RESPIRATORY CARE Paper in Press. Published on July 23, 2013 as DOI: 10.4187/respcare.02570

Meditative movement for respiratory function: a systematic review

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Conflict of interest: None to declare

RESPIRATORY CARE Paper in Press. Published on July 23, 2013 as DOI: 10.4187/respcare.02570

Abstract

Background

Meditative movement (MM; tai chi/yoga/qi gong) may be beneficial for 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. This systematic review synthesised the evidence for MM for respiratory function to provide a clinical summary and inform research into MM for CF.

Methods

Chinese and English language databases were searched using keywords for tai chi/yoga/qi gong, and respiratory function/cough/dyspnoea. Articles were screened and selected by two researchers. Controlled studies published in English/Chinese after 1980 were included. Data were extracted using a specially designed spreadsheet. Two researchers independently evaluated study quality and reporting using three standardised checklists. Meta-analysis was not possible due to heterogeneous methodology.

Results

1649 papers were identified, 43 included (30 English language, 13 Chinese), 23 RCTs, 20 non-randomised trials. None studied CF; 11 studied patients with respiratory disorders, 27 healthy people. Very few were high quality. The main bias with RCTs was randomisation and non-random/poorly reported sampling, for non-randomised studies poor reporting of samples and non-equivalent groups. Although no clinically significant changes were shown, MM may

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improve FEV_1 in healthy people compared to no treatment/exercise (intervention groups showed changes from 0.07 to 0.83) but MM did not appear to affect FEV_1/FVC ratio in COPD.

Key study limitations were: poor reporting of sampling or methods; small, potentially underpowered samples; non-randomised design; lacking description of randomisation; randomisation by centre; no blinding; lack of reporting of important aspects of MM; short-term follow up.

Conclusion

There is no evidence for MM in CF, and very limited evidence for respiratory function in healthy populations. Due to heterogeneity of populations and lack of sampling information, clinically-relevant conclusions cannot be drawn and more research is needed in this area, in particular powered, randomised studies.

Keywords: tai ji; Signs and Symptoms, Respiratory; Cystic Fibrosis; yoga; Breathing Exercises; review

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Background

This review was conducted to summarise 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 which particularly affects the respiratory and digestive systems (Cystic Fibrosis Trust. Annual data report. 2010. Available at: http://www.cftrust.org.uk/aboutus/what_we_do/care/UK_CF_Registry_-_Annual_Data_Report_2010.pdf. *Accessed July 15 2013*). CF is one of the UK's most common life-threatening inherited diseases, with over 9000 people living with CF in the UK (Cystic Fibrosis Trust. Annual data report. 2010. Available at: http://www.cftrust.org.uk/aboutus/what_we_do/care/UK_CF_Registry_-_Annual_Data_Report_2010.pdf. *Accessed July 15 2013*). The most common symptoms of CF are respiratory: persistent coughing and wheezing, and recurrent chest and lung infections (NHS Choices. Symptoms of cystic fibrosis. 2012. Available at: www.nhs uk/Conditions/cystic-fibrosis/Pages/Symptoms.aspx. *Accessed July 15 2013*), as well as poor weight gain, malabsorption, and malnutrition (1;2). CF treatment varies between patients, however as an example a pancreatic insufficient individual with chronic *Pseudomonas aeruginosa* infection will require: 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 nebulised antibiotic twice a day; pulmozyme nebulised once a day and azithromycin three times a week (Cystic Fibrosis Trust. The Standards Of Care And Good Clinical Practice For The Physiotherapy Management Of Cystic Fibrosis. 2011. Available at:

http://www.cftrust.org.uk/aboutcf/publications/consensusdoc/Physio_standards_of_care.pdf *Accessed July 15 2013*). They may also suffer stress, frustration, depression, irritability, worry, insomnia, /behavioural issues, poor posture and as a result miss school or work (2-5).

Meditative movement (MM) is a recently coined term for gentle exercises that incorporate meditation, breathing and relaxation(6). MM (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(7;8) and cognitive impairment (9). MM may be beneficial for people with CF as exercise is part of their recommended treatment package (10)(Cystic Fibrosis Trust. The Standards Of Care And Good Clinical Practice For The Physiotherapy Management Of Cystic Fibrosis. 2011. Available at: http://www.cftrust.org.uk/aboutcf/publications/consensusdoc/Physio_standards_of_care.pdf *Accessed July 15 2013*), although they may have limited functional capacity. However, a brief literature search identified that there was no specific research evidence on the use of MM for cystic fibrosis. This review therefore focused on the effectiveness of MM for respiratory function, which is the main clinical feature and cause of death in people with CF(11).

In the USA, research indicates that 65% of children with CF use complementary and alternative medicine (CAM) (including prayer) 49% being mind-body approaches(12). CAM has been used for CF symptoms such as mucous clearance, anxiety, and general health, with 77% finding it useful(12).

The practice of MM is popular in both China and the West (13-16). MM, 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 'energises' the body; and

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a deep state of physical and mental relaxation(6). Tai chi and qi gong have ancient roots in China as martial practice, and yoga was originally a spiritual practice (17;18). Qi gong is considered the most ancient practice of bringing awareness to and directing the movement of 'qi' in the body(17;19). Tai chi is one form of qi gong, is particularly choreographed and can be tailored to meet individual needs (17). Yoga similarly aims to create physical and emotional balance through the use of postures (asanas) and breathing exercises (pranayama)(20). Tai chi and qi gong are based on the theory and philosophy of Traditional Chinese Medicine (TCM). In TCM '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 TCM, it is the expansive action of tai chi which affects the lungs and diaphragm which can also aid digestion and fluid movement in the body (21). In recent years evidence of positive effect for a variety of chronic conditions has emerged for all three practices, for example cardiovascular disease, arthritis and falls risk (13;18;22).

A previous systematic review found positive evidence for people with asthma for improving cardiorespiratory function using yoga, although included studies were poor quality(23). Other reviews of tai chi used to improve aerobic capacity (24) and for yoga practice improving pulmonary function (25) found positive evidence, however the focus was on healthy adults rather than chronic disease populations and 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(26). Although aerobic exercise is recommended for CF (10), excessive exercise can in some cases lead to dyspnoea, stress and fatigue. Conversely MM allows patients to work

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within their functional capacity, using gentle movements, to stimulate movement of Qi, mucus, blood, and lymph. MM's gentle yet demanding movements are low impact and low stress, calm the sympathetic nervous system and engage the parasympathetic systems(21). 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 QOL (21).

This review synthesised 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 two aims: 1) to identify the gaps in research on MM for respiratory function, to inform future research in this area, in particular a trial of tai chi for adults with CF being conducted by the authors; 2) to provide a summary for CF clinicians and patients of the evidence for MM for respiratory function. Only controlled studies were included, with any control treatment, in any population. There is no protocol registered for this review.

Methods

The search terms used were: MeSH terms 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; non MeSH 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; and for Chinese databases Qigong OR yoga OR taiji AND cystic fibrosis OR lung function OR asthma OR dyspnea. An example search is given below:

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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

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

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

Inclusion criteria

- Investigated tai chi, qi gong or yoga
- Measured effects on cystic fibrosis or respiratory function (using one or more pulmonary function measurement or scale: FEV/FVC, FEV1, VO2 max, Borg scale, VC, Cardio resp fitness index, peak expiratory flow)
- Published in English or Chinese Databases
- A controlled trial
- Published later than 1980 (to ensure a certain level of quality)

Exclusion criteria

- Other outcomes which do not measure pulmonary function (e.g. 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 the intervention, control, outcomes, population, findings and conclusions. Two researchers independently evaluated the quality of the research and quality of the reporting using three standardised checklists: for RCTs the CONSORT(27) (plus extension for non-pharmacological treatments (28), Cochrane Risk of Bias (Cochrane Collaboration. The Cochrane

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Collaboration's tool for assessing risk of bias. Available at: www.mrc-bsu cam ac uk/cochrane/handbook/chapter_8/table_8_5_a_the_cochrane_collaborations_tool_for_assessing.htm. *Accessed July 15 2013*) and meditative movement reporting checklist(6); for non-randomised trials TREND (29), Downs and Black (30) and meditative movement reporting checklist(6)

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.

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.

The studies were divided into levels of quality (see Table 1)

Results

A total of 1632 papers were identified (889 from English language databases and 743 Chinese databases). An additional 17 papers were identified from the reference lists of included papers/systematic reviews. After excluding duplicate articles and articles with inappropriate

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study design or study focus, the final total of included papers remaining was 43 papers (30 English language, 13 Chinese) (see Fig 1 and Table 3 for details).

Twenty three of the retrieved articles were RCTs (31-52) and 20 non-randomised trials (53-73). Of these, 13 evaluated yoga, 20 tai chi, 9 qi gong, 1 tai chi and qi gong combined. All 3 types of meditative movement are discussed together in this review.

Samples

No studies identified included people with CF.

Eleven studies focussed on patients with respiratory disorders – COPD (35;38;40;42;48;49;69;73), asthma (39;44) and pleural effusion (45). Twenty seven studied healthy people, including 17 on older adults(31;32;47;52;55;57-62;70-72;74;75), other healthy populations were healthy adults(56) healthy males(63;66),soldiers (41), students(43;50;68), children (34), 'residents' (56) and practitioners of tai chi/yoga(53;64;65). The remaining 6 studies were on non-respiratory disorders: lower limb disabilities (67), breast cancer patients (51), heart disease(46), impaired vision (33), Parkinson's disease (37) and hypertension (36) but also measured respiratory outcomes. The majority of studies identified involved adults, only 3 included children (33;34;39).

Sample size ranged from 10 to 158. Most studies had between 20 and 60 participants, only 5 had over 100.

Quality of studies

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As shown in Table 2, very few individual studies were rated 'very good' (none of the non-randomised studies, due to their inherent bias from using a non-randomised study design).

Figure 3 provides a general indication on the quality of studies and demonstrates some improvement over time, although this is far from a constant trend.

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

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

Summary of findings

Study designs

Most (38) studies were 2-armed with control treatments of no treatment/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 MM to people with no experience. Four studies were 3-armed, comparing MM with exercise and no intervention (2 studies); conventional treatment and physiotherapy; yoga plus meditation or no intervention, and one study was four-armed.

Intervention details

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From the meditative movement checklist (6;34), most studies reported the duration and frequency of intervention, and 59% reported the style or philosophy. However, approximately two-thirds of the studies did not adequately report details about the teacher, their qualification or style, degree of meditative focus, 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, 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 7mins to 2 hours - most common was between 30mins and 1hour. Yoga tended to be practiced for longer and more frequently than tai chi/qi gong. 9 studies specified encouraging home practice, usually daily. 2 used a video, one a tape recording, one a list of movements and one 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, yoga respiratory training. Most studies used a 2 or 3 month follow up period; a minority followed up for up to 5 years.

Outcome data

As observed in previous SRs, 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.

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Table 3 provides outcome data for each study for the main respiratory function outcome. The results from studies assessed as 'very good' and 'good' suggest:

- In healthy populations (including older people, soldiers and students), MM appears to improve FEV_1 compared to no treatment or exercise, either daily or less frequently. Intervention groups showed changes of 0.07 (38), 0.31 (71), 0.6 (41) and 0.83 (50). It is unlikely that MM compared with no treatment affects VO_2, cardio-respiratory fitness index or maximal aerobic capacity although one study showed an increase of 0.23 (men) and 0.07 (women) (61).
- In people with COPD, MM compared to no treatment does not appear to affect FEV_1/FVC. However, in two of these studies the intervention was less than weekly (35;40;67), which may have influenced outcomes. MM may result in improved FEV_1/FVC compared to exercise as found by Zhu et al (48) who also found a significant result between three groups MM/exercise/no treatment. However Xu et al (49) found that respiratory rehabilitation was actually better than MM.
- In people with Parkinson's disease, MM may reduce the Borg scale by 1 point compared to exercise although only one study was identified that had investigated this outcome(37)

Studies rated as 'poor' or 'very poor' provide further evidence, although this is unreliable due to the study quality. These studies suggest: weekly TC may improve VO_2 max in healthy older people compared to sedentary older people (although from non randomised studies and all from the same research group)(58-61); weekly yoga may improve FEV_1 in healthy people

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including students, older people and yogis, although this is based on matched rather than randomised controls (43;53;63) and VC in older people(47). In chronic disease populations, poorer quality studies suggest that TC (39) and yoga (44) may improve respiratory function in asthma, and QG may improve respiratory function in pulmonary heart disease(46) and COPD(69).

Discussion

Summary of evidence

There is no published research on MM and CF. In people with COPD, MM compared to no treatment does not appear to affect FEV_1/FVC, although it may have an effect compared to exercise. Evidence on MM for asthma is of poor quality. In people with Parkinson's disease, MM may reduce the Borg scale by 1 point compared to exercise although findings relate to only one study (37).

In healthy populations, there appears to be some preliminary good quality evidence from 4 studies (38;41;50;71) that MM improves FEV_1, when compared to either no treatment or exercise. Effects sizes for FEV_1 range from 0.07 to 0.83. This is confirmed by a meta-analysis for TC which found improved aerobic capacity(24). A series of studies from one research group found evidence for TC improving VO_2 in healthy older people, but these studies were of poor quality(57;60-62). Yoga may improve FEV_1, but this evidence is of poor quality (43;53;63).

There is little evidence that MM improves FEV_1/FVC. This may be due to these studies using an less frequent intervention (2 or 3 times a week)(35;40;53;67). One study in fact found that respiratory rehabilitation was better than MM in improving FEV_1/FVC(48). MM is unlikely to affect the cardio-respiratory fitness index, although only one study investigated this(39). The results from clinical respiratory parameters may have implications for the design of future trials as, although a commonly used outcome measure in clinical practice, these health parameters vary widely for people with CF; the broader impact of MM on quality of life, wellbeing and psychosocial outcomes may be more appropriate to capture in studies of MM (76;77).

Although the studies included indicate that it is unlikely that MM compared with no treatment affects VO_2 or maximal aerobic capacity, a previous meta-analysis of experimental studies of tai chi found a small effect size for VO_2 of 0.33 (CI - 0.41, 1.07) (24).

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 MM over and above extra attention. Many of the studies, from Taiwan especially, compared experienced tai chi practitioners to sedentary people, a design which is open to high risk of bias from confounding factors.

The details of the MM 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 MM, or whether tai chi, yoga or qi gong were more effective. Less than weekly practice did appear less likely to result in a significant improvement in spirometry. Although most studies reported the duration and frequency of intervention there

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was very limited evidence, due to lack of reporting, for specific (important) aspects of MM 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 MM may act as a moderate intensity exercise, may stabilise the sympathetic nervous system/condition the autonomic function, decrease airway resistance and improve muscle strength, but data is very limited for these mechanisms.

Limitations

Few studies were rated as 'very good'. The main limitations of the studies are outlined below:

- Many studies did not report their sampling frame and sampling methods, giving no information on how and where participants were recruited. This severely limits the studies as sampling methods may introduce significant bias and results may not be generalisable.
- Many studies had small, potentially underpowered sample sizes.
- Non-random group allocation means we cannot draw definitive conclusions as to the effect of the MM, as non-randomised controlled trials can be subject to confounding factors such as time-related or seasonal bias. Well-conducted randomised trials are more likely to have internal validity and thus accurately estimate the causal effects of interventions than non-randomised studies.
- The randomisation process was rarely described.
- Some studies randomised centres or schools rather than individuals, the implications of which were not adequately discussed.

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- Blinding was rare, although this is challenging in complex interventions such as MM(78)
- Studies often did not include details of important aspects of the MM such as focus on meditative/breathing aspects, practice at home and adherence, making it difficult to compare results and generalise 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 review

- Although this review 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.

Implications

Clinical/practical

This review provides a summary of the current evidence for MM and respiratory function, with implications for a CF population, although no studies actually included subjects with CF. The findings relating to COPD suggest that MM may not affect respiratory function, but this cannot be applied to a CF population. Very limited evidence from 4 studies suggests that MM 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

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common use of FEV_1as a clinical measure of lung function in CF (as it is quick, easy and reflects airflow limitation and lung volume). However, for CF patients, the limitation of 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)(79). The impact of tai chi on aerobic capacity may also be affected by gender, exercise intensity, duration and frequency, and participants' initial level of physical activity (24).

This review has found that the evidence for MM for people with CF is non-existent; however, evidence suggests that MM has both physical and psychological benefits for people with chronic health conditions (76;77). The possible benefit of MM for CF may not be for respiratory function, but rather as a holistic intervention incorporating physical, psychological, social and philosophical aspects (80) 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, oral and nebulised antibiotics, predominantly self-administered, resulting in high burden for patients (81). Most MM can easily be adapted to be practiced in a range of situations and can be practiced in short time periods, can be tailored to suit the individual's needs, practiced standing, seated and lying down, with minimal space, no specialist materials or clothing, indoors or outdoors. MM may provide a very useful self-management tool for people with CF, as a useful adjunct to conventional care. MM is also likely to improve flexibility and posture, a symptom and aggravator of CF (4). The mindful awareness of the movements can reduce the body's stress levels, and improve QOL and wellbeing.

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This review provides important implications for researchers to design more suitable studies with appropriate outcomes. It is difficult to apply the findings to existing MM programs given the huge variation the definition of MM , and lack of reporting of specific aspects (i.e. Larkey's criteria (6)).

Research

Due to the relative wellbeing 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 emphasised by this review.

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

The MM interventions used in the included studies varied widely, in particular in duration, frequency and support provision. Future research may wish to consider using a standardised intervention, using guidance (6) to report their intervention.

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Given the limited evidence for MM in this area, continuing to compare MM 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 MM need to ensure the use of checklists such as CONSORT when designing studies. Many studies did not adequately report important details such as randomisation processes, sampling and intervention details. Reporting of MM interventions according to Larkey's(6) 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 results regarding adherence. This is important given that the style of MM may affect the results(24). Larkey suggests using methods such as brain wave activity (for level of relaxation) and specifically-designed self-report measures (e.g. for degree of meditative focus) (6).

Certain study designs are more appropriate for certain interventions and populations(82) and contention is emerging about how complementary medicine should be evaluated(83-88). The complexity of interventions such as MM, including practitioner and non-specific effects, the influence of patient choice, and potential synergistic effects, require innovative evaluative approaches.

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Conclusions

There is no evidence for MM for CF, and some negative evidence in COPD, but results suggest that MM may have the potential to improve respiratory function in healthy populations, although 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 powered, randomised studies using broader outcomes such as quality of life and symptom scores.

Funding

This systematic review is part of a study on tai chi for adults with cystic fibrosis, which has been supported and funded by the Tracie Lawlor Trust for Cystic Fibrosis.

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Table 1: Criteria used to assign level of quality			
RCTs			
	Consort items reported	**Risk of bias from Cochrane items**	**MM 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 randomised			
	Trend items reported	**Quality score**	**MM 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%

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Table 2: Overall quality of studies					
		RCTs		**Non randomised**	
		Studies	**Comments**		
Very poor	English language	Six [37;43;46-49]	Little or no details of how randomisation or blinding was performed. Inadequate reporting for multiple areas. Recruitment procedures not detailed and no information on population or generalisability of findings. Some had small sample sizes.	Three [58; 67; 69]	No details of where the sample was recruited , the population, how control group was chosen. Limited information on the intervention. Many had small samples.

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	Chinese language	Two [50; 51]	No details about the methods used to generate the random allocation sequence No information about blinding was done or who was blinded Recruitment procedures not detailed No information on how sample size was determined	Three [72; 73; 76]	Almost all aspects were not adequately reported. Small samples
Poor	English language	Three [38; 40; 59]	Either no information on randomisation procedure or bias in procedure e.g. groups randomised rather than individuals. Missing reporting on at least one important issue e.g. control treatment, population or intervention.	Six [62-65; 68; 70]	Limited data on where the sample came from, the population or biased samples e.g. volunteer sample. Limited information on the intervention.

Good	English language	Three [35; 44; 45]	Although only one study had an adequate description of randomisation, the other aspects of the study were reported, with detailed descriptions of interventions.	Five [36; 60;61; 66; 71]	No details of recruitment procedures Interventions and controls were very simply described.
	Chinese language	Four [53-55;56 Xu 2000	No details about the methods of randomization. The interventions and outcomes were described clearly.	Three [74;75;77]	Some had limited data on recruitment and some were biased e.g. control group recruited at different time and place} Many had potential bias in comparison groups e.g. non-equivalent groups or only a single group. Some description of intervention.
Very good	English language	Four [39; 41;42;57]	Randomisation described in all studies. Good descriptions of interventions. Some blinding used. Low risk of bias.	0	

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	Chinese language	One [52]	The procedure of randomization was reported. Detailed description of inclusion criteria and exclusion criteria. Other aspects were reported clearly. Low risk of bias	0	

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Table 3: Summary of included studies

Author (E = English; C=Chinese)	Year	Population	Study design	Quality[3]	Intervention – weekly or more (W) or less than weekly (L)	Control[4]	Additional information	Resp. function outcome	Baseline				Follow up[2]				
									intervention		control group		intervention		control group		p value
									Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Jones[E]	2005	Healthy	NRCT	VG	TC (L)	O	control *	**FEV_1**	2.17	0.46	2.21	0.46	2.21	0.42	none	none	0.112 **
Villien[E]	2005	Healthy	NRCT	P	Yoga (W)	O	Matched controls	**FEV_1**	3.2	0.2	3.2	0.04	Did not report follow up figures				NS
Makwana [E]	1988	Healthy	NRCT	VP	Yoga (W)	O	Control = sedentary people	**FEV_1**	2.5	N/A	2.4	0.31	2.9	0.05	2.4	0.05	p(yoga)< 0.005, p(control)>0. 005
Harinath [E]	2004	Healthy (soldiers)	RCT	G	Yoga (W)	E		**FEV_1**	3.2	0.12	3.2	0.12	3.8	0.12	3.3	0.13	<0.05
Telles [E]	1997	Healthy (children)	RCT	VP	Yoga (W)	O	Matched controls	**Respiration rate**	N/A	N/A	N/A	N/A	22.5	4.2	18.3	2.4	p<0.001
Wu [C]	2009	Healthy (students)	RCT	G	Yoga (L)	E		**FEV_1**	2. 19	0. 57	2. 61	0. 96	3. 02	0. 373	3. 30	0. 52	P<0.05
Mandamohan [E]	2003	Healthy (students)	RCT	VP	Yoga (W)	O	Study = control	**FEV_1**	1.84	0.07	1.9	0.05	2.12	0.09	2.03	0.07	p<0.001
Fei [C]	2007	Healthy (students)	NRCT	VP	QG (W)	N		**VC(ml)**	3606. 4	840.3			3924.9	771.7	3695.2	717.4	
Kui [C]	1990	Healthy (older)	NRCT	G	TC/QG (L)	N		**FEV_1**	92.29	5.59	75.76	8.03	94.92	6.27	73.17	8.06	NS
Liu [C]	2010	Healthy (older)	NRCT	G	TC (L)	N		**FEV_1**	1.96	0.55	2.01	0.46	2.27	0.41	1.95	0.53	p<0.05
Lie [C]	1998	Healthy (older)	NRCT	P	QG ***	O	No control	**VC**	2287. 1	401.15			3494.1 5	317.4 3			<0.001
Chen [E]	2008	Healthy (older)	NRCT	P	TC (W)	O	Own controls	**Cardioresp**	37.3 (first	6.8			40.0 (last of	5.8			NS

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								fitness index	of 3 measures)				4 measures)			
Wang [C]	1999	Healthy (older)	RCT	VP	QG (W)	O	Control = conventional medicine	**VC(ml)**	N/A	N/A	N/A	N/A	3410	576	2992	684	P<0.05
Lan [E]	2008	Healthy (older)	NRCT	P	TC (W)	O	Control = sedentary older people	**VO_2 max**	31.4	7	25.2	4.5	29.8	6.8	22.7	4.4	p=0.04
Audette [E]	2006	Healthy (older)	RCT	VG	TC (W)	E	Control = brisk walking	**VO_2 max**	21.55	5.2	23.73	4.7	25.75	3.03	23.93	2.63	NS
Lan [E]	2004	Healthy (older)	NRCT	P	TC (W)	O	Control = sedentary older people	**VO_2 max**	N/A	N/A	N/A	N/A	29.3	4.7	24.3	3.6	p<0.05, Qigong versus TCC/ control; TCC versus control
Lan [E]	1998	Healthy (older) male	NRCT	P	TC (W)	O	Control = sedentary older people	**VO_2 max**	1.53	0.45	1.53	0.36	1.76	0.44	1.51	0.34	p=0.005
		Healthy (older) female						**VO_2 max**	0.93	0.17	0.93	0.17	1.1	0.2	0.92	0.15	p=0.007
Lan[E]	1996	Healthy (older)	NRCT	P	TC (W)	N	Males	**VO_2 max**	1.53	0.45	1.53	0.36	1.76	0.44	1.51	0.34	0.005
							Females	**VO_2 max**	0.93	0.17	0.93	0.17	1.1	0.2	0.92	0.15	0.007
Lai [E]	1995	Healthy (older)	NRCT	VG	TC (L)	N	male	**VO_2 max**	1.15	0.4	0.87	0.21	1.08	0.28	0.79	0.2	NS
							female	**VO_2 max**	0.72	0.16	0.64	0.11	0.68	0.16	0.58	0.12	NS

Lai [E]	1993	Healthy (older) male	NRCT	P	TC (W)	O	Control = sedentary older people	**VO_2 max**		N/A			2.16	0.472	1.716	0.352	p<0.01
		Healthy (older) female						**VO_2 max**					1.251	0.187	1.035	0.18	p<0.001
Rohm Young[E] RCT	1999	Healthy (older)	NRCT	G	TC (L)	E		**max aerobic capacity ml/kg/day**	20.4	3.9	19.2	4.5	21.37	4.71	20.84	5.36	NS
Chen[E]	2008	Healthy (older)	NRCT	VG	TC (L)	N	Control = pre period (same people)	**Cardio resp fitness index**	39.2	6.2	37.3	6.8	40	5.8	39.6	6.6	NS
Gao [C]	2009	Healthy (older)	RCT	G	TC (W)	N		**VC(ml)**	2046.06	222.16	1952.37	195.06	2421.68	206.19	1973.75	186.04	p<0.01
Stanescu [E]	1990	Healthy (yogis)	NRCT	VP	Yoga (W)	O	Control = people with no yoga experience	**FEV_1**		N/A			3.24	0.86	3.36	0.57	NS
Chandran [E]	2004	Healthy (yogis)	NRCT	VP	Yoga***	O	Matched controls	**FEV_1**		N/A			3.3	0.47	2.92	0.4	p<0.05
Schneider & Leung[E]	1991	Healthy (martial arts; male)	NRCT	P	TC (L)	O	Control = Wing Chun	**VO_2 max**	44.3	6.6	43.4	4	16	3.9	23.3	7.5	p<0.05
Chan[E]	2011	COPD	RCT	VG	TC (L)	E		**FEV_1**	0.89	0.38	0.91	0.39	0.96	0.39	0.92	0.38	<0.05
						N		**FEV_1**	0.89	0.38	0.89	0.39	0.96	0.39	0.85	0.35	<0.05
Donesky-Cuenco[E]	2009	COPD	RCT	G	Yoga (L)	N		**FEV_1/FVC**	0.46	0.08	0.43	0.13	0.45	0.06	0.44	0.12	NS
Kulpati [E]	1982	COPD	RCT	VP	Yoga (W)	O	Control = conventional treatment	**$PACO_2$**	33	1.3	33.8	1.14	33.7	1.35	39.7	1.68	NS

							Control = physiotherapy (breathing exercise)	**$PACO_2$**	33	1.3	38.9	1.52	33.7	1.35	39.3	1.58	NS
Lv [C]	1994	COPD	NRCT	VP	QG ***	N		**FEV_1**	1.24	0.1	1.25	0.12	1.58	0.12	1.24	0.11	P<0.05
Xu [C]	2010	COPD	RCT	G	QG (W)	O	Western Medication	**FEV_1/FVC**	51.2	10.1	51.2	10.1	56.5	11	52.5	10.9	NS
							Western Rehabilitation	**FEV_1/FVC**	51.2	10.1	51.2	10.1	56.5	11	55.8	11.7	NS
							Respiratory rehabilitation	**FEV_1/FVC**	51.2	10.1	51.2	10.1	56.5	11	59.3	11	p<0.05
Yeh [E]	2010	COPD	RCT	VG	TC (W)	N	Medians & ranges	**FEV_1/FVC**	73	48-87	54	42-73	69	53-85	54	43-72	NS
Zhu [C]	2010	COPD	RCT	VG	QG (W)	E		**FEV_1/FVC**	64.92	10.74	64.15	8.76	76.14	10.67	70.97	12.87	p<0.05; P<0.01 between 3 groups
								FEV_1/FVC	64.92	10.74	63.51	9.58	76.14	10.67	62.76	10.04	P<0.01 between 3 groups
Zhu [C]	2011	COPD	NRCT	G	QG (W)	O	Walking	**FEV1 FEV_1C**	63. 92	10. 54	65. 14	9. 76	76. 14	10. 67	68. 96	11. 87	Not reported
						N		**FEV_1/FVC**	63. 92	10. 54	64. 51	9. 59	76. 14	10. 67	61. 76	10. 01	p<0.05
Gu [C]	1998	Pulmonary heart disease	RCT	VP	QG (W)	N		**VC(L)**	2.41	0.57	2.43	0.62	2.83	0.43	2.4	0.58	p<0.05
Chang [C]	2008	Asthma (children)	RCT	VP	TC (W)	N		**FEV_1**	2.41	0.49	2.23	0.50	3.22	0.66	2.71	0.47	p=0.004
Nagarath and Nagendra [E]	1985	Asthma	RCT	VP	Yoga (W)	O	Standard care	**Peak expiratory flow**	290.1	93.1	264.2	117.2	362.8	107.6	290.8	12.2	p<0.05

Prakasama [E]	1984	Pleural effusion	RCT	VP	Yoga (W)	O	Physiotherapy as control	**FEV_1**		N/A			233	N/A	249	N/A	N/A
Lee [E]	2003	Hypertension	NRCT	P	TC***	N		**FVC/FEV**	2.02	0.44	2.21	0.65	2.48	0.48	2.19	0.64	p < 0.001
Telles [E]	1998	Imparied vision children	RCT	P	Yoga ***	E		**respiration rate**		N/A			22.8	5.4	19.2	3.2	p<0.01
Cheung[E]	2007	Lower limb disability	NRCT	VG	TC (L)	N		**FEV_1/FVC**	90.56	7.54	91.2	6.73	91.24	8.02	90.38	9.46	NS
Qiang [C]	2011	Cancer	RCT	G	TC (L)	E		**$V0_2$ max**	1.7	0.32	1.78	0.3	1.85	0.37	1.8	0.29	NS
Burini[E] RCT	2006	Parkinsons	NRCT	VG	QG (L)	E	First session	**Borg scale (0 to 10)**	2.5	0-5 (range)	1.5	1-4 (range)	2	0-4 (range)	0.7	0-3 (range)	p<0.001
							Second session		1.5	0-5 (range)	2	0-7 (range)	1.5	0-4 (range)	1	0-3 (range)	p<0.001

*** control= experienced TC practitioners, only measured at baseline **pre post for intervention group ***duration not specified**
[E]=English language; [C]=Chinese language

1. **Only one outcome was used for each study - FEV or FVC if available.**
2. **If more than one follow up point the longest was used**
3. **Very good (VG); good (G); poor (P); very poor (VP)**
4. **No treatment (N); Exercise (E); Other (O)**

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Figure 1: Flowchart of study selection

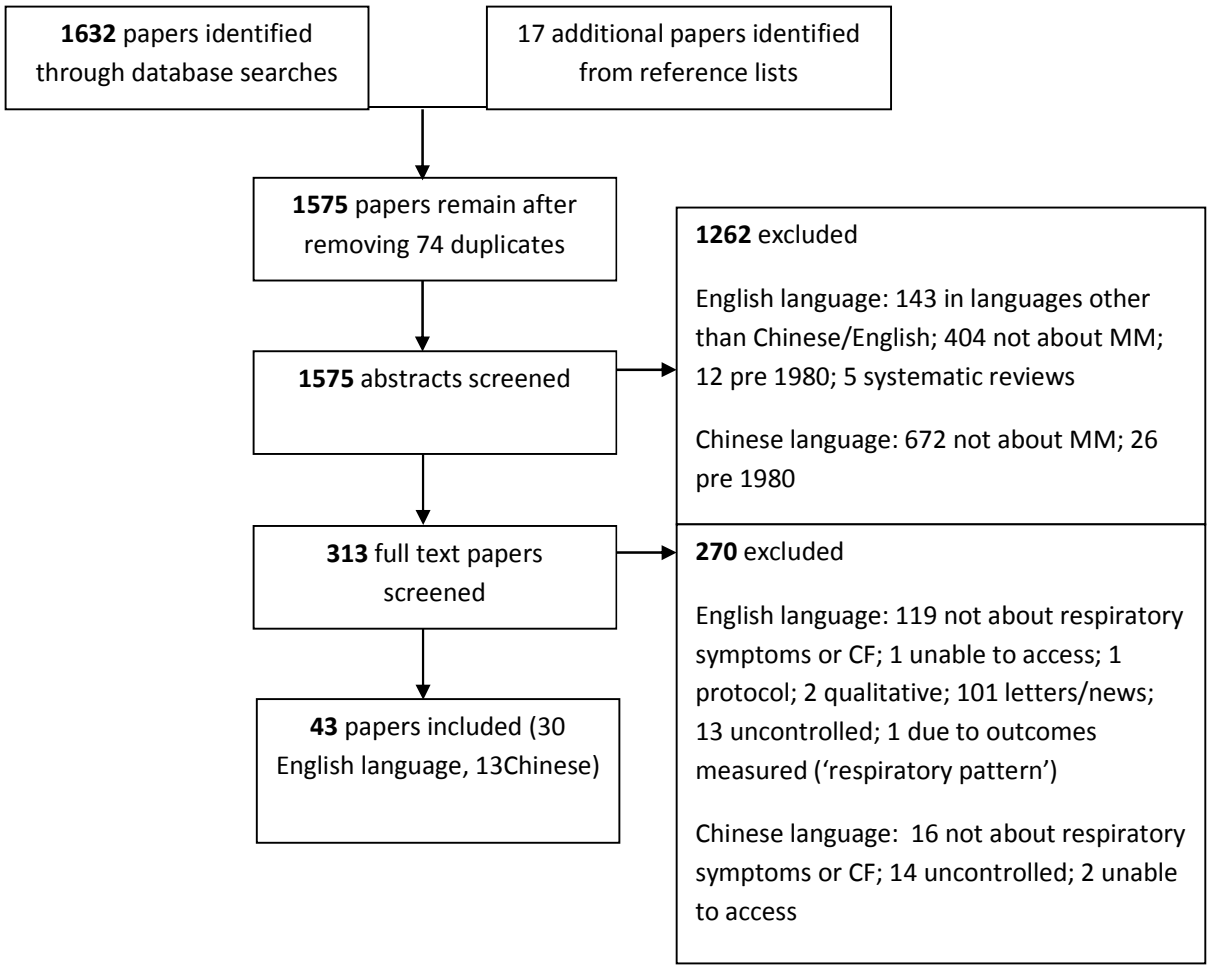

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Figure 2: Quality of studies

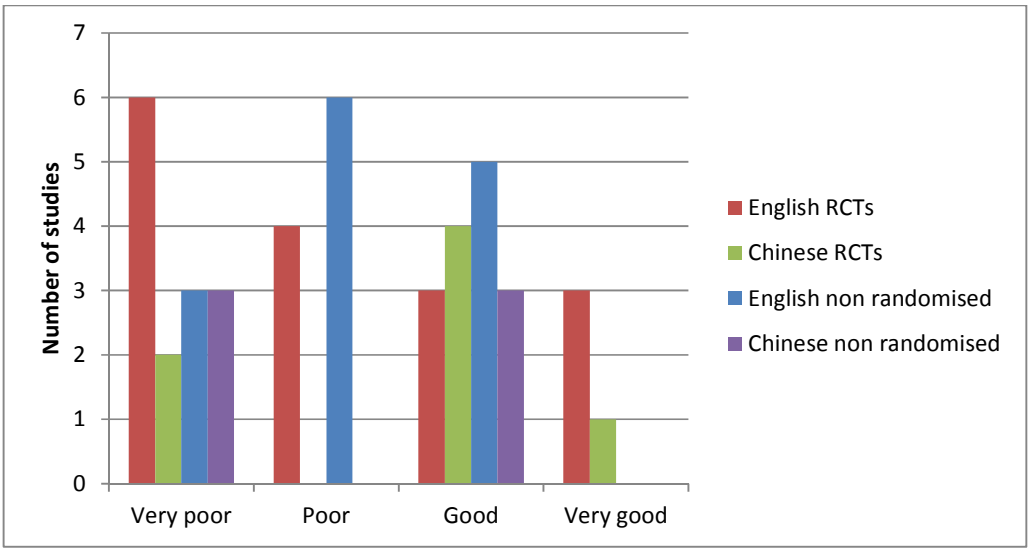

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Figure 3: Study quality over time