Meditative Movement for Respiratory Function: A Systematic Review

Ava B Lorenc PhD, Yuyi Wang, Susan L Madge PhD, Xiaoyang Hu MSc, Awais M Mian, and Nicola Robinson PhD

BACKGROUND: Meditative movement, such as tai chi, yoga, and qi gong, may benefit people with cystic fibrosis (CF), as a form of gentle exercise incorporating meditation, breathing, and relaxation. Respiratory function is the most common issue in CF. In this systematic review we synthesized the evidence on the effect of meditative movement on respiratory function in patients with CF. METHODS: We searched Chinese and English language databases with terms relating to tai chi/yoga/qi gong, and respiratory function/cough/dyspnea. Articles were screened and selected by 2 researchers. We included controlled studies published in English or Chinese after 1980, and extracted data using a specially designed spreadsheet. Two researchers independently evaluated study quality and reporting, using 3 standardized checklists. Meta-analysis was not possible due to heterogeneous methods. RESULTS: We found 1,649 papers, included 43 (30 in English, 13 in Chinese), 23 of which were randomized controlled trials, and 20 were non-randomized trials. No studies were concerned with CF. Eleven studies included patients with respiratory disorders, and 27 included healthy people. Very few studies were high quality. The main problems with the randomized controlled trials was the randomization and non-random and/or poorly reported sampling. The main problems with the non-randomized studies were poor reporting of samples and non-equivalent groups. Although no clinically important changes were found, meditative movement may improve FEV_1 in healthy people, compared to no treatment/exercise (the intervention groups showed effect-size changes from 0.07 to 0.83), but meditative movement did not appear to affect FEV_1/FVC in subjects with COPD. Key study limitations were: poor reporting of sampling or methods; inadequate sample size; non-randomized design; inadequate description of randomization; randomization by center; no blinding; lack of reporting of important aspects of meditative movement; and short-term follow-up. CONCLUSIONS: The available evidence does not support meditative movement for patients with CF, and there is very limited evidence for respiratory

function in healthy populations. The available studies had heterogeneous populations and provided inadequate sampling information, so clinically relevant conclusions cannot be drawn. Well powered, randomized studies of meditative movement are needed. *Key words: meditative movement; cystic fibrosis; tai chi; taichi; taiji; tai ji; yoga; qigong; qi gong; lung function; asthma; breathing exercises*. [Respir Care 2014;59(3):427–440. © 2014 Daedalus Enterprises]

Introduction

This review was conducted to summarize the available evidence on meditative movement for respiratory function for clinical use and to inform research, in particular a feasibility study planned by the authors on the use of tai chi, a type of meditative movement, for adults with cystic fibrosis (CF). CF is a genetic disorder that particularly affects the respiratory and digestive systems.[1] CF is one of the United Kingdom's most common life-threatening inherited diseases, with over 9,000 people living with CF in the United Kingdom.[1] The most common symptoms of CF are respiratory: persistent coughing and wheezing, and recurrent chest and lung infections,[2] as well as poor weight gain, malabsorption, and malnutrition.[3,4] CF treatment varies between patients. However, common treatments in a pancreatic insufficient individual with chronic *Pseudomonas aeruginosa* infection may include airway clearance technique approximately twice a day; a high calorie diet with dietary supplements daily; pancreatic enzyme supplementation with all meals and snacks; at least one nebulized antibiotic twice a day; pulmozyme nebulized once a day; and azithromycin 3 times a week.[5] They may also suffer stress, frustration, depression, irritability, worry, insomnia,/behavioral issues, and poor posture, and as a result miss school or work.[4,6-8]

Meditative movement is a recently coined term for gentle exercises that incorporate meditation, breathing, and relaxation.[9] Meditative movement (also called complementary/alternative exercise or mind-body exercise) as a group of therapies is increasingly the focus of studies and reviews, with evidence identified for fibromyalgia[10,11] and cognitive impairment.[12] Meditative movement may be beneficial for people with CF, as exercise is part of their recommended treatment package,[5,13] although they may have limited functional capacity. However, a brief literature search identified that there was no specific research evidence on the use of meditative movement for patients with CF. This review therefore focused on the effectiveness of meditative movement for respiratory function, which is the main clinical feature and cause of death in people with CF.[14]

In the United States, research indicates that 65% of children with CF use complementary and alternative medicine (including prayer), 49% being mind-body approaches.[15] Complementary and alternative medicine has been used for CF symptoms such as mucus clearance, anxiety, and general health, with 77% finding it useful.[15]

The practice of meditative movement is popular in both China and the West.[16-19] Meditative movement, most commonly tai chi, yoga, and qi gong, incorporates: focus of the mind; movements, usually slow, relaxed, flowing and choreographed; a focus on breathing to rest the mind, which also "energizes" the body; and a deep state of physical and mental relaxation.[9] Tai chi and qi gong have ancient roots in China as martial practice, and yoga was originally a spiritual practice.[20,21] Qi gong is considered the most ancient practice of bringing awareness to and directing the movement of "qi" in the body.[20,22] Tai chi, which is one form of qi gong, is particularly choreographed and can be tailored to meet individual needs.[20] Yoga similarly aims to create physical and emotional balance through the use of postures (asanas) and breathing exercises (pranayama).[23] Tai chi and qi gong are based on the theory and philosophy of traditional Chinese medicine, in which "meridians" or energy channels throughout the body are used to treat different aspects of disease. Some meridians are related to organs in the body. The underpinning Chinese medical philosophy is that the lung meridian influences fluid metabolism and lung function. According to traditional Chinese medicine it is the expansive action of tai chi that affects the lungs and diaphragm and can also aid digestion and fluid movement in the body.[24] In recent years evidence of positive effect for a variety of chronic conditions has emerged for all 3 practices, including cardiovascular disease, arthritis, and falls risk.[16,21,25]

Dr Lorenc, Ms Hu, Mr Mian, and Professor Robinson are affiliated with the Department of Allied Health Sciences, London South Bank University, London, United Kingdom. Ms Wang is affiliated with the Centre for Evidence-Based Chinese Medicine, Beijing University of Chinese Medicine, Beijing, China. Dr Madge is affiliated with the Department of Cystic Fibrosis, Royal Brompton Hospital, Sydney Street, London, United Kingdom.

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Correspondence: Ava B Lorenc PhD, Department of Allied Health, London South Bank University, 103 Borough Road, London SE1 0AA, United Kingdom. E-mail: lorenca@lsbu.ac.uk.

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A previous systematic review found positive evidence for people with asthma for improving cardiorespiratory function using yoga, although included studies were poor quality.[26] Other reviews of tai chi for improving aerobic capacity,[27] and yoga for improving pulmonary function,[28] found positive evidence, but the focus was on healthy adults rather than patients with chronic disease, and the Chinese literature was not included. In addition, the focus was on tai chi as a form of aerobic exercise rather than a treatment for respiratory function.[29] Although aerobic exercise is recommended for CF,[13] excessive exercise can in some cases lead to dyspnea, stress, and fatigue. Conversely, meditative movement allows patients to work within their functional capacity, using gentle movements to stimulate movement of qi, mucus, blood, and lymph. Meditative movement's gentle yet demanding movements are low-impact, low-stress, calm the sympathetic nervous system, and engage the parasympathetic system.[24] This can improve cardiovascular and pulmonary function without release of stress hormones, aiding immune function, reducing inflammation due to chronic illness, preventing infections, and improving quality of life.[24]

This review synthesized the evidence available in Western and Chinese databases on meditative movement (tai chi, qi gong, or yoga) for respiratory function. Respiratory function was chosen as the main clinical feature since the primary cause of death in CF is lung disease. This review had 2 aims.

- Identify the gaps in research on meditative movement for respiratory function, to inform future research, in particular a trial of tai chi for adults with CF being conducted by the authors
- Summarize for CF clinicians and patients the evidence for meditative movement for respiratory function

Only controlled studies were included, with any control treatment, in any population. There was no protocol registered for this review.

Methods

We used the United States National Library of Medicine's Medical Subject Headings (MeSH) terms in the following search string: tai ji OR yoga OR breathing exercises AND cystic fibrosis OR dyspnea OR cough OR respiratory function tests OR respiration OR respiratory tract disorders OR breath tests. We used non-MeSH terms in the following search string: tai chi OR taichi OR taiji OR tai ji OR yoga OR qigong or qi gong AND cystic fibrosis OR respiratory system AND disorders/OR respiratory OR dyspnea OR cough OR respiration OR breath tests. To search the Chinese databases we used the search string: qigong OR yoga OR taiji AND cystic fibrosis OR lung function OR asthma OR dyspnea. An example search is given below.

1. Tai chi/
2. Breathing exercises/
3. Yoga/
4. 1 or 2 or 3
5. Cystic fibrosis/
6. Dyspnea/
7. Cough/
8. Respiratory function tests/
9. Respiration/
10. Respiratory tract disorders/
11. Breath tests/
12. 5 or 6 or 7 or 8 or 9 or 10 or 11
13. 4 and 12

The literature searches were carried out on English and Chinese language databases by native language speakers. The English databases, searched from their dates of conception until the end of 2011, were MEDLINE, all Cochrane Library resources, CINAHL, AMED, PsycINFO, ScienceDirect, and Index to Theses. The Chinese databases, searched from January 1, 1990, to April 1, 2012 were China National Knowledge Infrastructure, Vip, and Chinese BioMedical. The reference lists of included articles and all systematic reviews were also searched for additional references.

Articles were screened and selected by 2 researchers, based on the following study inclusion/exclusion criteria.

Inclusion Criteria

- Investigated tai chi, qi gong, or yoga
- Measured effects on CF or respiratory function, using one or more pulmonary function measurements or assessment scales: FEV_1/FVC, FEV_1, maximum $\dot{V}_{O_2}$, Borg dyspnea scale, vital capacity, cardiorespiratory fitness index, peak expiratory flow
- Included in the English or Chinese databases
- Controlled trial
- Published later than 1980, to ensure a certain level of quality

Exclusion Criteria

- Studied outcomes that do not measure pulmonary function (eg, ventilatory frequency, ventilatory equivalent, tidal volume, oxygen cost, respiratory pattern)
- Uncontrolled studies, letters, news items, reviews, case reports
- Published in 1980 or earlier

Data were extracted from each included article using a specially designed spreadsheet to collect information on

Table 1. Criteria Used to Assign Quality Rating

Randomized Controlled Trials	CONSORT Items Reported	Cochrane Risk of Bias Items Reported	Meditative Movement Reporting Checklist Intervention Items Reported
Very poor	Less than a third	6 or more	Less than half
Poor	Less than 60%	5 and possible risk from 1 other	Between 40 and 60%
Good	Between a third and 50%	4 and possible risk from 1 other	More than half
Very good	More than 60%	3 or less from 1 other	More than 60%
Non-randomized trials	**Trend Items Reported**	**Quality Score**	**Meditative Movement Reporting Checklist Intervention Items Reported**
Very poor	Less than a third	Less than 33%	Less than 25%
Poor	Between 30 and 41%	Between 20 and 50%	Between 0 and 54%
Good	Over 33%	Between 37 and 100%	Over 29%

the intervention, control, outcomes, population, findings, and conclusions. Two researchers independently evaluated the quality of the research and quality of the reporting, using 3 standardized checklists: for randomized controlled trials (RCTs) the Consolidated Standards of Reporting Trials (CONSORT)[30] (plus extension for non-pharmacologic treatments,[31] the Cochrane Risk of Bias assessment tool (http://www.mrc-bsu.cam.ac.uk/cochrane/handbook/chapter_8/table_8_5_a_the_cochrane_collaborations_tool_for_assessing.htm), and the meditative movement reporting checklist.[9] For non-randomized trials we used the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement checklist,[32] the methods of Downs and Black,[33] and the meditative movement reporting checklist.[9]

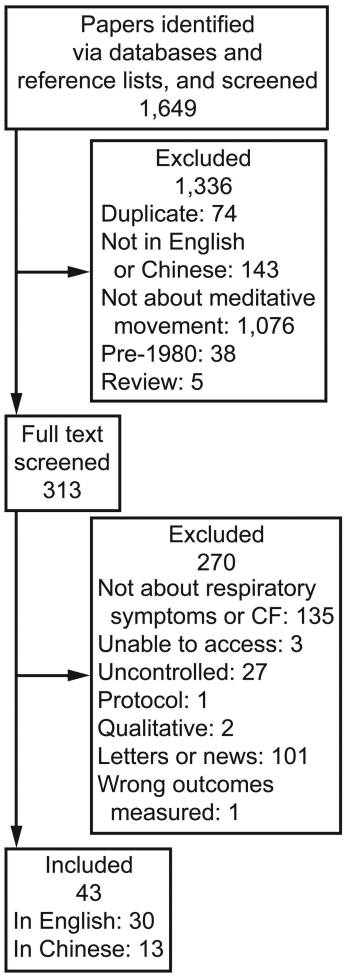

Fig. 1. Flow chart. CF = cystic fibrosis.

Each paper was given a score of 0 (not reported or high risk of bias), 0.5 (partially reported or possible risk of bias), or 1 (reported or no risk of bias) for each item on the checklist, summed to give total scores for reporting and quality (Table 1).

Given the extensive heterogeneity of interventions and comparison groups used in the studies, and the poor quality and reporting of many of the papers, a meta-analysis was deemed inappropriate and potentially misleading. Narrative synthesis was used for each combination of intervention and control, to describe the direction and size of effect and consistency across studies.

Results

We identified 1,632 papers: 889 in the English language databases and 743 in the Chinese databases. An additional 17 papers were identified from the reference lists. After excluding duplicates and studies with inappropriate study design or study focus, the final total of included studies was 43: 30 in English, 13 in Chinese (Fig. 1).

Twenty-three of the included studies were RCTs[34-55] and 20 were non-randomized trials.[56-75] Of these, 13 eval-

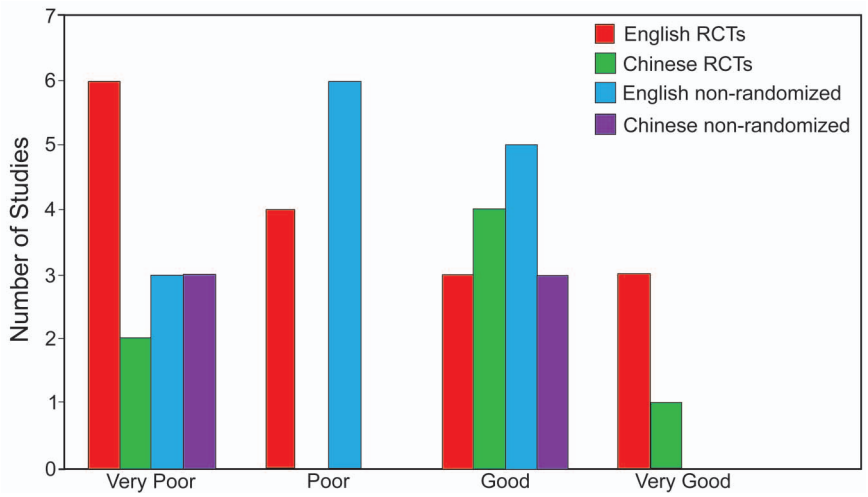

Fig. 2. Quality of included studies. RCT = randomized controlled trial.

uated yoga, 20 tai chi, 9 qi gong, and 1 tai chi and qi gong combined. Yoga, tai chi, and qi gong are discussed together in this review.

Samples

None of the studies identified included people with CF. Eleven studies focused on patients with respiratory disorders: COPD,[38,41,43,45,51,52,72,75] asthma[42,47] and pleural effusion.[48] Twenty-seven studied healthy people: older adults,[34,35,50,55,57,58,60-65,73-77] healthy adults,[59] healthy males,[66,69] soldiers,[44] students,[46,53,71] children,[37] "residents,"[59] and practitioners of tai chi/yoga.[56,67,68] The remaining 6 studies were on non-respiratory disorders (lower-limb disabilities,[70] breast cancer patients,[54] heart disease,[49] impaired vision,[36] Parkinson's disease,[40] and hypertension[39]) but also measured respiratory outcomes. The majority of the studies involved adults; only 3 included children.[36,37,42]

The sample sizes ranged from 10 to 158. Most studies had 20–60 subjects, and only 5 studies had over 100.

Quality of Studies

As shown in Figure 2 and Tables 2 and 3, very few individual studies were rated very good (none of the non-randomized studies, due to their inherent bias from using a non-randomized study design).

Figure 3 shows the change in the quality of studies over time; there was some improvement, but it is far from a constant trend.

The main risk of bias with RCTs was from problems with randomization (lack of reporting, or inadequate randomization process), and sampling (non-random or not reported, in particular no reporting about the population and how the sample was selected).

The main risks of bias in the non-randomized studies were due to lack of reporting of how and where the subjects were recruited, and non-equivalent groups. The non-randomized trials had less variation in quality than did the RCTs, being overall poorer quality.

Study Designs

Thirty-eight studies were 2-armed. These studies had control groups that received either no treatment or usual care (16 studies), or physical exercise (6 studies). Other controls included sedentary older people, matched controls, or another martial art, and 8 studies compared people experienced in meditative movement to people with no experience. Four studies were 3-armed, comparing meditative movement to exercise and to no intervention (2 studies); conventional treatment and physiotherapy; or yoga plus meditation or no intervention. One study was 4-armed.

Interventions

From the meditative movement checklist,[9] most studies reported the duration and frequency of the intervention, and 59% reported the style or philosophy. However, approximately two thirds of the studies did not adequately report details about the teacher, the teacher's qualifications or style, the degree of meditative focus, the degree of focus on breathing, achievement of deep relaxation (none reported), extent of practice at home, or results regarding adherence. The reporting of details of group composition,

Table 2. Overall Quality of Studies

		Randomized Controlled Trials		Not Randomized	
	Language	Studies	Comments	Studies	Comments
Very poor	English	Six[36,42,45-48]	Few or no details of how randomization or blinding was performed. Inadequate reporting of multiple factors. Recruitment procedures not detailed and no information on population or generalizability of findings. Some had small sample sizes.	Three[56,66,68]	No details of where the sample was recruited, the population, or how the control group was chosen. Limited information on the intervention. Small sample sizes.
	Chinese	Two[49,50]	No details about the methods used to generate the random allocation sequence. No information about how blinding was done or who was blinded. Recruitment procedures not detailed. No information on how sample size was determined.	Three[71,72,75]	Almost all factors not adequately reported. Small sample size.
Poor	English	Three[37,39,58]	Either no information on randomization procedure or bias in procedure (eg, groups randomized rather than individuals). Did not report at least one important factor (eg, control treatment, population, or intervention).	Six[61-64,67,69]	Limited data on where the sample came from, the population, or biased sampling (eg, volunteer sample). Limited information on the intervention.
Good	English	Three[34,43,44]	Although only one study had an adequate description of randomization, the other aspects of the studies were reported, including detailed descriptions of the interventions.	Five[35,59,60,65,70]	No details of recruitment procedures. Interventions and controls inadequately described.
	Chinese	Four[52-55]	No details about the randomization methods. The interventions and outcomes were clearly described.	Three[52,73,74]	Limited data on recruitment and bias risks (eg, control group recruited at different time and place). Potential bias in comparison groups (eg, non-equivalent groups or only a single group). Some description of intervention.
Very good	English	Four[38,40,41,57]	Randomization described in all studies. Good descriptions of interventions. Some blinding used. Low risk of bias.	None	
	Chinese	One[52]	Reported the randomization procedure. Detailed description of inclusion criteria and exclusion criteria. Other aspects clearly reported. Low risk of bias	None	

face to face or supporting materials, and types of movement varied widely, with around half reporting this information and a third not reporting any of these details.

The length of intervention ranged from 7 minutes to 2 hours; most common was 30–60 min. Yoga tended to be practiced for longer and more frequently than tai chi/qi gong. Nine studies specified encouraging home practice, usually daily. Two used a video, one used a tape recording, one used a list of movements, and one used verbal instructions. Yang style tai chi was most common (6 studies). Others included "health" tai chi, simplified tai chi, Wu style tai chi, Chen style 32 tai chi, Cheng short style tai chi, light intensity tai chi, Shuxinpingxuegong (qi gong), Emei qi gong, Wu qinxi (qi gong), tai chi qi gong, qi gong, Iyengar yoga, Hatha yoga, Karlaripayattu yoga, and yoga respiratory training. Most studies used a 2 or 3 month follow-up period; a minority followed up for up to 5 years.

Outcomes

As in previous systematic reviews, meta-analysis was not possible because the outcomes measured were so heterogeneous: less than half of the studies in any comparison group used the same outcome.

Table 3 shows the respiratory function outcome data. The results from studies assessed as very good and good suggest that:

- In healthy populations (including older people, soldiers, and students), meditative movement appears to improve FEV_1, compared to no treatment or exercise, either daily or less frequently. The intervention groups showed effect-size changes of 0.07,[73] 0.31,[74] 0.6,[44] and 0.83.[53] It is unlikely that meditative movement, compared with no treatment, affects $\dot{V}_{O_2}$, cardiorespiratory fitness index, or maximum aerobic capacity, although one study showed an increase of 0.23 (men) and 0.07 (women).[64]
- In people with COPD, meditative movement, compared to no treatment, does not appear to affect FEV_1/FVC. However, in 2 of these studies the intervention was less than weekly,[38,43] which may have influenced outcomes. Meditative movement may improve FEV_1/FVC, compared to exercise, as found by Zhu et al,[51] who also found a significant difference between 3 groups: meditative movement, exercise, and no treatment. However, Xu et al[52] found that pulmonary rehabilitation was actually better than meditative movement.
- In people with Parkinson's disease, meditative movement may reduce the Borg dyspnea score by 1 point, compared to exercise, although only one study investigated that outcome.[40]

The studies rated as poor or very poor provide further evidence, although this is unreliable due to the study quality. These studies suggest that: weekly tai chi may improve maximum $\dot{V}_{O_2}$ in healthy older people, compared to sedentary older people (although from non-randomized studies, and all from the same research group)[61-64]; weekly yoga may improve FEV_1 in healthy people, including students, older people, and yogis, although this is based on matched rather than randomized controls,[46,56,66] and vital capacity in older people.[50] In chronic-disease populations the poorer quality studies suggest that tai chi[42] and yoga[47] may improve respiratory function in asthma, and qi gong may improve respiratory function in cor pulmonale[49] and COPD.[72]

Discussion

There is no published research on meditative movement and CF. In people with COPD, meditative movement, compared to no treatment, does not appear to affect FEV_1/FVC, although it may have an effect compared to exercise. The evidence on meditative movement for asthma is of poor quality. In people with Parkinson's disease, meditative movement may reduce the Borg dyspnea score by 1 point, compared to exercise, although that finding is from only one study.[40]

In healthy subjects there appears to be some preliminary good quality evidence, from 4 studies,[44,53,73,74] that meditative movement improves FEV_1, compared to either no treatment or exercise. The effect size range for FEV_1 was 0.07–0.83. This was confirmed by a meta-analysis of tai chi, which found improved aerobic capacity.[27] A series of studies from one research group found evidence for tai chi improving $\dot{V}_{O_2}$ in healthy older people, but these studies were of poor quality.[60,63-65] Yoga may improve FEV_1, but the evidence is of poor quality.[46,56,66]

There is little evidence that meditative movement improves FEV_1/FVC. This may be due to these studies using a less frequent intervention (2 or 3 times a week).[38,43,56,70] One study found that respiratory rehabilitation was better than meditative movement in improving FEV_1/FVC.[51] Meditative movement is unlikely to affect the cardiorespiratory fitness index, although only one study investigated the outcome.[42] The results regarding clinical respiratory parameters may have implications for the design of future trials, because, although a commonly used outcome measure in clinical practice, these health parameters vary widely for people with CF; the broader impact of meditative movement on quality of life, well-being, and psychosocial outcomes may be more appropriate to capture in studies of meditative movement.[78,79]

Although the studies included indicate that it is unlikely that meditative movement, compared with no treatment, affects $\dot{V}_{O_2}$ or maximum aerobic capacity, a previous meta-analysis of experimental studies of tai chi found a small effect size for $\dot{V}_{O_2}$ (0.33, 95% CI 0.41–1.07).[27]

Most of the studies compared the intervention with either standard care or no treatment, which limits the interpretation of the evidence regarding the specific effects of meditative movement over and above extra attention. Many of the studies, especially those from Taiwan, compared experienced tai chi practitioners to sedentary people, which is a design with high risk of bias from confounding factors.

The details of the meditative movement used were heterogeneous, which made direct comparison problematic. Combination of results from high-quality studies did not reveal any definitive conclusions regarding the effective "dose" of meditative movement, or whether tai chi, yoga, or qi gong were more effective. Less than weekly practice did appear less likely to significantly improve spirometry. Although most studies reported the duration and frequency of intervention, there was very limited evidence, due to

Table 3. Included Studies

First Author	Language	Year	Population	RCT or Not	Quality	Intervention	Frequency	Control	Additional Information	Respiratory Function Outcome*	Baseline, mean ± SD		Follow-up, mean ± SD†		*P*
											Intervention Group	Control Group	Intervention Group	Control Group	
Jones[59]	English	2005	Healthy	Not an RCT	Very good	Tai chi	Less than weekly	Other	Control group consisted of experienced tai chi practitioners, only measured at baseline	FEV_1	2.17 ± 0.46	2.21 ± 0.46	2.21 ± 0.42	None	.11 for before vs after in intervention group
Villien[69]	English	2005	Healthy	Not an RCT	Poor	Yoga	Weekly	Other	Matched controls	FEV_1	3.2 ± 0.2	3.2 ± 0.04	Did not report follow-up values		> .05
Makwana[66]	English	1988	Healthy	Not an RCT	Very poor	Yoga	Weekly	Other	Control = sedentary people	FEV_1	2.5 (no SD)	2.4 ± 0.31	2.9 ± 0.05	2.4 ± 0.05	Yoga < .005 Control > .005
Harinath[44]	English	2004	Healthy (soldiers)	RCT	Good	Yoga	Weekly	Exercise		FEV_1	3.2 ± 0.12	3.2 ± 0.12	3.8 ± 0.12	3.3 ± 0.13	< .05
Telles[37]	English	1997	Healthy (children)	RCT	Very poor	Yoga	Weekly	Other	Matched controls	Breathing frequency	NA	NA	22.5 ± 4.2	18.3 ± 2.4	< .001
Wu[53]	Chinese	2009	Healthy (students)	RCT	Good	Yoga	Less than weekly	Exercise		FEV_1	2.19 ± 0.57	2.61 ± 0.96	3.02 ± 0.373	3.30 ± 0.52	< .05
Mandanmohan[46]	English	2003	Healthy (students)	RCT	Very poor	Yoga	Weekly	Other	Study = control	FEV_1	1.84 ± 0.07	1.9 ± 0.05	2.12 ± 0.09	2.03 ± 0.07	< .001
Fei[71]	Chinese	2007	Healthy (students)	Not an RCT	Very poor	Qi gong	Weekly	No treatment		Vital capacity, mL	3,606.4 ± 840.3		3,924.9 ± 771.7	3,695.2 ± 717.4	
Kui[73]	Chinese	1990	Healthy (older)	Not an RCT	Good	Tai chi, qi gong	Less than weekly	No treatment		FEV_1	92.29 ± 5.59	75.76 ± 8.03	94.92 ± 6.27	73.17 ± 8.06	> .05
Liu[74]	Chinese	2010	Healthy (older)	Not an RCT	Good	Tai chi	Less than weekly	No treatment		FEV_1	1.96 ± 0.55	2.01 ± 0.46	2.27 ± 0.41	1.95 ± 0.53	< .05
Lie[75]	Chinese	1998	Healthy (older)	Not an RCT	Poor	Qi gong	Not specified	Other	No control	Vital capacity	2,287.1 ± 401.15		3,494.15 ± 317.43		< .001
Chen[58]	English	2008	Healthy (older)	Not an RCT	Poor	Tai chi	Weekly	Other	Own controls	Cardiorespiratory fitness index	37.3 ± 6.8 (first of 3 measures)		40.0 ± 5.8 (last of 4 measures)		> .05
Wang[50]	Chinese	1999	Healthy (older)	RCT	Very poor	Qi gong	Weekly	Other	Control = conventional medicine	Vital capacity, mL	NA	NA	3,410 ± 576	2,992 ± 684	< .05
Lan[62]	English	2008	Healthy (older)	Not an RCT	Poor	Tai chi	Weekly	Other	Control = sedentary older people	$\dot{V}_{O_2}$	31.4 ± 7	25.2 ± 4.5	29.8 ± 6.8	22.7 ± 4.4	.04
Audette[57]	English	2006	Healthy (older)	RCT	Very good	Tai chi	Weekly	Exercise	Control = brisk walking	$\dot{V}_{O_2}$	21.55 ± 5.2	23.73 ± 4.7	25.75 ± 3.03	23.93 ± 2.63	> .05
Lan[63]	English	2004	Healthy (older)	Not an RCT	Poor	Tai chi	Weekly	Other	Control = sedentary older people	$\dot{V}_{O_2}$	NA	NA	29.3 ± 4.7	24.3 ± 3.6	< .05, qi gong vs tai chi/ control tai chi vs control
Lan[65]	English	1998	Healthy (older) male	Not an RCT	Poor	Tai chi	Weekly	Other	Control = sedentary older people	$\dot{V}_{O_2}$	1.53 ± 0.45	1.53 ± 0.36	1.76 ± 0.44	1.51 ± 0.34	.005
			Healthy (older) female							$\dot{V}_{O_2}$	0.93 ± 0.17	0.93 ± 0.17	1.1 ± 0.2	0.92 ± 0.15	.007
Lan[64]	English	1996	Healthy (older)	Not an RCT	Poor	Tai chi	Weekly	No treatment	Male	$\dot{V}_{O_2}$	1.53 ± 0.45	1.53 ± 0.36	1.76 ± 0.44	1.51 ± 0.34	.005
									Female	$\dot{V}_{O_2}$	0.93 ± 0.17	0.93 ± 0.17	1.1 ± 0.2	0.92 ± 0.15	.007
Lai[60]	English	1995	Healthy (older)	Not an RCT	Very good	Tai chi	Less than weekly	No treatment	Male	$\dot{V}_{O_2}$	1.15 ± 0.4	0.87 ± 0.21	1.08 ± 0.28	0.79 ± 0.2	> .05
									Female	$\dot{V}_{O_2}$	0.72 ± 0.16	0.64 ± 0.11	0.68 ± 0.16	0.58 ± 0.12	> .05
Lai[61]	English	1993	Healthy (older) male	Not an RCT	Poor	Tai chi	Weekly	Other	Control = sedentary older people	$\dot{V}_{O_2}$	NA		2.16 ± 0.472	1.716 ± 0.352	< .01
			Healthy (older) female							$\dot{V}_{O_2}$			1.251 ± 0.187	1.035 ± 0.18	< .001
Rohm Young[34]	English	1999	Healthy (older)	Not an RCT	Good	Tai chi	Less than weekly	Exercise		Maximum aerobic capacity mL/kg/d	20.4 ± 3.9	19.2 ± 4.5	21.37 ± 4.71	20.84 ± 5.36	> .05
Chen[35]	English	2008	Healthy (older)	Not an RCT	Very good	Yoga	Less than weekly	No treatment	Control = before period (same people)	Cardiorespiratory fitness index	39.2 ± 6.2	37.3 ± 6.8	40 ± 5.8	39.6 ± 6.6	> .05
Gao[55]	Chinese	2009	Healthy (older)	RCT	Good	Tai chi	Weekly	No treatment		Vital capacity, mL	2,046.06 ± 222.16	1,952.37 ± 195.06	2,421.68 ± 206.19	1,973.75 ± 186.04	< .01

(continued)

Table 3. Continued

First Author	Language	Year	Population	RCT or Not	Quality	Intervention	Frequency	Control	Additional Information	Respiratory Function Outcome*	Baseline, mean ± SD		Follow-up, mean ± SD†		*P*
											Intervention Group	Control Group	Intervention Group	Control Group	
Stanescu[68]	English	1990	Healthy (yogis)	Not an RCT	Very poor	Yoga	Weekly	Other	Control = people with no yoga experience	FEV_1	NA		3.24 ± 0.86	3.36 ± 0.57	> .05
Chandran[56]	English	2004	Healthy (yogis)	Not an RCT	Very poor	Yoga	Not specified	Other	Matched controls	FEV_1	NA		3.3 ± 0.47	2.92 ± 0.4	< .05
Schneider[67]	English	1991	Healthy (martial arts, male)	Not an RCT	Poor	Tai chi	Less than weekly	Other	Control = wing chun	$\dot{V}_{O_2}$	44.3 ± 6.6	43.4 ± 4	16 ± 3.9	23.3 ± 7.5	< .05
Chan[41]	English	2011	COPD	RCT	Very good	Tai chi	Less than weekly	Exercise		FEV_1	0.89 ± 0.38	0.91 ± 0.39	0.96 ± 0.39	0.92 ± 0.38	< .05
								No treatment		FEV_1	0.89 ± 0.38	0.89 ± 0.39	0.96 ± 0.39	0.85 ± 0.35	< .05
Donesky-Cuenco[43]	English	2009	COPD	RCT	Good	Yoga	Less than weekly	No treatment		FEV_1/FVC	0.46 ± 0.08	0.43 ± 0.13	0.45 ± 0.06	0.44 ± 0.12	> .05
Kulpati[45]	English	1982	COPD	RCT	Very poor	Yoga	Weekly	Other	Control = conventional treatment	P_{aCO_2}	33 ± 1.3	33.8 ± 1.14	33.7 ± 1.35	39.7 ± 1.68	> .05
									Control = physiotherapy (breathing exercise)	P_{aCO_2}	33 ± 1.3	38.9 ± 1.52	33.7 ± 1.35	39.3 ± 1.58	> .05
Lv[72]	Chinese	1994	COPD	Not an RCT	Very poor	Qi gong	Not specified	No treatment		FEV_1	1.24 ± 0.1	1.25 ± 0.12	1.58 ± 0.12	1.24 ± 0.11	< .05
Xu[52]	Chinese	2010	COPD	RCT	Good	Qi gong	Weekly	Other	Western medication	FEV_1/FVC	51.2 ± 10.1	51.2 ± 10.1	56.5 ± 11	52.5 ± 10.9	> .05
									Western rehabilitation	FEV_1/FVC	51.2 ± 10.1	51.2 ± 10.1	56.5 ± 11	55.8 ± 11.7	> .05
									Respiratory rehabilitation	FEV_1/FVC	51.2 ± 10.1	51.2 ± 10.1	56.5 ± 11	59.3 ± 11	< .05
Yeh[38]	English	2010	COPD	RCT	Very good	Tai chi	Weekly	No treatment	Medians and ranges	FEV_1/FVC	73 ± 48–87	54 ± 42–73	69 ± 53–85	54 ± 43–72	> .05
Zhu[51]	Chinese	2010	COPD	RCT	Very good	Qi gong	Weekly	Exercise		FEV_1/FVC	64.92 ± 10.74	64.15 ± 8.76	76.14 ± 10.67	70.97 ± 12.87	< .05 < .01 between 3 groups
										FEV_1/FVC	64.92 ± 10.74	63.51 ± 9.58	76.14 ± 10.67	62.76 ± 10.04	< .01 between 3 groups
Zhu[76]	Chinese	2011	COPD	Not an RCT	Good	Qi gong	Weekly	Other	Walking	FEV_1 FEV_1C	63.92 ± 10.54	65.14 ± 9.76	76.14 ± 10.67	68.96 ± 11.87	Not reported
								No treatment		FEV_1/FVC	63.92 ± 10.54	64.51 ± 9.59	76.14 ± 10.67	61.76 ± 10.01	< .05
Gu[49]	Chinese	1998	Pulmonary heart disease	RCT	Very poor	Qi gong	Weekly	No treatment		Vital capacity, L	2.41 ± 0.57	2.43 ± 0.62	2.83 ± 0.43	2.4 ± 0.58	< .05
Chang[42]	Chinese	2008	Asthma (children)	RCT	Very poor	Tai chi	Weekly	No treatment		FEV_1	2.41 ± 0.49	2.23 ± 0.50	3.22 ± 0.66	2.71 ± 0.47	.004
Nagarath[47]	English	1985	Asthma	RCT	Very poor	Yoga	Weekly	Other	Standard care	Peak expiratory flow	290.1 ± 93.1	264.2 ± 117.2	362.8 ± 107.6	290.8 ± 12.2	< .05
Prakasama[48]	English	1984	Pleural effusion	RCT	Very poor	Yoga	Weekly	Other	Physiotherapy as control	FEV_1	NA		233 (no SD)	249 (no SD)	NA
Lee[39]	English	2003	Hypertension	Not an RCT	Poor	Tai chi	Not specified	No treatment		FVC/FEV	2.02 ± 0.44	2.21 ± 0.65	2.48 ± 0.48	2.19 ± 0.64	< .001
Telles[36]	English	1998	Impaired vision children	RCT	Poor	Yoga	Not specified	Exercise		Breathing frequency	NA		22.8 ± 5.4	19.2 ± 3.2	< .01
Cheung[70]	English	2007	Lower limb disability	Not an RCT	Very good	Tai chi	Less than weekly	No treatment		FEV_1/FVC	90.56 ± 7.54	91.2 ± 6.73	91.24 ± 8.02	90.38 ± 9.46	> .05
Qiang[54]	Chinese	2011	Cancer	RCT	Good	Tai chi	Less than weekly	Exercise		$\dot{V}_{O_2}$	1.7 ± 0.32	1.78 ± 0.3	1.85 ± 0.37	1.8 ± 0.29	> .05
Burini[40]	English	2006	Parkinsons	Not an RCT	Very good	Qi gong	Less than weekly	Exercise	First session	Borg dyspnea scale (0 to 10)	2.5 range 0–5	1.5 range 1–4	2 range 0–4	0.7 range 0–3	< .001
									Second session		1.5 range 0–5	2 range 0–7	1.5 range 0–4	1 range 0–3	< .001

* Only one outcome was used for each study: FEV_1 or FVC if available.
† If there was more than one follow-up point, the longest was used.
$\dot{V}_{O_2}$ = maximum oxygen uptake

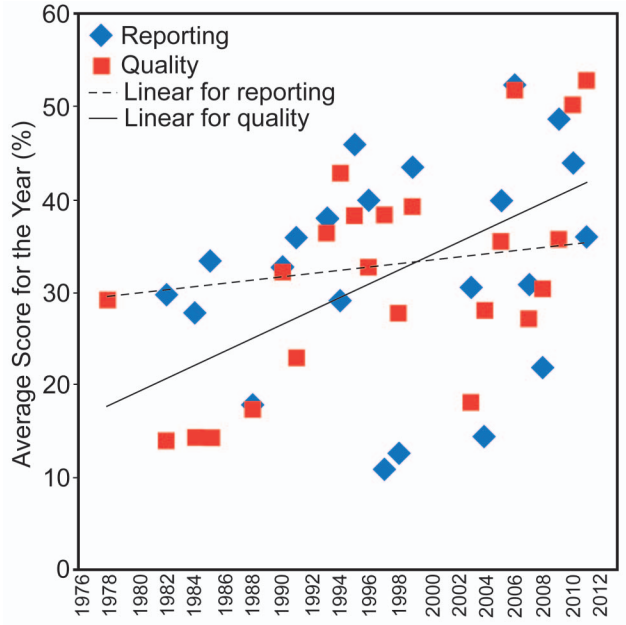

Fig. 3. Study quality versus time.

lack of reporting, for specific (important) aspects of meditative movement interventions. We are therefore unable to make firm conclusions regarding the details of the best approach to use as an intervention. Some studies suggested that meditative movement may act as a moderate intensity exercise, may stabilize the sympathetic nervous system/condition autonomic function, decrease airway resistance, and improve muscle strength, but data are very limited for these outcomes.

Limitations of the Studies

Few studies were rated as very good. The main limitations of the studies are summarized below.

- Many studies did not report their sampling frame and sampling methods (ie, no information on how and where subjects were recruited). This problem severely limits study validity because sampling methods can introduce important bias and the results may not be generalizable.
- Many studies had small, potentially underpowered sample sizes.
- Non-random group allocation therefore means we cannot draw definitive conclusions as to the effect of the meditative movement, because non-randomized trials can be subject to confounding factors such as time-related or seasonal bias. Well conducted randomized trials are more likely to have internal validity and thus accurately estimate the causal effects of interventions than are non-randomized studies.
- The randomization process was rarely described.
- Some studies randomized centers or schools rather than individuals, the implications of which were not adequately discussed.
- Blinding was rare, although blinding is challenging in complex interventions such as meditative movement.[80]
- The studies often did not include details about important aspects of the meditative movement, such as focus on meditative/breathing aspects, practice at home, and adherence, making it difficult to compare results and generalize in practice.
- Follow-up was usually a maximum of 3 months, which may be too short for those with chronic illnesses, who are likely to have long periods of ill health and fluctuations over time.

Limitations of the Review

- Although we accessed both English and Chinese language databases and papers, research in other languages may have been missed.
- Meta-analysis could not be performed due to the heterogeneity of outcomes.
- Dates were restricted to post-1980.

Clinical/Practical Implications

This review provides a summary of the current evidence for meditative movement and respiratory function, with implications for a CF population, although none of the studies included subjects with CF. The findings relating to COPD suggest that meditative movement may not affect respiratory function, but this cannot be applied to a CF population. Very limited evidence from 4 studies suggests that meditative movement may improve FEV_1 in healthy people. Although the application of these findings to CF patients is limited, they may be important, given the impact of declining lung function in CF, and the common use of FEV_1 as a clinical measure of lung function in CF (because it is quick, easy, and reflects air-flow limitation and lung volume). However, for CF patients, lung function alone as an end point is limited by the relative wellness of people with CF today, echoed by the low annual rate of decline in FEV_1 (0.5% per year).[81] The impact of tai chi on aerobic capacity may also be affected by sex, exercise intensity, duration, frequency, and the subject's initial level of physical activity.[27]

This review has found that the evidence for meditative movement for people with CF is non-existent; however,

evidence suggests that meditative movement has both physical and psychological benefits for people with chronic health conditions.[78,79] The possible benefit of meditative movement for CF may not be respiratory function, but rather as a holistic intervention incorporating physical, psychological, social, and philosophical aspects,[82] and in providing self-management, gentle exercise, flexibility, posture, mindfulness, and improved quality of life. Treatment for people with CF is complex and includes daily chest physiotherapy, exercise, supplements to avoid malnutrition, and oral and nebulized antibiotics (predominantly self-administered), resulting in high burden for patients.[83] Most meditative movement can easily be tailored to suit individual needs and adapted for practice in a range of situations, including short time periods; standing, seated, or lying down positions; minimal space; without specialized materials or clothing; and in- or outdoors. Meditative movement may provide a very useful self-management tool for people with CF, as an adjunct to conventional care. Meditative movement is also likely to improve flexibility and posture: a symptom and aggravator of CF.[6] The mindful awareness of the movements can reduce the body's stress level and improve quality of life and well-being.

This review provides important implications for researchers to design more suitable studies with appropriate outcomes. It is difficult to apply the findings to existing meditative movement programs, given the huge variation in the definition of meditative movement, and lack of reporting of specific aspects (ie, Larkey's criteria[9]).

Research Implications

Due to the relative well-being of people with CF today, large numbers will be required for clinical trials to show any differences in lung function. The use of various patient reported outcomes should be included in addition to lung function, in order to gain a better understanding of the meaning of change in health status, which is individually relevant. Some of the studies in this review did include such measures. The importance of measuring objective physiological parameters has been emphasized by this review.

There is clearly a need for studies of meditative movement for people with CF, as well as more studies on respiratory function in conditions other than COPD. The lack of research on meditative movement for CF may be a result of the emphasis in CF research on basic science and developing new life-prolonging medical treatments rather than complementary healthcare approaches. There is also a need to explore the broader impact of meditative movement on health and well-being, quality of life, and as a self-management tool, given the range of individual differences and lack of stability in day to day functioning in people with CF.

The meditative movement interventions used in the included studies varied widely, in particular in duration, frequency, and support provision. Future research may wish to consider using a standardized intervention, using guidance[9] to report their intervention.

Given the limited evidence for meditative movement in this area, continuing to compare meditative movement to usual care, perhaps using comparative effectiveness studies, is more appropriate than prematurely attempting to explore specific effects or mechanisms through comparing to other forms of movement/exercise.

Future studies of meditative movement need to ensure the use of checklists such as CONSORT when designing studies. Many studies did not adequately report important details such as randomization processes, sampling, and intervention details. Reporting of meditative movement interventions according to Larkey's[9] criteria was inadequate. Although duration and frequency is usually included, there is a need for reporting of other important aspects, namely details of the teacher, degree of meditative focus, degree of focus on breathing, achievement of deep relaxation, extent of practice at home, and adherence. This is important because the style of meditative movement may affect the results.[27] Larkey suggests using methods such as brain wave activity (for level of relaxation) and specifically designed self-report measures (eg, for degree of meditative focus).[9]

Certain study designs are more appropriate for certain interventions and populations,[84] and contention is emerging about how complementary medicine should be evaluated.[85-90] The complexity of interventions such as meditative movement, including practitioner and non-specific effects, the influence of patient choice, and potential synergistic effects, require innovative evaluative approaches.

Conclusions

There is no evidence for meditative movement for CF, and some negative evidence in COPD, but results suggest that meditative movement may have the potential to improve respiratory function in healthy populations, although the evidence is very limited. Due to the heterogeneity of study populations and lack of information on sampling, clinically relevant conclusions cannot be drawn. More research is needed in this area, in particular on people with CF, and well powered, randomized studies using broader outcomes such as quality of life and symptom scores.

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