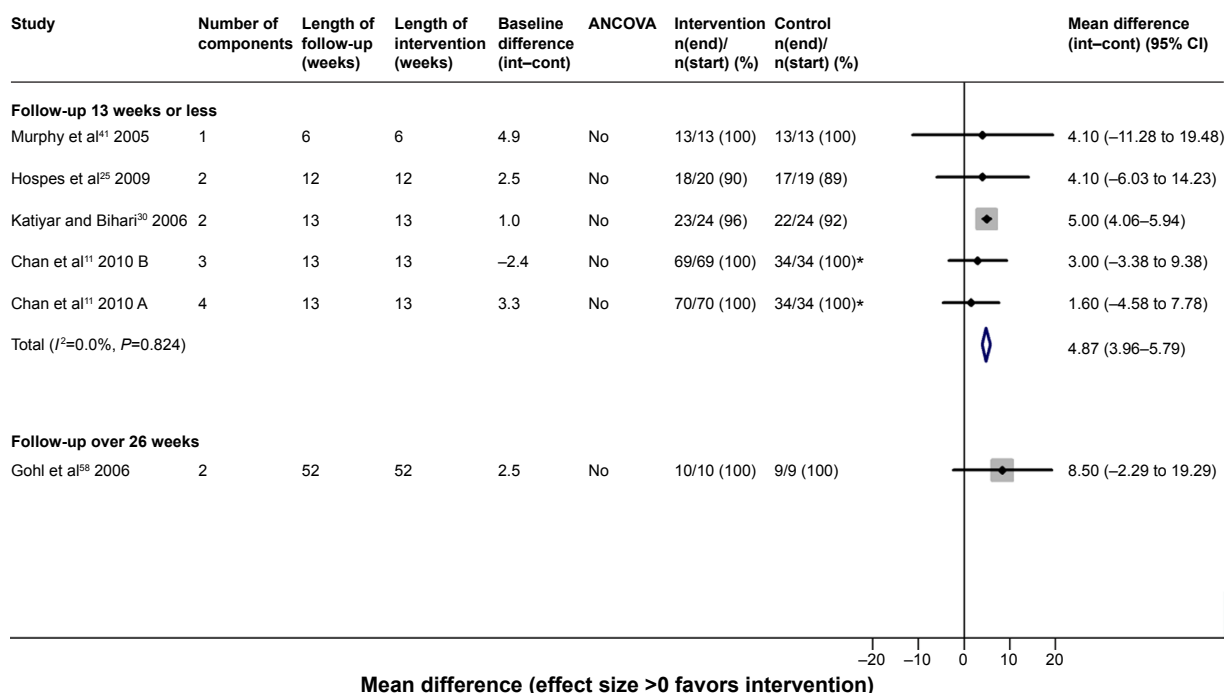
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; SGRQ, St George's respiratory questionnaire; Int, intervention group; Cont, control group.



**Figure S2** HRQoL (CRQ) at final follow-up for comparisons assessing the effects of one additional component of self-management.

**Note:** D = rehabilitation (traditional and modern) + qigong + breathing training + limb training vs modern rehabilitation + breathing training + limb training.

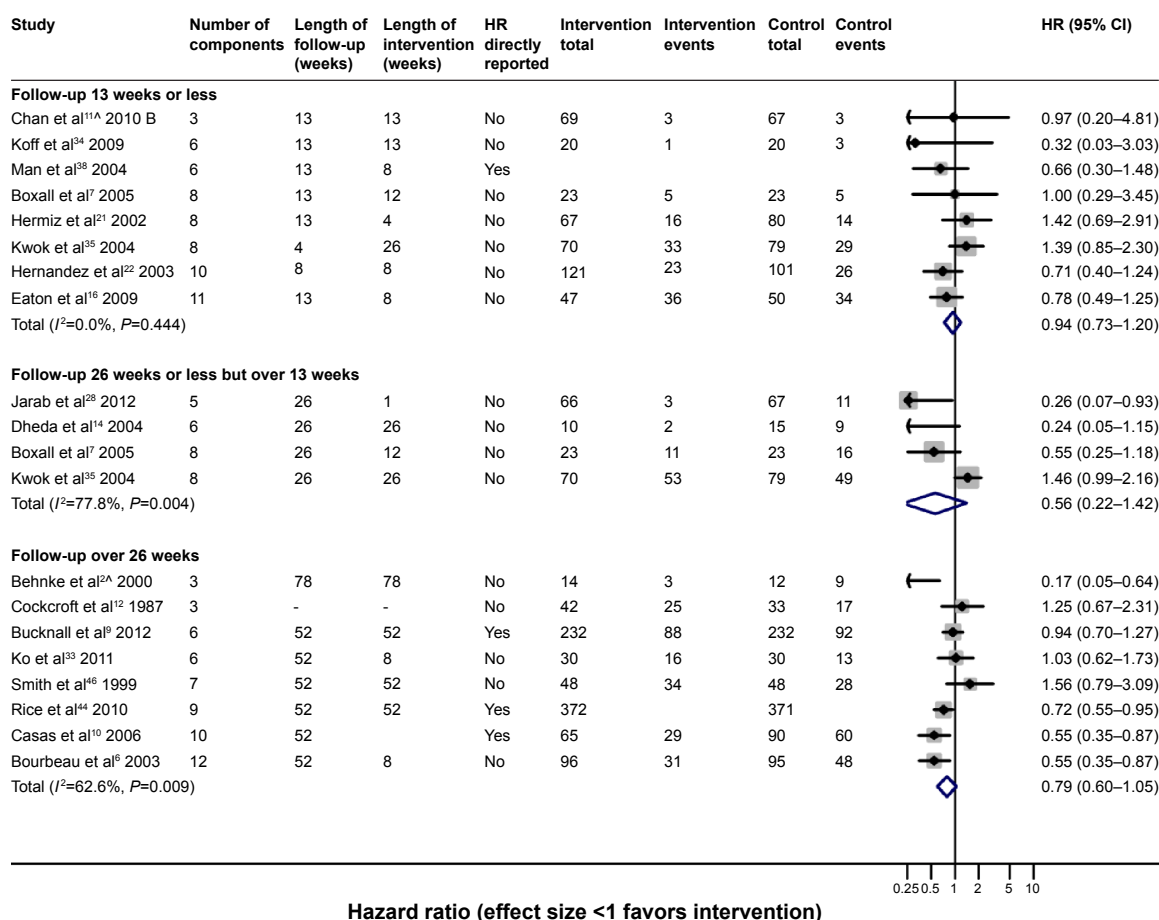
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; CRQ, Chronic Respiratory disease Questionnaire.



**Figure S3** HRQoL (SGRQ) outcomes for exercise-only interventions versus usual care/sham intervention.

**Note:** \*The control group that has been halved in size (split between two comparisons). A = t'ai chi qigong vs control. B = exercise vs control.

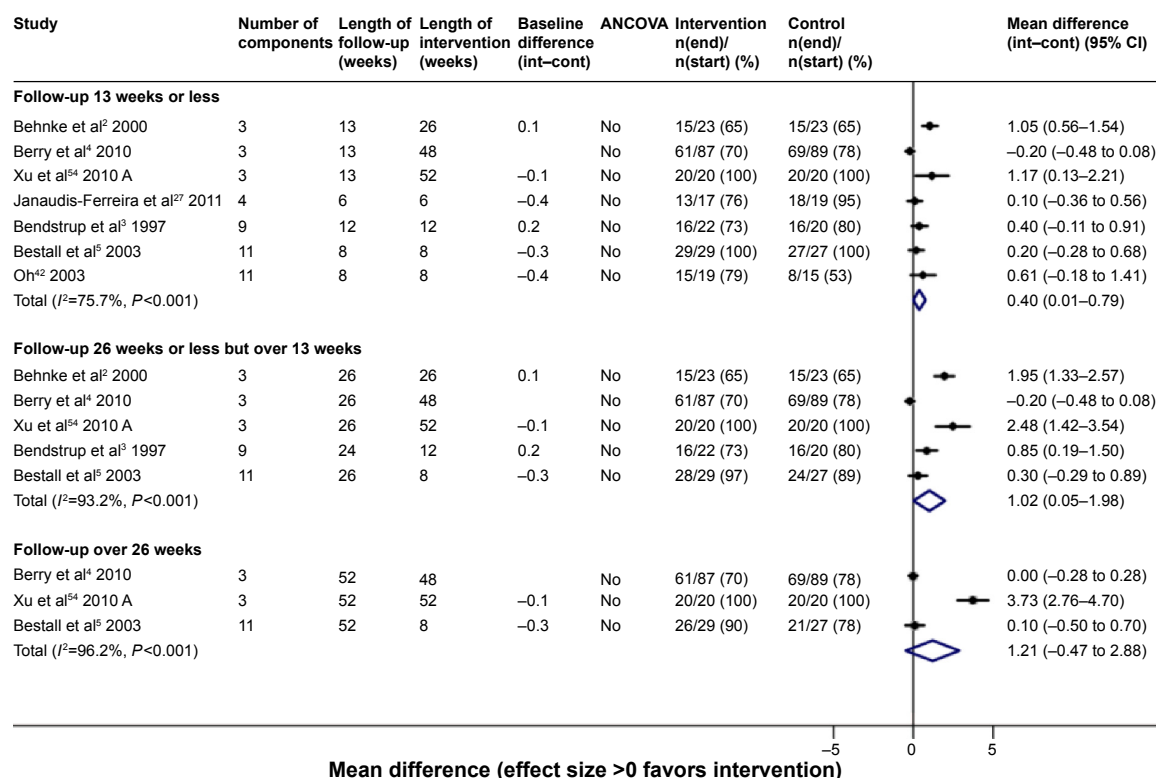
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; SGRQ, St George's respiratory questionnaire.



**Figure S4** Hospital admissions for multicomponent self-management interventions versus usual care.

**Notes:** B = exercise vs control. ^Several papers are represented by this lead publication.

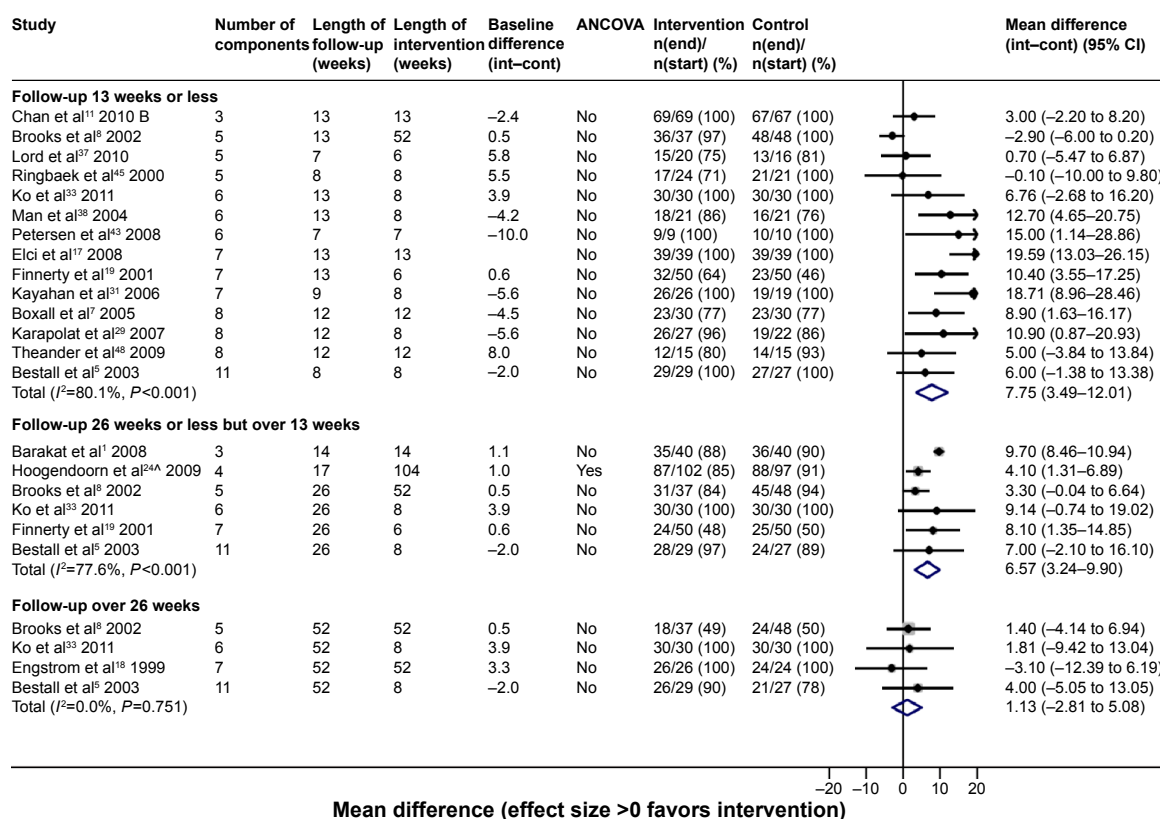
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HR, hazard ratio.



**Figure S5** HRQoL (CRQ) outcomes for multicomponent self-management intervention versus usual care.

**Note:** A = rehabilitation (traditional and modern) + qigong + breathing training + limb training vs UC.

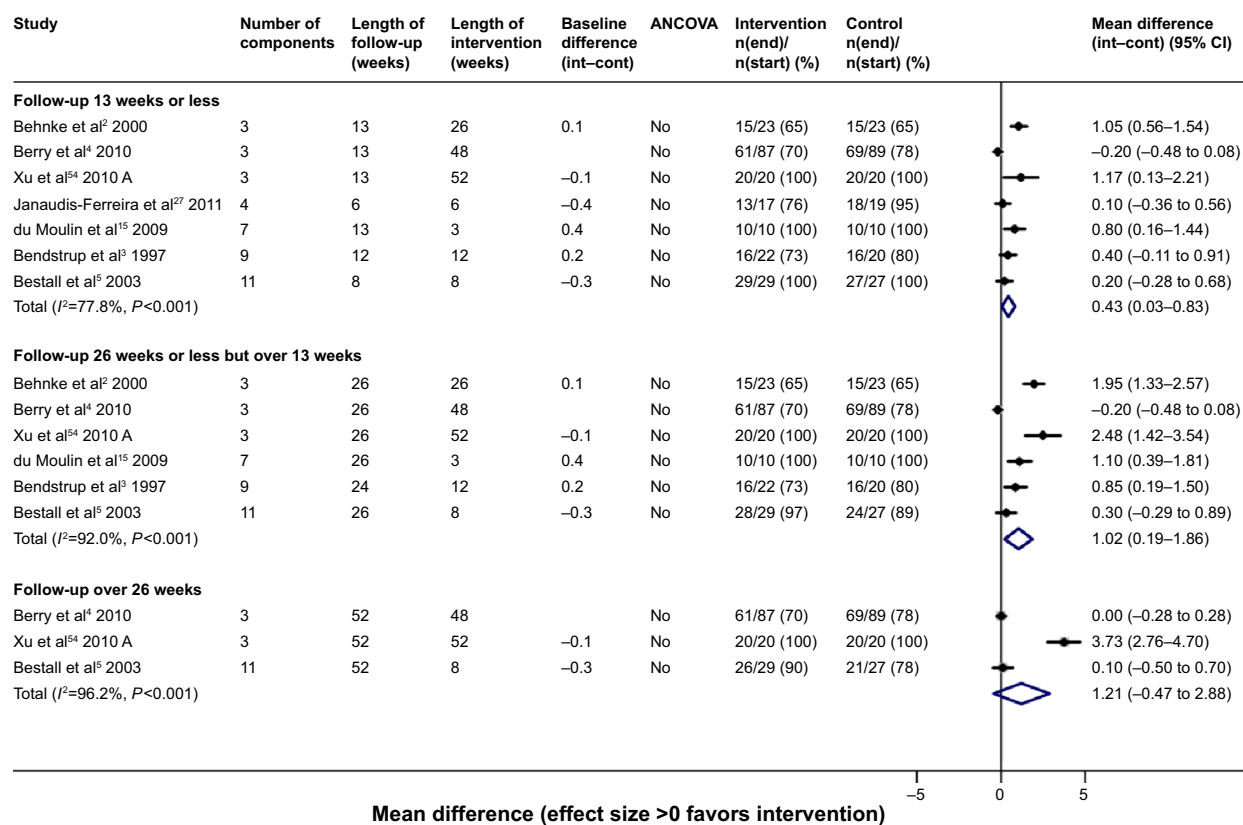
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; CRQ, Chronic Respiratory disease Questionnaire; UC, usual care.



**Figure S6** HRQoL (SGRQ) outcomes for multicomponent self-management interventions including supervised exercise versus usual care/control.

**Notes:** B = exercise vs control. <sup>A</sup>Several papers are represented by this lead publication.

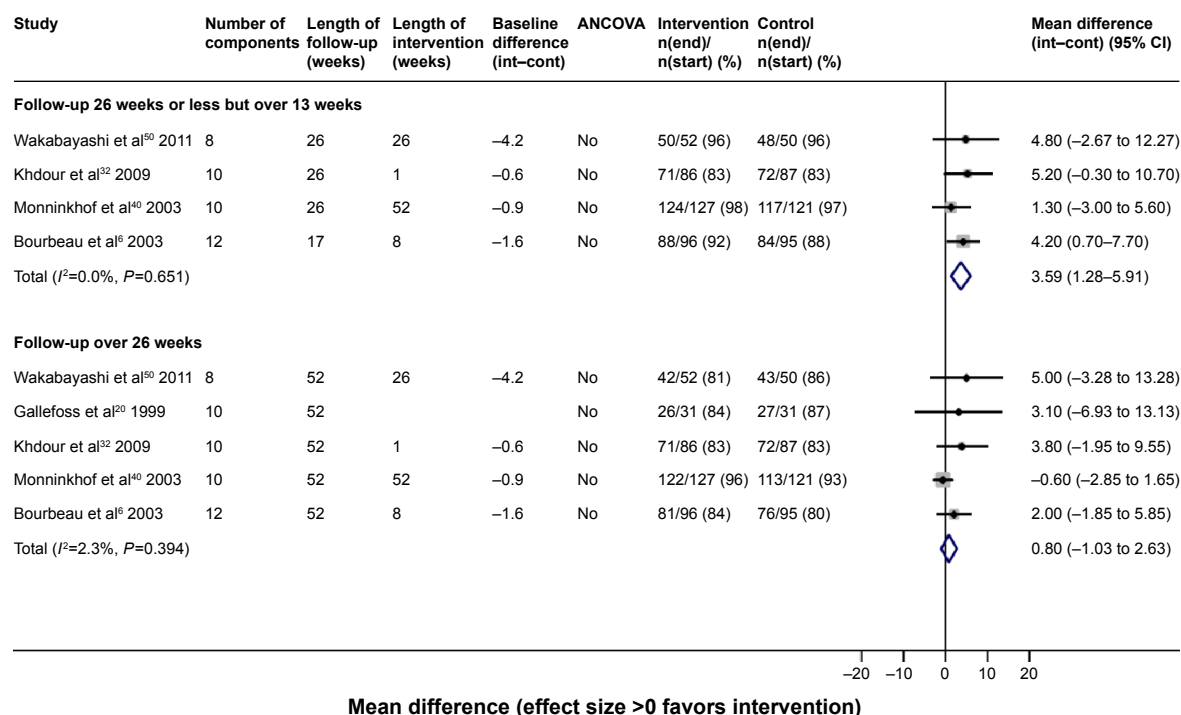
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; SGRQ, St George's respiratory questionnaire.



**Figure S7** HRQoL (CRQ) outcomes for multicomponent self-management interventions including supervised exercise versus usual care/control.

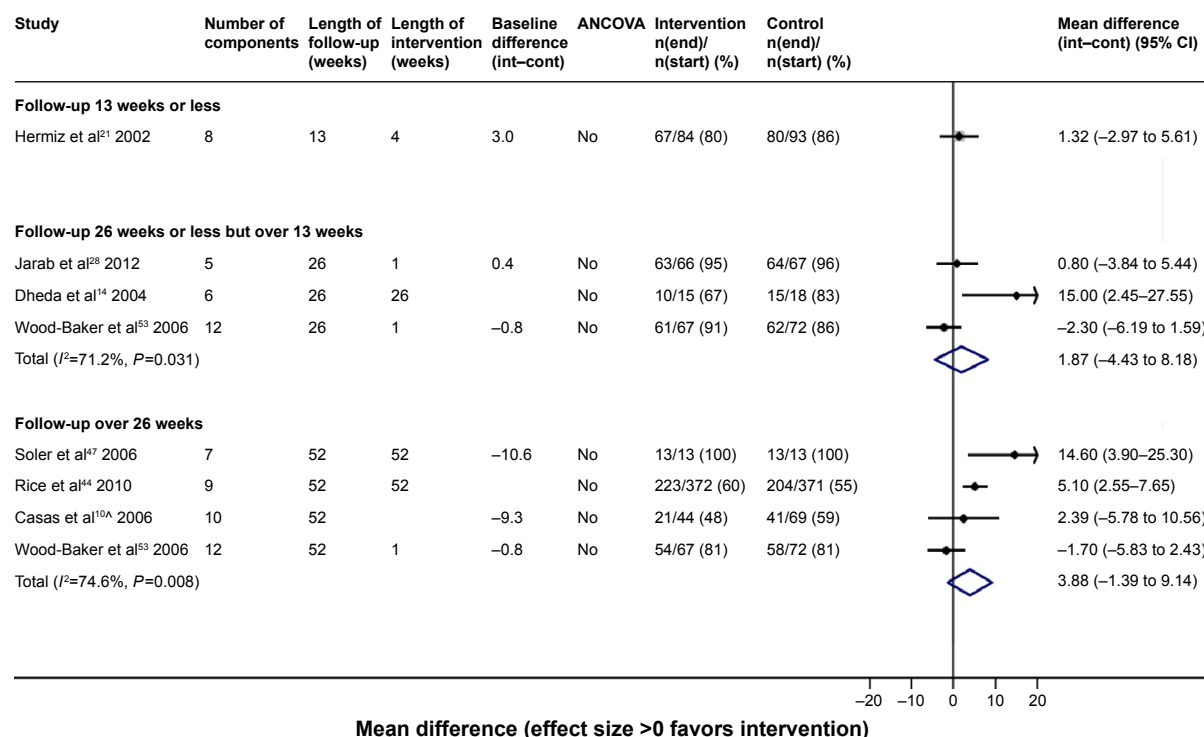
**Note:** A = rehabilitation (traditional and modern) + qigong + breathing training + limb training vs UC.

**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; CRQ, Chronic Respiratory disease Questionnaire; UC, usual care.



**Figure S8** HRQoL (SGRQ) outcomes for multicomponent self-management interventions with structured, unsupervised exercise versus usual care/control.

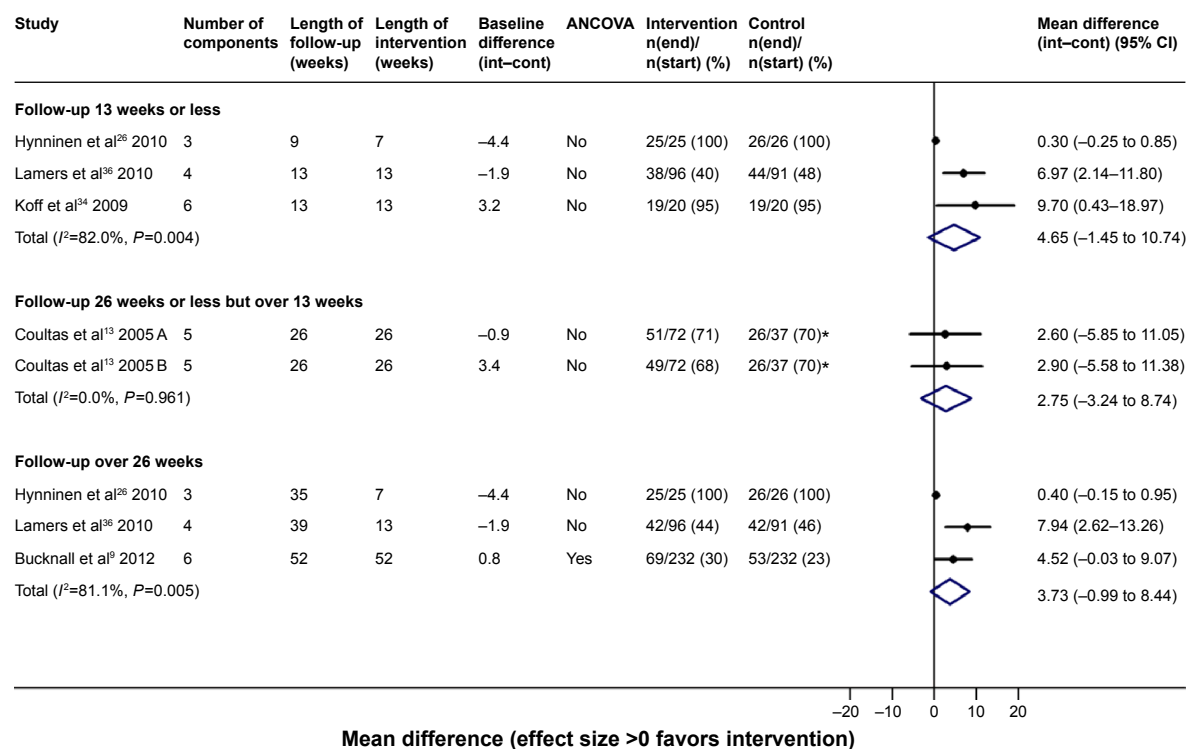
**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; SGRQ, St George's respiratory questionnaire.



**Figure S9** HRQoL (SGRQ) outcomes for multicomponent self-management interventions with exercise counseling only versus usual care/control.

**Note:** ^Several papers are represented by this lead publication.

**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; SGRQ, St George's respiratory questionnaire.



**Figure S10** HRQoL (SGRQ) outcomes for multicomponent self-management interventions without an exercise element versus usual care/control.

**Notes:** \*The control group that has been halved in size (split between two comparisons). A = nurse-assisted collaborative management vs UC; B = nurse-assisted medical management vs UC.

**Abbreviations:** ANCOVA, analysis of covariance; CI, confidence interval; HRQoL, health-related quality of life; SGRQ, St George's respiratory questionnaire; UC, usual care.



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