The risks and benefits of yoga for patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis

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Abstract

Objectives: To determine the effectiveness and safety of yoga interventions on disease symptoms, quality of life and function in patients diagnosed with chronic obstructive pulmonary disease (COPD).

Data sources: Medline/PubMed, Scopus, and CENTRAL (Cochrane Central Register of Controlled Trials) were searched through 6 June 2019.

Review methods: Randomized controlled trials assessing the effects of yoga on quality of life, dyspnea, exercise capacity, and pulmonary function (FEV1) in patients with COPD were included. Safety was defined as secondary outcome. Mean differences (MD) and standardized mean differences (SMD) with 95% confidence intervals (CIs) were computed. Risk of bias was assessed using the Cochrane tool.

Results: Eleven randomized controlled trials with a total of 586 patients were included. Meta-analysis revealed evidence for effects of yoga compared to no treatment on quality of life on the COPD Assessment Test (MD=3.81; 95% CI=0.97 to 6.65; $P=0.009$, $I^2=70\%$), exercise capacity assessed by the 6-minute walk test (MD=25.53 m; 95% CI= 12.16 m to 38.90 m; $P=0.001$, $I^2=0\%$), and pulmonary function assessed by FEV1 predicted (MD = 3.95%; 95% CI= 2.74% to 5.17%; $P<0.001$, $I^2=0\%$). Only the effects on exercise capacity and pulmonary function were robust against methodological bias. Effects were only present in breathing-focused yoga interventions but not in interventions including yoga postures. Adverse events were reported infrequently.

Conclusion: This meta-analysis found robust effects of yoga on exercise capacity and pulmonary function in patients with COPD. Yoga, specifically yoga breathing techniques, can be an effective adjunct intervention for patients with COPD. Yoga's safety needs to be assessed in more depth in future studies.

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Introduction

A 2015 Cochrane review found that rehabilitation programs, including physical exercise, were beneficial for improving health-related quality of life and exercise capacity in chronic obstructive pulmonary disease.¹

The combination of physical, breathing, and meditative practices in traditional yoga may provide an alternative exercise activity for patients with chronic obstructive pulmonary disease. Interestingly, adults with chronic obstructive pulmonary disease are among those with the lowest utilization rate of yoga.^{2,3} Conversely, adults with asthma are among the highest yoga users,^{2,3} with evidence suggesting yoga significantly improves quality of life and respiratory function in that clinical population.⁴ Chronic obstructive pulmonary disease has been a major focus of research identified in a bibliometric analysis of yoga research,⁵ with a large number of trials published in recent years. As the 2015 Cochrane review¹ specifically excluded yogic exercise interventions, the potential benefits of yoga have not been systematically assessed. As such, this current systematic review aims to determine the effectiveness and safety of yogic interventions in patients diagnosed with chronic obstructive pulmonary disease. We hypothesized that yoga would be more effective than no treatment in improving quality of life, dyspnea, exercise capacity, and pulmonary outcomes in patients diagnosed with chronic obstructive pulmonary disease.

Methods

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines⁶ and the recommendations of the Cochrane Collaboration⁷ as a framework for the reporting

structure of this review. The review protocol was not registered.

We included randomized controlled trials, randomized cross-over studies, and cluster-randomized trials on adult patients with chronic obstructive pulmonary disease, regardless of publication language. Studies on yoga interventions were included, regardless of yoga tradition, length or frequency of the yoga sessions, or intervention duration. Studies allowing individual co-interventions in addition to the study interventions were included. We grouped the yoga interventions according to their content:

1. Interventions including yoga breathing only (based on yoga theory and/or traditional yoga practices), without physical postures, meditation, or lifestyle advice.
2. Complex yoga interventions including yoga breathing and at least 1 of the following: physical postures, meditation, and/or lifestyle advice (based on yoga theory and/or practices).

Regarding control interventions, we included studies comparing yoga to no treatment, sham yoga, or any active control intervention.

In terms of outcome measures, studies were included if they assessed at least one of our primary outcomes:

1. Quality of life, assessed by validated disease-specific or generic instruments. We preferred disease-specific instruments over generic ones when multiple instruments were used in a single study.
2. Dyspnea, assessed by validated self-report instruments.
3. Exercise capacity, clinician-assessed using standardized tests such as the 6-minute walk test.

4. Pulmonary function, operationalized as absolute or predictive forced expiratory volume in one second, assessed by validated measures such as spirometry.

Safety of the intervention, assessed as the number of patients with adverse events, was defined as a secondary outcome.

On the basis of these eligibility criteria, we searched three electronic databases from their inception through 6 June 2019: Medline (via PubMed), Scopus, and the Cochrane Central Register of Controlled Trials (CENTRAL). We adapted the search strategy for each database as necessary. The complete search strategy for each database searched is given in the Supplemental Appendix. In addition, we manually screened reference lists of identified original articles or reviews, and the tables of contents of the *International Journal of Yoga Therapy* and the *Journal of Yoga & Physical Therapy*.

Two reviewers independently conducted the abstract screening and selection process, and read in full potentially eligible articles. Disagreements over article inclusion were settled through discussion with a third reviewer until consensus was reached. If necessary, we obtained additional information from the authors of the primary study.

Two reviewers independently extracted data on demographics (e.g. age, gender, ethnicity), methods (e.g. randomization, allocation concealment), interventions (e.g. yoga type, frequency, duration), control interventions (e.g. type, frequency, duration), outcomes (e.g. outcome measures, assessment time points), and results using an a priori developed data extraction form. Likewise, two reviewers independently assessed risk of bias using the Cochrane risk of bias tool. This tool assesses risk of bias on seven criteria: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. Each criteria is rated as either low, unclear, or high risk of bias.⁷ Discrepancies were checked with a third reviewer, and consensus was achieved by discussion.

In statistical analysis, we conducted separate meta-analyses for the different control conditions. We conducted meta-analyses using Review Manager software (Version 5.1; The Nordic Cochrane Centre, Copenhagen) by random effects model, using the generic inverse variance method if at least two studies assessing a specific outcome were available. We calculated standardized mean differences with 95% confidence intervals as the difference in means between groups divided by the pooled standard deviation.⁷ Where no standard deviations were available, we calculated them from standard errors, confidence intervals, or *t*-values,⁷ or contacted the trial authors by email for clarification. We defined a positive standardized mean difference as indicating beneficial effects of yoga compared to the control intervention (i.e. increased quality of life, exercise capacity, and pulmonary function), except for dyspnea where we defined a negative standardized mean difference as indicating beneficial effects (i.e. lower dyspnea). We used Cohen's⁸ categories to evaluate the magnitude of the overall effect size with standardized mean differences of (1) 0.2–0.5: small; (2) 0.5–0.8: medium, and (3) 0.8: large effect sizes. Where the same assessment instrument was used in multiple studies, we further calculated mean differences and their 95% confidence intervals as the absolute difference between mean values in the two groups.⁷ We further analyzed the magnitude of heterogeneity using the I^2 statistic. The statistic was categorized as (1) $I^2=0\%–24\%$: low; (2) $I^2=25\%–49\%$: moderate; (3) $I^2=50\%–74\%$: substantial; and (4) $I^2=75\%–100\%$: considerable heterogeneity.⁷ We further used the chi-square test to assess whether differences in results were compatible with chance alone. Given the low power of this test when only few studies or studies with low sample size are included in a meta-analysis, we regarded a *P*-value equal or less than 0.10 to indicate significant heterogeneity.⁷

We conducted subgroup analyses for the type of yoga intervention (yoga breathing interventions vs complex yoga interventions). To test the robustness of significant results, we conducted sensitivity analyses for studies with high versus low risk of bias at the following domains: selection bias, detection

bias, and attrition bias. If present in the respective meta-analysis, we also used subgroup and sensitivity analyses to explore possible reasons for statistical heterogeneity.

If at least 10 studies were included in a meta-analysis, we originally planned to generate funnel plots to assess publication bias.⁷ Since less than 10 studies were included in each meta-analysis, this was not possible.

Results

The results of the literature search are shown in Figure 1; Table 1 presents characteristics of the included studies, Table 2 the interventions used in the included studies, and Table 3 the risk of bias of the included studies. The 11 studies included in the review⁹⁻²¹ had a combined total of 586 patients, with a median sample size of 49 patients. The median age of included patients was 57.6 years; the studies included a median of 16.7% female patients. The median duration of the yoga interventions was 12 weeks, with a median frequency of five yoga sessions per week.

Regarding patient-reported outcomes, our meta-analysis found no evidence for superiority of yoga to no treatment on quality of life or dyspnea when multiple outcome measures were included in the analysis (Figure 2). However, when we limited the analysis to studies using the chronic obstructive pulmonary disease assessment test, we found evidence for positive effects compared to no treatment (Table 4).

Regarding clinician-assessed outcomes and including multiple assessment methods in the analyses, we found positive effects of yoga compared to no treatment on exercise capacity, but not for forced expiratory volume in one second (Figure 3). When we limited the analysis to studies using the same assessment method, we found further effects of yoga compared to no treatment on predicted but not on absolute values of forced expiratory volume in one second (Table 4). We found no differences between yoga and physiotherapy on forced expiratory volume in one second.

In subgroup analyses, when limiting the analysis to studies using breathing-based yoga interventions,

we found positive effects compared to no treatment on dyspnea, exercise capacity, and predicted forced expiratory volume in one second (Table 5). When limiting the analysis to complex yoga interventions, we only found effects on exercise capacity.

In sensitivity analyses, including only studies with low risk of selection bias, only the effects of yoga compared to no treatment on quality of life on the chronic obstructive pulmonary disease assessment test and on exercise capacity on the 6-minute walk test remained significant, based on a single study (72 patients). In studies with low risk of detection bias, only the effects on exercise capacity (6-minute walk test, 3 studies, 160 patients) and predicted forced expiratory volume in one second (2 studies, 88 patients) remained significant. Finally, when we considered only studies with low risk of attrition bias, the effects of yoga compared to no treatment on exercise capacity (5 studies, 228 patients) and predicted forced expiratory volume in one second (2 studies, 88 patients) remained significant.

Only 2 of the 11 studies reported safety-related outcomes. Of these, one study reported one serious adverse event (a case of cancer), but it was unclear in which group this event occurred.¹² The other study reported 1 (4%), 6 (24%), and 4 (16%) serious adverse events (hospitalizations; no reasons reported) in the yoga, no treatment, and physiotherapy groups, respectively.²² None of these studies reported whether the adverse events were intervention-related or not.

Discussion

In this systematic review and meta-analysis of 11 randomized trials on yoga for patients with chronic obstructive pulmonary disease, we found evidence for beneficial effects of yoga on disease-specific quality of life and physical outcomes. Both complex and breathing-based yoga interventions were effective for improving exercise capacity; breathing-based interventions additionally improved dyspnea and predicted forced expiratory volume. Only the effect on exercise capacity was robust against methodological bias. Reporting of safety was insufficient; however, where reported, rates of

Figure 1. Flowchart of the results of the literature search.

serious adverse events in the yoga group were lower than in both active (physiotherapy) and passive (no treatment) control groups.

Only one other systematic review on chronic obstructive pulmonary disease so far has exclusively

targeted yoga interventions.²³ The 2014 review, analyzing five studies, found evidence for positive effects of yoga on lung function and exercise capacity; however, patient-reported outcomes were not included, and the analysis did not differentiate

Table 1. Characteristics of the included studies.

Reference	Origin	Recruited from	Sample size	Sociodemographic characteristics (mean age, % female, % Caucasians)	Disease severity	Outcomes	Between-group effects
Donesky-Cuenco et al. ⁹	USA	American Lung Association, advertisements, outpatients	41	69.9 years, 72.4% female, 79.3% Caucasians	GOLD stage I to IV COPD (FEV1/FVC < 0.7) with dyspnea (oxygen saturation $\geq$ 80% on $\leq$ 6 L/minute of nasal oxygen during 6MW)	(1) SF-36 (2) CRQ (3) 6MW (5) Safety	(1) not significant (2) not significant (3) $P=0.04$ in favor of yoga (5) not reported
Fukuoka et al. ¹⁰	Japan	Hospital	8	75.5 years, 12.5% female, ethnicity not reported	GOLD stage II COPD (FEV1/FVC < 0.7 and FEV1 < 0.8)	(1) SF-36 (2) mMRC (3) 6MW (4) FEV1	(1) not significant (2) not significant (3) not significant (4) not significant
Gupta et al. ¹¹	India	Tertiary care	50	52.3 years, 4.0% female, ethnicity not reported	GOLD stage II or III COPD (FEV1/FVC < 0.7 and FEV1 0.5–0.8 or FEV1 0.3–0.5)	(1) CAT (3) 6MW (4) FEV1	(1) < 0.001 in favor of yoga (3) < 0.05 in favor of yoga (4) not significant
Kaminsky et al. ¹²	USA	Pulmonary practices	46	68.0 years, 60.5% female, ethnicity not reported	GOLD stage II to IV COPD (FEV1/FVC < 0.7 and FEV1 < 0.8) with dyspnea (mMRC > 2)	(1) CAT (2) BDS, mMRC (3) 6MW (4) FEV1 (5) Safety	(1) not significant (2) not significant (3) not significant (4) not significant (5) not reported
Katiyar and Bihari ¹³	India	Not reported	48	52.2 years, 16.7% female, ethnicity not reported	GOLD stage III COPD (FEV1/FVC < 0.7 and FEV1 < 0.5)	(1) SGRQ (3) 6MW (4) FEV1	(1) not reported (figures indicate $P < 0.05$ in favor of yoga) (3) not reported (4) not reported (figures indicate $P < 0.05$ in favor of yoga)
Kulpati et al. ¹⁴	India	Hospital	75	49.3 years, 0.0% female, ethnicity not reported	Not reported	(4) FEV1 (5) Safety	(4) not reported (5) Significant less hospitalizations in yoga group compared to conventional drug therapy

Table 1. (Continued)

Reference	Origin	Recruited from	Sample size	Sociodemographic characteristics (mean age, % female, % Caucasians)	Disease severity	Outcomes	Between-group effects
Raj and Moorthy ¹⁵	India	Charitable trust	60	Mean age, gender and ethnicity not reported	GOLD stage I to IV COPD (FEV1/FVC < 0.7)	(1) CAT (3) 6MW (4) FEV1	(1) $P < 0.001$ in favor of yoga (3) $P < 0.001$ in favor of yoga (4) $P < 0.001$ in favor of yoga
Ranjita et al. ^{16,17}	India	Working population	81	54.1 years, 0.0% female, ethnicity not reported	GOLD stage I or II COPD (FEV1/FVC < 0.7 and FEV1 > 0.8 or FEV1 0.5–0.8)	(1) CAT (2) BDS, VAS (3) 6MW	(1) $P < 0.001$ in favor of yoga (2) $P = 0.018$ in favor of yoga (3) $P = 0.047$ in favor of yoga (4) not reported
Soni et al. ^{18,19}	India	Hospital	60	47.2 years, 47.2% female, ethnicity not reported	GOLD stage I or II COPD (FEV1/FVC < 0.7 and FEV1 > 0.8 or FEV1 0.5–0.8)	(4) FEV1	(4) not reported
Tandon ²⁰	Australia	Hospital	24	60.0 years, 0.0% female, ethnicity not reported	Not reported	(2) Control of dyspnea attacks (3) Cycling: maximum work (kpm) (4) FEV1	(2) not reported (3) not reported (4) not reported
Thokchom et al. ²¹	India	Hospital outpatients	53	59.2 years, 12.2% female, ethnicity not reported	GOLD stage II or III COPD	(1) SGRQ (3) 6MW (4) FEV1	(1) not reported (3) not reported (4) not reported

6MW: 6-minute walk test; BDS: Borg Dyspnea Scale; COPD: chronic obstructive pulmonary disease; CAT: COPD Assessment Test; CRQ: Chronic Respiratory Disease Questionnaire; FVC: forced expiratory volume in one second; GOLD: Global Initiative for Chronic Obstructive Lung Disease; Kpm: kilopond meters; L: liter; mMRC: Modified Medical Research Council Dyspnea Scale; SF-36: 36-Item Short Form Health Survey; SGRQ: St. George's Respiratory Questionnaire; VAS: visual analogue scale.

Table 2. Interventions used in the included studies.

Reference	Intervention		Control intervention(s)							
	Yoga style	Postures	Breathing	Meditation	Other yoga exercises	Duration	Frequency	Session duration	Prescribed co-interventions	
Donesky-Cuenco et al. ⁹ Fukuoka et al. ¹⁰	Iyengar yoga	Yes	Yes	No	None	12 weeks	Twice weekly	60 minutes, additional home practice 10 minutes	None	Usual care (educational pamphlet)
	Laugher yoga	No	Yes	No	None	2 weeks	Once weekly		Physiotherapy (exercise, education), once weekly	Physiotherapy (exercise, education), once weekly
Gupta et al. ¹¹	Pranayama	No	Yes	No	None	12 weeks	Twice weekly	30 minutes	Conventional drug therapy	Conventional drug therapy
Kaminsky et al. ¹²	Kripalu yoga	No	Yes	No	None	2 weeks, then 10 weeks	Twice weekly for first 2 weeks, one additional session at week 6	30 minutes plus 30 minutes education for first 2 weeks	None	Education twice weekly 60 minutes for 2 weeks, one additional session at week 6
Katiyar and Bihari ¹³	Pranayama	No	Yes	No	None	12 weeks	Once daily	30 minutes	Usual physical activity and medications	Usual physical activity and medications for 12 weeks
Kulpati et al. ¹⁴	Yogasana	Yes	Yes	No	None	12 weeks	Twice daily	30 minutes	Conventional drug therapy	(1) Conventional drug therapy for 12 weeks (2) Physiotherapy (breathing), twice daily 30 minutes for 12 weeks, additional conventional drug therapy
Raj and Moorthy ¹⁵	Not specified	Yes	Yes	Yes	Education	12 weeks	3 times per week	45 minute	Conventional treatment	Wait-list, conventional treatment for 12 weeks
Ranjita et al. ^{16,17}	Integrated approach of yoga therapy	Yes	Yes	Yes	Cleansing exercises, education	12 weeks	Once daily	90 minutes	Conventional therapy	Wait-list, conventional therapy
Soni et al. ^{18,19}	Not specified	Yes	Yes	Yes	Lifestyle education	8 weeks	Once daily	40–50 minutes	Conventional drug therapy	Conventional drug therapy
Tandon ²⁰	Hatha yoga	Yes	Yes	No	None	9 months	3 times per week for 4 weeks, twice weekly for 4 weeks, once weekly for 7 months	60 minutes	Conventional therapy	Physiotherapy (exercise, breathing), three times per week 60 minutes for 4 weeks, 2 times per week 60 minutes for 4 weeks, then once weekly 60 minutes for 7 months, additional conventional therapy
Thokchom et al. ²¹	Not specified	Yes	Yes	Yes	Cleansing and loosening exercises	2 weeks	Once daily	50 minutes	Conventional drug therapy	Conventional drug therapy

Table 3. Risk of bias assessment of the included studies using the Cochrane risk of bias tool.

Reference	Bias		Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
	Random sequence generation (selection bias)	Allocation concealment (selection bias)					
Donesky-Cuenca et al. ⁹	Unclear risk	Unclear risk	Unclear risk	Unclear risk	High risk	Unclear risk	High risk
Fukuoka et al. ¹⁰	Unclear risk	Low risk	Unclear risk	Unclear risk	Low risk	Unclear risk	High risk
Gupta et al. ¹¹	High risk	High risk	Unclear risk	Unclear risk	Unclear risk	Unclear risk	High risk
Kaminsky et al. ¹²	Unclear risk	Unclear risk	High risk	Low risk	Low risk	Low risk	Low risk
Katiyar and Bihari ¹³	Unclear risk	Unclear risk	Unclear risk	Low risk	Low risk	Unclear risk	High risk
Kulpati et al. ¹⁴	Unclear risk	Unclear risk	Unclear risk	Unclear risk	Low risk	High risk	High risk
Raj and Moorthy ¹⁵	Unclear risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Unclear risk	High risk
Ranjita et al. ^{16,17}	Low risk	Low risk	High risk	Low risk	Low risk	High risk	High risk
Soni et al. ^{18,19}	Unclear risk	Unclear risk	Unclear risk	Unclear risk	Unclear risk	High risk	High risk
Tandon ²⁰	Unclear risk	Unclear risk	Unclear risk	Low risk	Low risk	Unclear risk	High risk
Thokchom et al. ²¹	Low risk	Unclear risk	High risk	High risk	Low risk	High risk	High risk

Figure 2. Effects of yoga compared to no treatment on patient-reported outcomes.
 CI: confidence interval; df: degrees of freedom; IV: inverse variance.

between different types of yoga. Due to the mostly unclear risk of bias of studies included in that review, and an increased number of studies on yoga interventions for chronic obstructive pulmonary disease published in subsequent years, an updated review seemed warranted.

The findings of this systematic review and meta-analysis are partly in line with those of earlier reviews on related interventions. In a Cochrane review, McCarthy et al.¹ found exercise interventions beneficial for chronic obstructive pulmonary disease, but this review excluded yoga for not being aerobically demanding. A further Cochrane review²⁴ found limited evidence for breathing interventions; however, only 2 out of 16 included studies were on yoga-based breathing⁹ while the other studies used a variety of other types of breathing exercises.

There are several ways that yoga may benefit patients with chronic obstructive pulmonary disease. Physical activity is fundamental to the management of chronic obstructive pulmonary disease,^{1,25} and

strongly correlated with functional exercise capacity.²⁶ However, chronic obstructive pulmonary disease patients are significantly less active than sedentary healthy individuals,²⁶ with physical activity being the strongest predictor of lower mortality in this patient group, an association partly explained by disease severity.²⁶

Patients with chronic obstructive pulmonary disease are capable of physical activity at a level effective for physiological change, as manifested by a reduction in blood lactate and ventilation.²⁷ While the practice of yoga commonly includes physical activity through the use of yoga postures, it has previously been questioned whether yoga postures are sufficiently physically demanding enough to reach these physiological levels of change in patients with chronic obstructive pulmonary disease.¹ This review challenges this viewpoint, with results suggesting that physical yoga postures are associated with improved exercise capacity. In addition, yoga may play a broader role in the management of chronic obstructive

Figure 3. Effects of yoga compared to no treatment and physiotherapy on clinician-assessed outcomes.

CI: confidence interval; df: degrees of freedom; IV: inverse variance.

pulmonary disease, through the positive impact of breathing-based yoga styles on parameters of dyspnea and predicted forced expiratory volume. Procedurally, breathing-based yoga and inspiratory muscle training share some similarity. In a recent systematic review, inspiratory muscle training is also found to be effective in decreasing dyspnea,²⁸ which may suggest their common

mechanism of action. A small randomized trial conducted among institutionalized frail older adults showed that breathing-based yoga is superior to inspiratory muscle training in respiratory strength and endurance,²⁹ but their comparative effectiveness among patients with chronic obstructive pulmonary disease on clinical relevant outcomes are yet to be evaluated.

Table 4. Effects of yoga compared to no treatment using mean differences.

Outcome ^a	No. of studies	No. of patients	Mean difference (95% confidence interval)	P (overall effect)	Heterogeneity I^2
Quality of life—CAT	3	115	3.81 (0.97, 6.65)	0.009	70%
Exercise capacity—6MW	7	288	25.53 m (12.16 m, 38.90 m)	<0.001	0%
FEV1 predicted	2	88	3.95% (2.74%, 5.17%)	<0.001	0%
FEV1 Liter	3	118	-0.16 L (-0.75 L, 0.44 L)	0.60	92%

^aOutcomes are only shown if sufficient data for meta-analysis were available.

6MW: 6-minute walk test; CAT: chronic obstructive pulmonary disease assessment test; FEV1: forced expiratory volume in 1 second.

Table 5. Effects of breathing-based yoga compared to no treatment.

Outcome ^a	No. of studies	No. of patients	Standardized mean difference (95% confidence interval)	Mean difference (95% confidence interval)	P (overall effect)	Heterogeneity I^2
Dyspnea	2	111	-0.43 (-0.81, -0.05)	—	0.03	0%
Exercise capacity	4	146	—	22.74 m (7.01 m, 38.48 m)	0.003	0%
FEV1	3	138	—	3.97% (2.79%, 5.15%)	<0.001	0%

^aOutcomes are only shown if sufficient data for meta-analysis were available.

FEV1: forced expiratory volume in 1 second.

Comparable effects of yoga are indicated in patients with hypertension, and were attributed to the effects of yoga breathing on sympathetic activation.^{30,31} Increasing parasympathetic activity and decreasing sympathetic activation is regarded as a primary mechanism of yoga therapy.^{30,32} Specifically, yoga breathing and relaxation exercises have been shown to increase parasympathetic activity both in healthy individuals^{33,34} and in patients with chronic obstructive pulmonary disease.^{35,36} Importantly, the addition of yoga postures does not further increase this effect,³³ meaning patients with reduced physical capacity may gain benefit from yoga through the practice of yoga-based breathing techniques alone. Our results also support the role of breathing in chronic conditions with similar sympathetic activation, such as cardiovascular conditions.³⁶ Slow breathing, integral to many yoga breathing exercises, has been shown to positively influence dyspnea and improve resting pulmonary gas exchange and exercise performance in patients with chronic heart failure,³⁷ possibly by reducing chemoreflex sensitivity.³⁸

A strength of this review is its adherence with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, the comprehensive literature search, and the rigorous predefined methods of analysis. The latter is important if yoga is to be used as an adjunct intervention for patients with chronic obstructive pulmonary disease. Although twice as many studies were available for this meta-analysis compared to the first one, the relatively small number of studies and their low sample and varying quality sizes still are the main limitations of this analysis. The interventions differed between studies making comparisons difficult, especially for adverse events. Safety was infrequently reported. We were thus unable to draw definite conclusions on the intervention's safety. Moreover, it is possible that this review missed some studies not listed in the standard databases.

The results of this review are further limited by the validity of the available data, and the paucity of safety reporting in trials to date. While attrition bias was generally low across all studies, a lack of transparency in treatment selection, data collection, and reporting of analysis limits the internal robustness

of the trials. Many of these issues concern the reporting, rather than the content, of trials. As such, the clinical use of yoga for the management of chronic obstructive pulmonary disease would be greatly enhanced by improved reporting of clinical yoga trials in line with accepted guidelines such as the Consolidated Standards of Reporting Trials,³⁹ improving the methodological transparency of trials. The additional use of reporting guidelines for intervention content⁴⁰ and safety⁴¹ in future research will aid the implementation of research into practice, by providing clinicians and yoga therapists with clear detail on the type and amount of yoga considered effective in chronic obstructive pulmonary disease management.

The participant demographics in the included studies are reflective of chronic obstructive pulmonary disease patients in the general population, making the results generalizable to clinical practice. Chronic obstructive pulmonary disease patients are typically first diagnosed in their 40s, with incidence slightly higher in men, and increasing with age.³⁸ A multidisciplinary program of pulmonary rehabilitation is recommended for all chronic obstructive pulmonary disease patients.⁴² Current programs tend to be physically based, with content focused on aerobic and strength-based exercise, such as walking, cycling, and resistance training.⁴³ Our review suggests the addition of breathing-based exercises may enhance these programs, through the improvement of exercise capacity. Furthermore, current guidelines recognize the likely presence of anxiety and depression in individuals with this chronic health problem, and recommend the integration of psychosocial management into rehabilitation program.⁴⁴ This review suggests yoga may positively affect quality of life in chronic obstructive pulmonary disease patients. In addition, prior reviews indicate yoga as a safe and effective option for the management of anxiety and depression.^{45,46}

Importantly, the low attrition rates across the included studies in this review suggest yoga as an acceptable form of physical and psychosocial symptom management for individuals with chronic obstructive pulmonary disease. This acceptance reflects trends in the general population, with the increased popularity of yoga for the management

of chronic and mental health conditions.^{2,47} With physical and breathing exercises commonly included in both instructor-delivered and self-managed yoga practice,^{48,49} yoga presents a viable option for the symptom management of chronic obstructive pulmonary disease. Future research into the content and dosage of effective yoga practice will further aid clinical recommendations for practice. More high-quality trials with adequate sample size and low risk of bias are needed.

Clinical messages

- Yoga may be an effective option for improving physical capacity and breathing parameters in chronic obstructive pulmonary disease rehabilitation.
- The safety of yoga in chronic obstructive pulmonary disease is inconclusive due to insufficient safety reporting in clinical trials to date.

Author contributions

H.C. and R.L. were responsible for conception and design. H.C., H.H., and P.K. were responsible for the analysis of the data. All authors made substantial contributions to conception and design and interpretation of the data, drafted the manuscript, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Supplemental material

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