

# Effectiveness of meditative movement on COPD: a systematic review and meta-analysis

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**Background:** The effectiveness of meditative movement (tai chi, yoga, and qigong) on COPD remained unclear. We undertook a systematic review and meta-analysis to determine the effectiveness of meditative movement on COPD patients.

**Methods:** We searched PubMed, Web of Science, EMBASE, and the Cochrane Center Register of Controlled Trials for relevant studies. The methods of standard meta-analysis were utilized for identifying relevant researches (until August 2017), quality appraisal, and synthesis. The primary outcomes were the 6-minute walking distance (6MWD), lung function, and dyspnea levels.

**Results:** Sixteen studies involving 1,176 COPD patients were included. When comparing with the control group, the 6MWD was significantly enhanced in the treatment group (3 months: mean difference [MD]=25.40 m, 95% CI: 16.25 to 34.54; 6 months: MD=35.75 m, 95% CI: 22.23 to 49.27), as well as functions on forced expiratory volume in 1 s (FEV<sub>1</sub>) (3 months: MD=0.1L, 95% CI: 0.02 to 0.18; 6 months: MD=0.18L, 95% CI: 0.1 to 0.26), and FEV<sub>1</sub> % predicted (3 months: 4L, 95% CI: 2.7 to 5.31; 6 months: MD=4.8L, 95% CI: 2.56 to 7.07). Quality of life for the group doing meditative movement was better than the control group based on the Chronic Respiratory Disease Questionnaire dyspnea score (MD=0.9 units, 95% CI: 0.51 to 1.29) and fatigue score (MD=0.75 units, 95% CI: 0.42 to 1.09) and the total score (MD=1.92 units, 95% CI: 0.54 to 3.31).

**Conclusion:** Meditative movement may have the potential to enhance lung function and physical activity in COPD patients. More large-scale, well-designed, multicenter, randomized controlled trials should be launched to evaluate the long-range effects of meditative movement.

**Keywords:** meditative movement, COPD, meta-analysis, tai chi, yoga, qigong

## Introduction

COPD is characterized by nonreversible airflow obstruction and intermittent exacerbations. It was a major cause of morbidity and mortality worldwide.<sup>1-4</sup> Despite progress in pharmacologic and surgical treatments, many patients continue to suffer from dyspnea and substantial limitations in daily activities. They are often trapped in a vicious cycle of inactivity, initiated by breathlessness.<sup>5,6</sup> Rehabilitation may alleviate the symptoms, impede the deterioration of lung functions, and improve health-related quality of life among (HRQoL) COPD patients. More and more experts are beginning to realize the importance of pulmonary rehabilitation for COPD patients. Exercise training should be one of the vital approaches in the treatment of COPD.<sup>7,8</sup>

Meditative movement is proposed as a gentle exercise training and incorporates meditation, breathing, and relaxation.<sup>9</sup> Meditative movement, including forms such

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as tai chi, yoga, and qigong, incorporates: focus on the mind; movements, usually slow, relaxed, flowing and choreographed; a focus on breathing, and a deep and calm state of physical and mental relaxation.<sup>9</sup> tai chi is a centuries-old Chinese health practice. It involves a series of movements performed in a slow, well-balanced and focused manner, and is accompanied by deep breathing. Qigong is also an ancient Chinese exercise that include meditation, physical movement, relaxation, and breathing exercises to restore and maintain balance. Qigong is designed to control the vital energy (qi) of the body along the energy channels (meridians). Qigong combined with tai chi may keep the body, mind, and spirit in a state of alignment and balance.<sup>10</sup> Yoga originated from ancient India, and consisted of pranayama, sithali, kapalabhati, asanas, and meditation. The exercises may coordinate the individual self with the transcendental self.<sup>11</sup>

Although some studies have reported that meditative movements exerted beneficial effects on COPD patients,<sup>12,13</sup> its definite effectiveness remains unclear. Hence, we performed a systematic review and meta-analysis to evaluate the effectiveness of meditative movement as complementary therapy for COPD patients.

## Methods

### Search strategy and study selection criteria

The following databases were searched: PubMed, EMBASE, Web of Science, and the Cochrane Center Register of Controlled Trials. No language restrictions were imposed. Search terms included: (Tai Chi or Taiji OR Tai Chi Chuan OR Qigong OR Qi Gong OR Chi Kung OR traditional Chinese exercise or yoga or meditative movement) AND (chronic obstructive pulmonary disease OR COPD OR chronic obstructive lung disease OR chronic obstructive airway disease OR emphysema OR chronic airflow limitation OR chronic airway obstruction). Studies were eligible for inclusion in this review if they met the following criteria: 1) were randomized controlled trials (RCTs); 2) used exercises training such as tai chi or qigong or tai chi combined with qigong or yoga as intervention in the experimental group; 3) included COPD patients according to the Global Initiative for Chronic Obstructive Lung Disease criteria; 4) used nonexercise in control groups or other physical exercise training in comparison groups.

### Data extraction

Two reviewers (LLW and KXL) independently screened studies for inclusion, retrieved potentially relevant studies, and determined study eligibility. Any discrepancies were

resolved by the way of consensus. The extracted information included the following: 1) the details of publication (the first author's last name, year of publication); 2) characteristics of participants in the study (the sample size, age, and severity of disease); 3) interventions (eg, the form of intervention, exercise time, the duration and frequency of training); 4) outcome measures.

### Outcome measures

The primary outcomes were 6-minute walking distance (6MWD), lung function (forced expiratory volume in 1 s [FEV<sub>1</sub>] and forced vital capacity [FVC]), dyspnea, and fatigue levels. The secondary outcomes were arterial blood gas tensions (PaCO<sub>2</sub>, PaO<sub>2</sub>) and scores from quality of life questionnaires. We categorized outcomes as short-term (1–3 months) and mid-term (6 months) follow-up. The outcomes that could not be pooled in the meta-analysis are listed in Table 1.

### Quality assessment

We used the Cochrane risk of bias assessment tool.<sup>14</sup> A low value, unclear or high-risk bias was assigned in the following domains: generation in random sequence, allocation concealment, blinding methods, incomplete data among the outcome data, selective reporting, and other biases. Two reviewers (LLW and KXL) independently appraised the quality of the included trials. Any discrepancies were resolved by consensus in the presence of a third investigator.

### Statistical analysis

We undertook statistical analysis by using Cochrane systematic review software Review Manager (RevMan; Version 5.3.5). Eligible studies were analyzed using the mean and SDs to measure the change from baseline to endpoint in each intervention period. Since all outcomes were continuous variables, mean difference (MD) with 95% CIs were calculated when studies reported their results of the same variables measured with the same units of measure. *I*<sup>2</sup> statistic was used to assess the heterogeneity. And random effect models were used to address variations in studies.<sup>15</sup> Meanwhile, *I*<sup>2</sup> values were classified as low (0% to <25%), medium (25% to <75%), and high (≥75%).<sup>16</sup> The results were displayed as Forest plots.

## Results

We retrieved a total of 1,145 references. Sixteen studies finally fulfilled the inclusion criteria and were further analyzed.<sup>36–51</sup> A flow chart for the studies evaluated and the reasons for exclusion is shown in Figure 1. Of the included

**Table I** Characteristics of included studies

Author, year	Country	Comparison arms	Sample size, N	Protocol	Mean age in years (SD/range)	FEV <sub>1</sub> predicted (%)	Duration	Outcomes
Chan et al, <sup>36</sup> 2013	Hong Kong, China	G1: TCQ G2: Exercise G3: Control	G1: 70 G2: 69 G3: 67	G1: 60 minutes/session 2 sessions/week 3 months G2: 60 minutes/day 3 months	G1: 71.7 (8.2) G2: 73.6 (7.5) G3: 73.6 (7.4)	G1: 50.1 (21.8) G2: 56.4 (25.6) G3: 55.1 (23.3)	6 months	1. 6MWD 2. FEV <sub>1</sub> , FVC 3. Borg 4. SaO <sub>2</sub> %
Chan et al, <sup>37</sup> 2013	Hong Kong, China	G1: TCQ G2: Exercise G3: Control	G1: 70 G2: 69 G3: 67	G1: 60 minutes/session 2 sessions/week 3 months G2: 60 minutes/day 3 months	G1: 71.7 (8.2) G2: 73.6 (7.5) G3: 73.6 (7.4)	G1: 50.1 (21.8) G2: 56.4 (25.6) G3: 55.1 (23.3)	6 months	SGQR
Zhang et al, <sup>38</sup> 2016	Jiangsu, China	G1: QYJJ G2: Exercise G3: Control	G1: 42 G2: 43 G3: 45	G1: 60 minutes/day 7 sessions/week 6 months G2: 60 minutes/day 6 months	G1: 64.77 (11.07) G2: 63.34 (7.86) G3: 62.35 (9.27)	G1: 59.12 (4.13) G2: 57.39 (5.37) G3: 58.11 (4.37)	6 months	1. 6MWD 2. FEV <sub>1</sub> , FEV <sub>1</sub> %, FEV <sub>1</sub> /FVC 3. CAT
Xiao and Zhuang, <sup>39</sup> 2015	Beijing, China	G1: LQG G2: Exercise	G1: 63 G2: 63	G1: 45 minutes/session 4 sessions/week 30 minutes walking/day 6 months G2: 30 minutes/day 6 months	G1: 72.2 (1.7) G2: 70.9 (1.4)	G1: 41.5 (4.5) G2: 40.7 (4.0)	6 months	1. 6MWD 2. CRQ, SF-36
Ng et al, <sup>40</sup> 2011	Hong Kong, China	G1: QG G2: Exercise	G1: 40 G2: 40	G1: 45 minutes/session 4 sessions/week 6 months G2: 30 minutes/day 6 months	G1: 71.75 (1.05) G2: 73.12 (1.33)	G1: 37.13 (2.22) G2: 36.75 (2.11)	6 months	1. 6MWD 2. CRQ, SF-36
Yeh et al, <sup>41</sup> 2010	USA	G1: TC G2: Control	G1: 5 G2: 5	G1: 60 minutes/session 2 sessions/week 3 months	G1: 65 (6) G2: 66 (6)	G1: 53 (7) G2: 47 (7)	3 months	1. 6MWD 2. FEV <sub>1</sub> /FVC 3. CRQ
Leung et al, <sup>42</sup> 2013	Australia	G1: TC G2: Control	G1: 22 G2: 20	G1: 60 minutes/day 7 days/week 3 months	73 (8)	59 (16)	3 months	1. CRQ
Niu et al, <sup>43</sup> 2014	Changsha, China	G1: TC G2: Control	G1: 20 G2: 20	G1: 50 minutes/session 1 days/session 7 sessions/week 6 months	G1: 59.7 (2.76) G2: 61.3 (2.89)	G1: 41.9 (5.50) G2: 43.7 (5.16)	6 months	1. 6MWD 2. FEV <sub>1</sub> , FEV <sub>1</sub> %, PaO <sub>2</sub> , PaCO <sub>2</sub>
Ng et al, <sup>44</sup> 2014	Hong Kong, China	G1: TC G2: Control	G1: 94 G2: 98	G1: 60 minutes/session 7 sessions/week 6 weeks	G1: 74.16 (6.46) G2: 74.13 (6.81)	G1: 56.4 (23.81) G2: 63.1 (22.12)	6 months	1. 6MWD 2. FVC, FEV <sub>1</sub> , FEV <sub>1</sub> % 3. SGRQ 4. SaO <sub>2</sub>
Ranjita et al, <sup>45</sup> 2016	India	G1: Yoga G2: Control	G1: 36 G2: 36	G1: 90 minutes/session 6 sessions/week 3 months	G1: 53.69 (5.66) G2: 54.41 (5.40)	NA	3 months	1. 6MWD 2. Brog 3. SpO <sub>2</sub> %
Gupta et al, <sup>46</sup> 2014	India	G1: Yoga G2: Control	G1: 25 G2: 25	G1: 30 minutes/session 2 sessions/week 3 months	G1: 52.5 (3.9) G2: 52 (4.1)	G1: 51.1 (8.7) G2: 49.6 (8.6)	3 months	1. 6MWD 2. FEV <sub>1</sub> % 3. CAT
Donesky-Cuenco et al, <sup>47</sup> 2009	USA	G1: Yoga G2: Control	G1: 14 G2: 15	G1: 60 minutes/session 2 sessions/week 3 months	G1: 72.2 (6.5) G2: 67.7 (11.5)	G1: 51.2 (10.5) G2: 44.4 (19.0)	3 months	1. 6MWD 2. FEV <sub>1</sub> /FVC, FEV <sub>1</sub> % 3. CRQ, SF-36
Soni et al, <sup>48</sup> 2012	India	G1: Yoga G2: Control	G1: 30 G2: 30	G1: 45 minutes/day 2 months	45 (7.65)	NA	2 months	1. TLCO

(Continued)

**Table 1** (Continued)

Author, year	Country	Comparison arms	Sample size, N	Protocol	Mean age in years (SD/ range)	FEV <sub>1</sub> predicted (%)	Duration	Outcomes
Tandon, <sup>49</sup> 1978	Australia	G1: Yoga G2: Control	G1: 12 G2: 12	G1: 60 minutes/session 1–4 weeks: 3 sessions/ week 5–8 weeks: 2 sessions/ week 9 weeks–9 months: 2 sessions/week 9 months	G1: 59 (3.06) G2: 58 (3.06)	NA	9 months	1. FEV <sub>1</sub> , FVC 2. PaO <sub>2</sub> , PaCO <sub>2</sub>
Kulpati et al, <sup>51</sup> 1982	India	G1: Yoga G2: Control	G1: 25 G2: 50	G1: 30 minutes/session 2 sessions/week 3 months	G1: 50.6 (12.23) G2: 48.65 (9.17)	NA	3 months	1. FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC 2. PaO <sub>2</sub> , PaCO <sub>2</sub>
Katiyar and Bihari, <sup>50</sup> 2006	India		G1: Yoga G2: Control	G1: 30 minutes/session 6 sessions/week 3 months	G1: 53.3 (2.9) G2: 51.1 (3)	G1: 48 (2.4) G2: 48 (2)	3 months	1. FEV <sub>1</sub> , FVC 2. SGRQ

**Abbreviations:** 6MWD, 6-minute walking distance; CAT, exercise of the COPD Assessment Test; CRQ, Chronic Respiratory Disease Questionnaire; FEV<sub>1</sub>, forced expiratory volume in 1 s; FEV<sub>1</sub>% predicted, FEV<sub>1</sub> percent predicted normal values; FVC, forced vital capacity; FEV<sub>1</sub>/FVC, the ratio of FEV<sub>1</sub> to FVC; G, Group; LQG, Liuzijue qigong; NA, not available; PaCO<sub>2</sub>, partial pressure of carbon dioxide; PaO<sub>2</sub>, partial pressure of oxygen; QG, Qigong; QYJJ, Qigong Yi Jinjing; SF-36, 36-Item Short Form Health Survey; SGRQ, St George Respiratory Questionnaire; TC, Tai chi; TCQ, Tai chi Qigong; Borg, Borg scale of dyspnea and fatigue levels; TLCO, transfer factor of lung for carbon monoxide.

studies, 7 evaluated yoga, 4 tai chi, 3 qigong, and 2 tai chi and qigong combined. Yoga, tai chi, and qigong were included. The exercise group used breathing and walking as a physical exercise. Breathing exercises comprised pursed-lip breathing and diaphragmatic breathing.

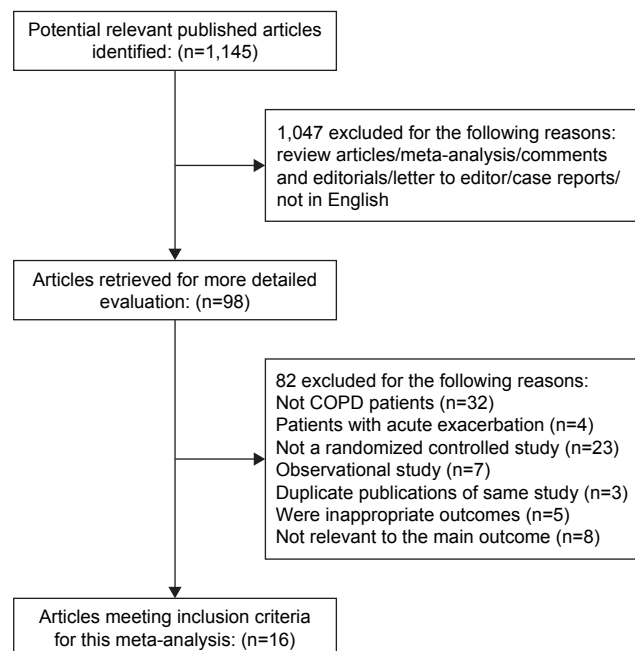
## Settings

Five of these 15 studies was conducted in India (Ranjita 2015; Gupta 2014; Soni 2012; Kulpati 1982; Katiyar 2006), 2 in

the USA (Yeh 2010; Donesky-Cuenco 2009), 2 in Australia (Leung 2013; Tandon 1978), 3 in Hong Kong (Chan 2010; Ng2011; Ng 2014), and the rest in other provinces in China (Zhang 2015; Xiao 2015; Niu 2014). Most studies were conducted in outpatient clinics and published between 1975 and 2015.

## Study characteristics

A total of 1,176 COPD patients were included in the current study. The sizes of sample, according to statistics, ranged from 10 to 206. The patients were recruited from outpatients or health care centers. Studies were conducted in a diverse array of countries, mostly in Southeast Asia. Characteristics of the included studies were summarized in Table 1. Four articles written by Chan et al<sup>52,53</sup> derived from the same study. Since the research by Chan et al had a patient population that appeared to be described in recent studies<sup>36,37</sup> of different study design, we decided to exclude the previous 2.<sup>52,53</sup> All studies were published between 1990 and 2017, and the duration ranged from 12 weeks to 9 months. Most of the trials used tai chi or yoga as the experimental intervention; furthermore, 3 trials used qigong<sup>38–40</sup> and 2 trials<sup>36,37</sup> used tai chi combined with qigong. All the included trials described the details involving the duration, frequencies, and session length of the interventions. The mean age ranged from 45 to 74.1 years, and the mean baseline lung function varied from 36.75% to 59.12% predicted FEV<sub>1</sub>. Disease severity ranged from mild to very severe, as reported by study authors. Five studies<sup>36–38,42,44</sup> recruited participants with disease severity



**Figure 1** Flow of study selection.

ranging from mild to moderate; 7<sup>39-41,43,46,47,51</sup> from moderate to severe; and 4<sup>45,48-50</sup> studies did not specify the level of severity included but provided the mean value of % predicted FEV<sub>1</sub> and SD within the range of mild-to-severe COPD. The frequencies of training ranged from 2 to 7 sessions each week, and the time of exercise lasted 30–90 minutes per session; most common was 30–60 minutes. Yoga tended to be practised for longer and more frequently than tai chi or qigong. One trial<sup>48</sup> measured the outcomes of 2 months, 7 trials<sup>41,42,45-47,50,51</sup> measured the outcomes for 3 months, 7 trials<sup>36-40,43,44</sup> measured the outcomes for 6 months, and 1 trial<sup>49</sup> measured the outcomes of 9 months. The interventions in control groups were education, breathing technique, and walking combined with or without breathing technique. All participants received the usual medical treatment in addition to the experimental intervention.

## Risk of bias of studies

The assessment of the included studies are shown in Table 2, which displayed<sup>36-51</sup> the risk of bias. Four trials,<sup>40-42,44</sup> according to the recommended criteria of the Cochrane Handbook, were judged to be in low risk in bias; 10 trials<sup>36,38,39,43,45-49,51</sup> were judged to be in unclear risk of bias, and 1 trial<sup>50</sup> was judged to be in high risk of bias as shown in Figure 2.

## Outcomes

### 6MWD

#### Meditative movement versus nonexercise

The 6MWD was significantly enhanced in the experimental group (MD 25.40 m, 95% CI: 16.25 to 34.54,  $P < 0.00001$ )

compared with the nonexercise group at the third month in a pooled analysis of 8 studies ( $n=644$ ).<sup>36,38,41,44-47,51</sup> These trials showed heterogeneity when they were pooled in a meta-analysis ( $P$  for heterogeneity=0.002,  $I^2=68\%$ ). Four RCTs ( $n=455$ )<sup>36,38,43,44</sup> provided information regarding 6MWD at the sixth month. Pooled analysis showed that experimental group was associated with a statistically significant improvement in 6MWD (MD 35.75 m, 95% CI: 22.23 to 49.27,  $P < 0.00001$ ) using a random-effects model. The results of the heterogeneity test was not significant ( $P$  for heterogeneity=0.009,  $I^2=74\%$ ; Figure 3A). The 6MWD effect size of 1 trial<sup>46</sup> was obviously lower than the other trials; furthermore, if this study was excluded, heterogeneity was markedly abated. Thus, a subgroup analysis was undertaken according to the different Style Meditative movement in the intervention.

## Meditative movement versus walking exercise

Two studies,<sup>36,38</sup> involving 224 participants, estimated changes in functional capacity using the 6-minute walk test at the third month. The combined MD from 2 studies ( $n=224$ ) was 15.53 m (95% CI: 11.59 to 19.48,  $P$ -value  $< 0.00001$ ). We detected no subgroup differences between experimental group and the exercise group ( $P$ -value=0.33,  $I^2=0\%$ ). Four trials<sup>36,38-40</sup> ( $n=430$ ) estimated the effects of 6MWD on the experimental group and compared with walking exercise at 6 months. It reported that the experimental group showed an improvement in 6MWD compared with exercise group, but the difference was not significant (MD 19.36 m, 95% CI: 9.0

**Table 2** Assessment of included studies for risk of bias

Author, year	Adequate sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias	Study design
Chan et al, <sup>36,37</sup> 2013	Low	Unclear	Unclear	Low	Low	Low	Unclear	RCT (single-blind)
Zhang et al, <sup>38</sup> 2016	Unclear	Unclear	Low	Unclear	Unclear	Low	Unclear	RCT (single-blind)
Xiao and Zhuang, <sup>39</sup> 2015	Unclear	Unclear	Low	Low	Low	Low	Unclear	RCT (single-blind)
Ng et al, <sup>40</sup> 2011	Low	Low	Low	Low	Low	Low	Unclear	RCT (single-blind)
Yeh et al, <sup>41</sup> 2010	Low	Low	Low	Low	Low	Low	Unclear	RCT (single-blind)
Leung et al, <sup>42</sup> 2013	Low	Low	Low	Low	Low	Low	Unclear	RCT (single-blind)
Niu et al, <sup>43</sup> 2014	Low	Unclear	Unclear	Low	Low	Low	Unclear	RCT (single-blind)
Ng et al, <sup>44</sup> 2014	Low	Low	Low	Low	Low	Low	Unclear	RCT (single-blind)
Ranjita et al, <sup>45</sup> 2016	Unclear	Unclear	Low	Low	Low	Low	Unclear	RCT (single-blind)
Gupta et al, <sup>46</sup> 2014	Unclear	Unclear	Low	Low	Unclear	Low	Unclear	RCT
Donesky-Cuenco et al, <sup>47</sup> 2009	Unclear	Unclear	Low	Low	Unclear	Low	Unclear	RCT
Soni et al, <sup>48</sup> 2012	Unclear	Unclear	Unclear	Unclear	Low	Low	Unclear	RCT
Tandon, <sup>49</sup> 1978	Unclear	Unclear	Unclear	Unclear	Low	Low	Unclear	RCT
Kulpati et al, <sup>51</sup> 1982	Unclear	Unclear	Unclear	Unclear	Unclear	Low	Unclear	RCT
Katiyar and Bihari, <sup>50</sup> 2006	Low	Unclear	Unclear	Low	Low	Low	Unclear	RCT

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

	Random sequence generation (selection bias)	Allocation concealment (selection 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
Chan et al, <sup>36,37</sup> 2013	+	?	?	+	+	+	?
Donesky-Cuenco et al, <sup>47</sup> 2009	?	?	+	+	?	+	?
Gupta et al, <sup>46</sup> 2014	?	?	+	+	?	+	?
Katiyar and Bihari, <sup>50</sup> 2006	+	?	?	+	+	+	?
Kulpati et al, <sup>51</sup> 1982	?	?	?	?	?	+	?
Leung et al, <sup>42</sup> 2013	+	+	+	+	+	+	?
Ng et al, <sup>40</sup> 2011	+	+	+	+	+	+	?
Ng et al, <sup>44</sup> 2014	+	+	+	+	+	+	?
Niu et al, <sup>43</sup> 2014	+	?	?	+	+	+	?
Ranjita et al, <sup>45</sup> 2016	?	?	+	+	+	+	?
Soni et al, <sup>48</sup> 2012	?	?	?	?	+	+	?
Tandon, <sup>49</sup> 1978	?	?	?	?	+	+	?
Xiao and Zhuang, <sup>39</sup> 2015	?	?	+	+	+	+	?
Yeh et al, <sup>41</sup> 2010	+	+	+	+	+	+	?
Zhang et al, <sup>38</sup> 2016	?	?	+	?	?	+	?

Figure 2 Risk of bias summary.

to 29.72,  $P < 0.0002$ ). The test for heterogeneity was significant ( $P$  for heterogeneity=0.0006,  $I^2=83%$ ; Figure 3B).

## Lung functions

### FEV<sub>1</sub>

#### Meditative movement versus nonexercise

Trough FEV<sub>1</sub> data were available in 4 trials<sup>36,38,44,50</sup> and in 4 trials<sup>36,38,43,44</sup> at 3 months and 6 months (n=489 and n=453, respectively). The differences were significant (MD 0.1L, 95% CI: 0.02 to 0.18,  $P=0.02$ ) at 3 months. However, the aggregate results of these studies indicated that the experimental group was in related with a significant improvement in FEV<sub>1</sub> comparing with the nonexercise group (MD 0.18L,

95% CI: 0.1 to 0.26,  $P < 0.00001$ ) at 6 months. Class differences did not appear significantly different at 3 and 6 months (Figure 4A).

## Meditative movement versus walking exercise

In a pooled analysis of 2 studies (n=226)<sup>36,38</sup> of experimental versus physical exercise groups, no significant difference was shown in FEV<sub>1</sub> (MD 0.13L, 95% CI: -1.04 to 0.31,  $P=0.13$ ) using a random-effects model at 3 months. For FEV<sub>1</sub>, the significant interaction effect of time by group ( $P$  for heterogeneity=0.14,  $I^2=54%$ ) was also observed. Again, no obvious improvement was seen at 6 months (MD 0.26L, 95% CI: -0.12 to 0.64,  $P=0.18$ ). The results of the heterogeneity test was significant ( $P$  for heterogeneity=0.001,  $I^2=91%$ ; Figure 4B).

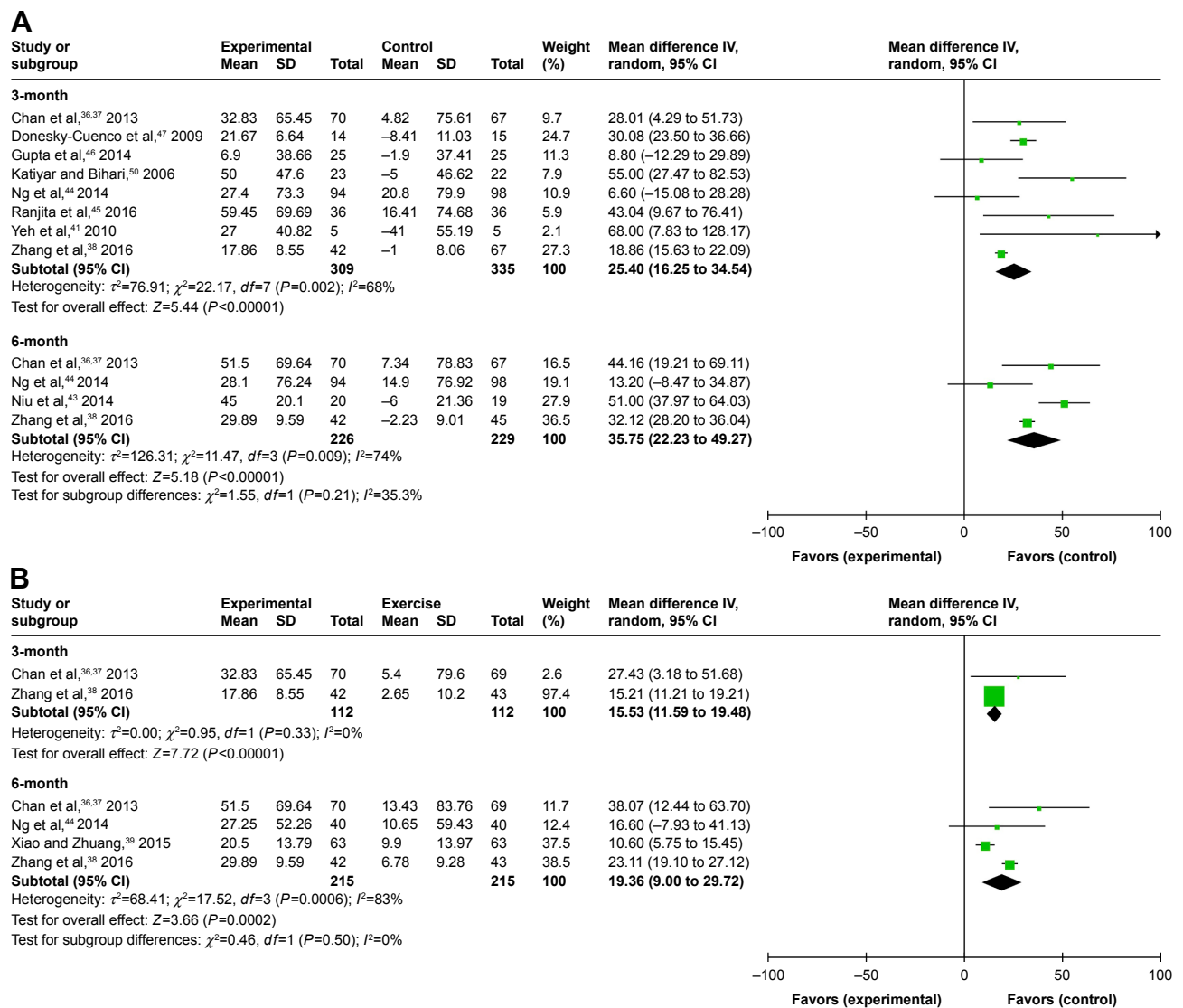
## FEV<sub>1</sub> percent predicted normal values

Four studies<sup>38,46,47,51</sup> on 211 participants examined the effects of experimental group versus nonexercise on dyspnea at 3 months, using FEV<sub>1</sub> % predicted normal values. Regarding lung function, the experimental group statistically increased FEV<sub>1</sub> (MD 4L, 95% CI: 2.7 to 5.31,  $P < 0.00001$ ,  $P$  for heterogeneity=0.69,  $I^2=0%$ ). However, there was a trend in favor of experimental group after 24 weeks (n=279, MD 4.8L, 95% CI: 2.56 to 7.07,  $P < 0.00001$ ). There was no statistically significant difference in FEV<sub>1</sub> pre% between groups ( $P$  for heterogeneity=0.60,  $I^2=0%$ ), as shown in Figure 5.

## Quality of life

### Meditative movement versus nonexercise

Two studies<sup>41,42</sup> used Chronic Respiratory Disease Questionnaire (CRQ) to evaluate changes in quality of life, with only 24 participants each in both the experimental group and the control group at 3 months. The MD in total score was 1.92 units (95% CI: 0.54–3.31,  $P$ -value=0.006). As to component scores, there were not statistically significant difference in mastery (95% CI: -0.49–3.62,  $P$ -value=0.14) and emotion (95% CI: -0.11–2.41,  $P$ -value=0.07) between groups. No significant differences in dyspnea and fatigue were also observed between groups (MD 0.9 units, 95% CI: 0.51–1.29,  $P < 0.00001$ ; MD 0.75 units, 95% CI: 0.42–1.09,  $P < 0.0001$ , respectively). However, the 2 component scores were highly heterogeneous, as one favored the emotion subscores ( $P$  for heterogeneity=0.03,  $I^2=78%$ ) and the other the mastery subscores ( $P$  for heterogeneity  $< 0.00001$ ,  $I^2=96%$ ; Figure 6). Furthermore, CRQ scores at 3 months were only captured in 2 studies (n=24); therefore, the end point was



**Figure 3 (A)** Forest plot of comparison: meditative movement versus nonexercise, outcome: 6-minute walk test. **(B)** Forest plot of comparison: meditative movement versus walking exercise, outcome: 6-minute walk test.

evaluated in a comparatively smaller population. Heterogeneity was also relatively high between the 2 trials comprising the third month end point.

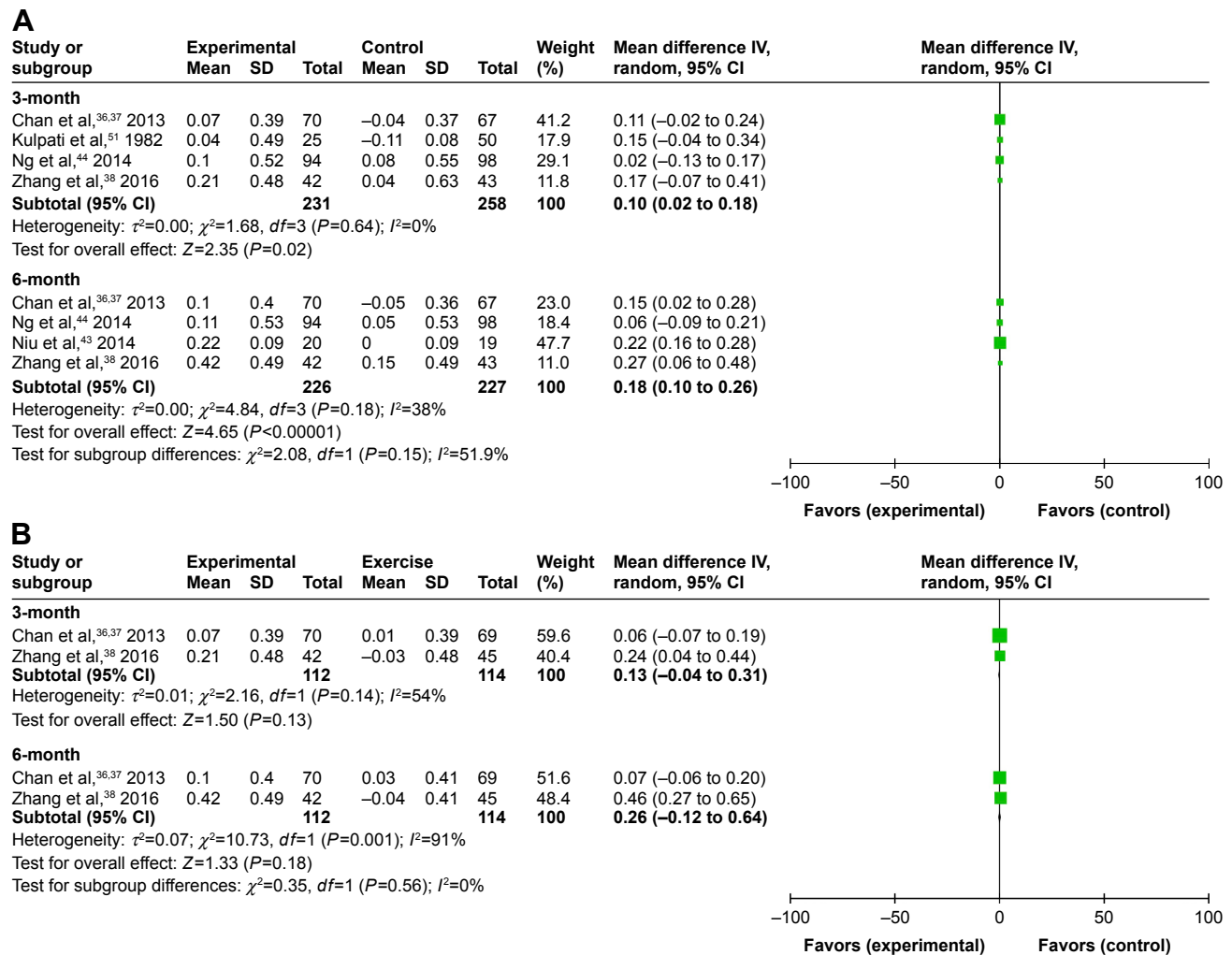
## Meditative movement versus walking exercise

HRQoL was evaluated by CRQ in 2 studies<sup>39,40</sup> at 6 months. The experimental group showed a significantly decreased fatigue subscores (MD 0.2 units, 95% CI: 0.12 to 0.28,  $P<0.00001$ ) compared with the exercise group. The pooled effect size showed that the experimental group had a lower CRQ score than the exercise group (dyspnea: MD 0.46 units, 95% CI: -0.28 to 1.20,  $P=0.23$ ; emotion: MD 0.04 units, 95% CI: -0.34 to 0.42,  $P=0.84$ ; mastery: MD 0.00 units, 95% CI: -0.32 to 0.33,  $P=0.98$ ). The improvement of dyspnea after

intervention was reported in another trial using the fatigue section of CRQ, but the difference was not significant (Figure 7). However, heterogeneity was high for the other end points.

## Discussion

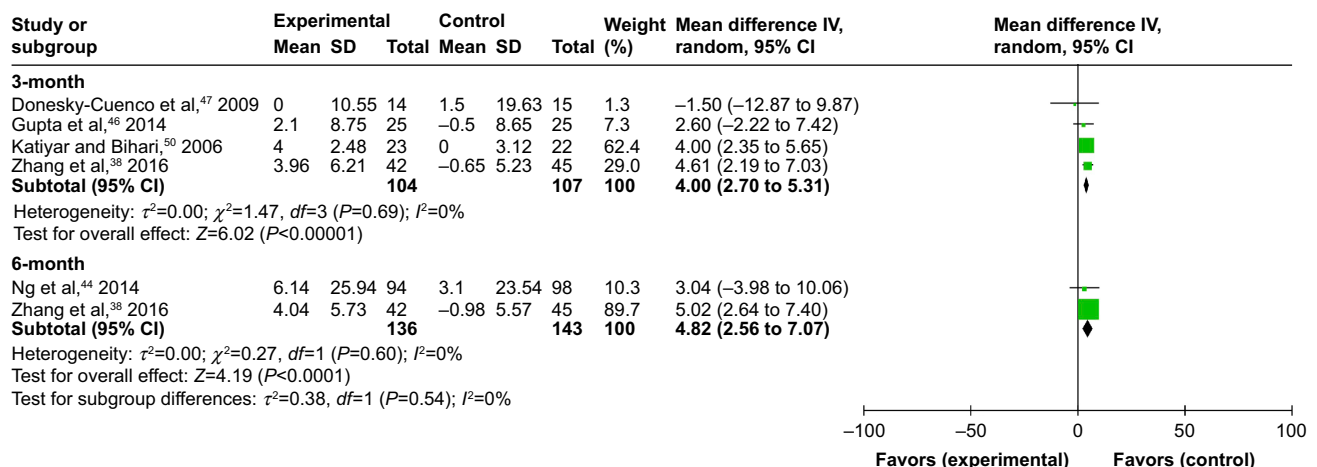
According to the results of the present review, the pooled effect sizes indicated that meditative movement might be more beneficial to improving lung function of people with COPD than nonexercise. A pooled effect from 2 trials shows that meditative movement was more beneficial to reducing dyspnea and fatigue in COPD patients than nonexercise after 3 months. This study aims to evaluate the effects of meditative movement across multiple COPD populations. The current meta-analysis is distinct from previous reviews in several aspects. Our meta-analysis identified and included



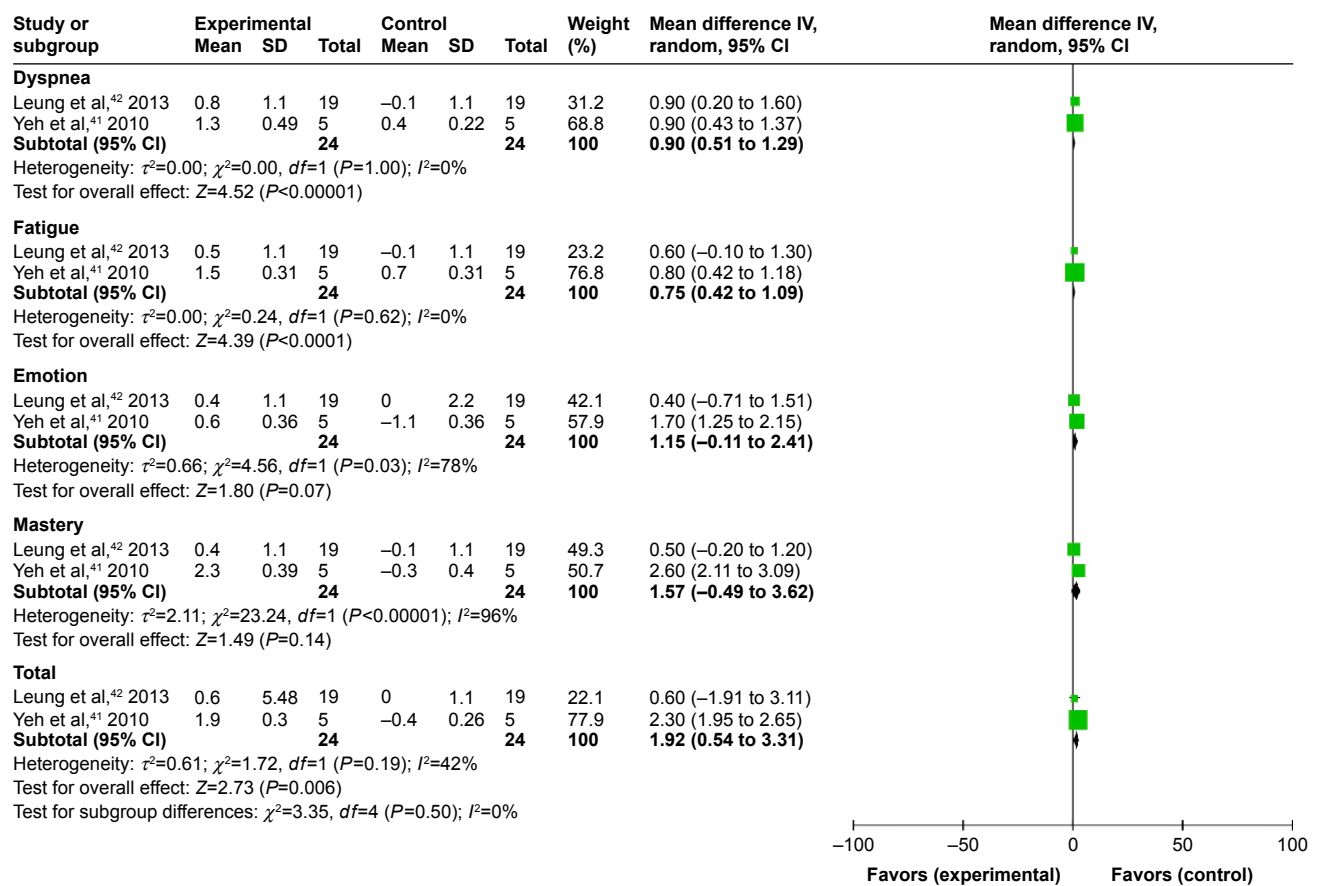
**Figure 4 (A)** Forest plot of comparison: meditative movement versus nonexercise, outcome: forced expiratory volume in l s. **(B)** Forest plot of comparison: meditative movement versus walking exercise, outcome: forced expiratory volume in l s.

more eligible studies than the previous reviews. Progressive decline in physical condition of COPD patients reduces their ability to perform daily physical activity. Our results aimed to evaluate the effectiveness of experimental programs in

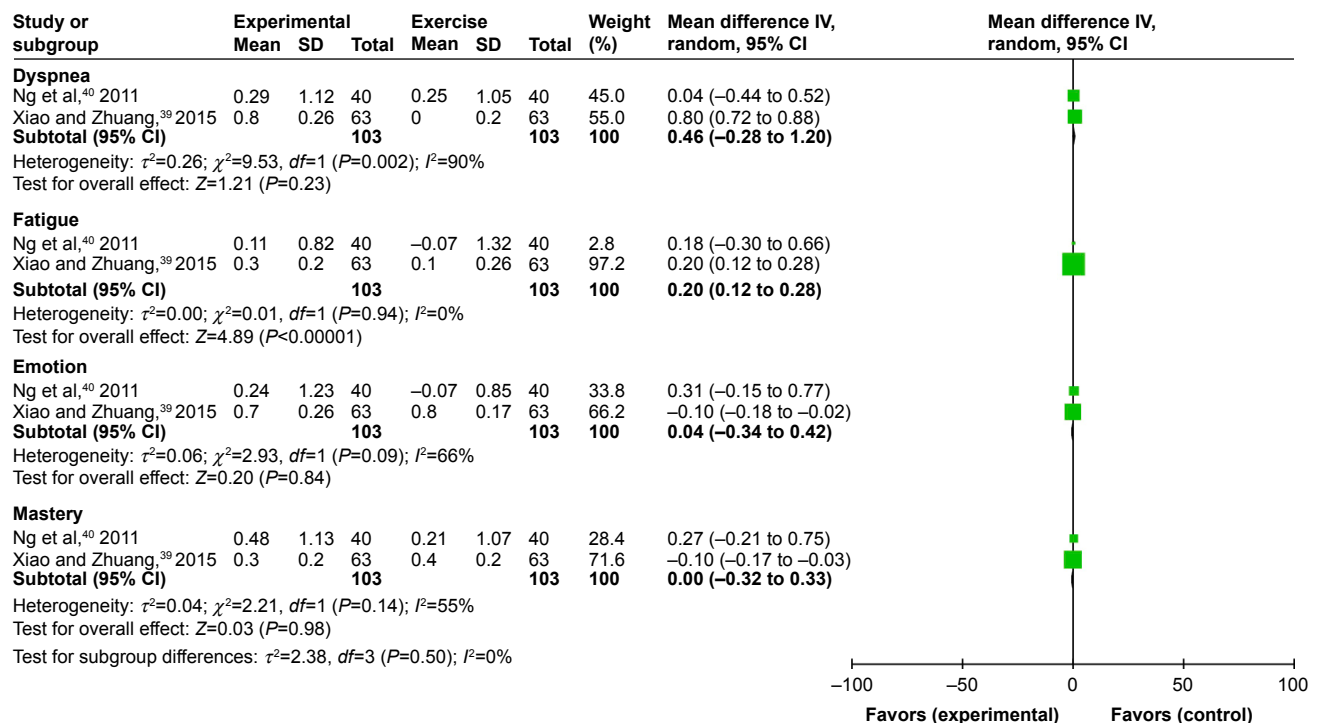
enhancing rehabilitation of COPD patients. The efficacy and safety of meditative movement have been evaluated in previous studies. A pulmonary rehabilitation index, comprising exercise capacity, lung function, and HRQoL, was measured



**Figure 5** Forest plot of comparison: meditative movement versus nonexercise, outcome: FEV<sub>1</sub> percent predicted normal values. **Abbreviation:** FEV<sub>1</sub>, forced expiratory volume in l s.



**Figure 6** Forest plot of comparison: meditative movement versus nonexercise, outcome: CRQ, 3-month. **Abbreviation:** CRQ, Chronic Respiratory Disease Questionnaire.



**Figure 7** Forest plot of comparison: meditative movement versus walking exercise, outcome: CRQ, 6-month. **Abbreviation:** CRQ, Chronic Respiratory Disease Questionnaire.

at baseline, 3 and 6 months. This review provided evidence of the effectiveness of meditative movement toward improving the exercise capacity. This study evaluates the effect of meditative movement across multiple COPD populations. This review provided evidence on the effectiveness of meditative movement in improving the exercise capacity, pulmonary function, and quality of life of COPD patients, as long as participants adhered to the protocol. Subjects in the experimental group required considerable practice to attain proficiency. Tai chi qigong (TCQ) is a low-intensity, rhythmic circular exercise incorporating musculoskeletal, respiration, and meditation training.<sup>17,18</sup> The movements are coordinated with deep breathing that draws the breath down into the lower tantien (the main energy center of the body). TCQ might enhance the lung capacity and diaphragm strength, and improve cardiorespiratory function.<sup>17</sup> Yoga exerted beneficial effects by reducing breathing frequency, modulating airway reactivity,<sup>19</sup> increasing respiratory sensation through conditioning of the breathing pattern,<sup>20</sup> reducing oxygen consumption,<sup>21</sup> decreasing responses to hypoxic and hypercapnic conditions<sup>22</sup> with better blood oxygenation without increasing minute ventilation,<sup>23</sup> improving respiratory muscle strength and endurance at least for a short-term,<sup>24</sup> and decreasing the resting heart rate and sympathetic reactivity.<sup>25</sup>

In recent decades, 6MWD has been used as a simple and valid evaluation parameter for exercise tolerance of COPD patients.<sup>26–28</sup> In our study, statistically significant increase in 6MWD was noted among participants allocated to meditative movement compared with those allocated to the nonexercise group. However, no significant difference was found in walking distance between the meditative movement and the walking exercise groups. This might be owing to the walking in the exercise group being self-paced instead of maximal shuttle walking, and most participants not gaining maximal exercise capacity during walking exercise unless closely monitored.<sup>29</sup> The result was similar to previous studies showing rehabilitation at home showed no objective improvement in exercise capacity among COPD patients.<sup>30,31</sup> The follow-up durations of meditative movement training in our studies ranged from 6 weeks to 9 months, the loss of lung function due to pathophysiological process of COPD might not be demonstrable in such short follow-up duration. Therefore, it remained unclear whether improvements gained in lung function owing to the treatment duration using meditative movement can be maintained in the longer term. Hence, the duration of meditative movement and assessment periods should be longer. Studies did not reveal

any definitive conclusions regarding the effective “dose” of meditative movement, or whether tai chi, yoga, or qigong were more effective. Future studies should pay attention to optimizing training intensity, duration, and frequency of meditative movement.

Previous studies have revealed that positive effects of pulmonary rehabilitation on HRQoL were achieved during hospitalization. However, the effects decreased and could not be sustained after discharge.<sup>32,33</sup> This study adopted the CRQ to evaluate HRQoL. Meditative movement might regulate more effective emotion to elicit much higher levels of general self-efficacy belief.<sup>34</sup> Emotional self-efficacy belief may improve individual subjective happiness, interpersonal relationships, and ability to build up a positive attitude toward diseases.<sup>35</sup> Participants can cherish feelings of concern and love from others through communicating and propagating health education. The results support the hypothesis that meditative movement appeared to be more beneficial than pulmonary rehabilitation incorporating the popular breathing and walking exercises in patients with COPD. However, firm conclusion could not be drawn owing to the small sample size.

Several limitations have to be mentioned regarding our systematic review and meta-analysis. First, there were heterogeneities in the inclusion the populations studied, the diverse style of meditative movement, time points when interventions was initiated, intensity, duration, and study quality. These factors were not comparable in most of the trials. These differences may explain the statistical heterogeneity that existed in some of the outcomes investigated. The duration of meditative movement observed included studies that were not too long enough to evaluate the long-term effects, and the optimal exercise intensity and duration currently remains unknown. Second, although we tried to pool results of all the trials, the number of patients included in this meta-analysis might not be sufficient to exclude any significant clinical benefits. Third, the quality of the included studies were not consistent, which could affect the direction and magnitude of treatment effects when performing a meta-analysis. Especially, the poor-quality trials that consistently reported active results of the outcomes. Fourth, some important physiological outcome measures, such as inflammatory biomarkers, and peripheral and respiratory muscle strength and functions were lacking in most studies. Moreover, despite multiple outcome measures being used, it is not always possible to interpret the effect against a minimal clinically important difference for each measure. Finally, since most trials were conducted in Southeast Asia, caution

should be taken regarding the generalization of results for the European population. It is possible that the willingness to participate in meditative movement training is impacted by national and ethnic cultures.

## Conclusion

The current systematic review and meta-analysis revealed that meditative movement might improve exercise capacity, dyspnea, HRQoL, and lung function in COPD patients. So, meditative movement should be encouraged as a potential and crucial approach to COPD. However, considering the limitations of our study, questions remain to be evaluated in large-scale, well-designed, multicenter, RCTs to substantiate the preliminary findings and investigate the long-term effects of meditative movement as well as the tailoring of the rehabilitation intervention for COPD patients.

## Disclosure

The authors report no conflicts of interest in this work.

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