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ORIGINAL ARTICLE

The Effects of Tai Chi on Lung Function, Exercise Capacity and Health Related Quality of Life for Patients With Chronic Obstructive Pulmonary Disease: A Pilot Study

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Background Although several studies have assessed the effect of Tai Chi in management of chronic obstructive pulmonary disease (COPD), these studies have a wide sample variation and convey inconclusive results. This study aims to determine if a 3-month Tai Chi program improves lung function, exercise capacity, and health related quality of life (HRQoL) in people with COPD.

Methods A randomised controlled, single blind trial was undertaken. Patients were randomly allocated to either Tai Chi group (n = 26) or control group (n = 24). Participants in the Tai Chi group received a Tai Chi exercise program three times weekly for 3-months while participants in the control group were advised to maintain their routine activities. Outcome measures included lung function, 6-minute walk distance (6WMD) and COPD Assessment Test (CAT). The measurements took place at baseline and immediately after the 3-month intervention period.

Results Of 50 participants, 46 completed the intervention. Compared to control, Tai Chi significantly increased 6WMD (mean difference 60.5m, 95% CI 30.27–78.69), and reduced score of CAT (mean difference 14 points, 95% CI 11–24). An 86% compliance to the Tai Chi training was noted and no adverse events were observed in Tai Chi group.

Conclusions The Tai Chi program is a safe, effective and feasible method to improve exercise capacity and health-related quality of life in people with COPD.

Keywords Chronic obstructive pulmonary disease • Tai Chi • Lung function • Exercise capacity • Health related quality of life

Introduction

ɔ Obstructive Pulmonary Disease (COPD) is a pro-
e lung disease which is characterised by a persistent

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blockage of airflow from the lungs and is not fully reversible [1]. Despite improvements in pharmacologic treatments, many patients still suffer from dyspnoea and disabilities in daily life. At present, the primary goals in COPD management are to alleviate symptoms, maintain or improve exercise capacity and health related quality of life (HRQoL), and slow down the deterioration of lung function [2]. Pulmonary rehabilitation programs (PRP) are widely accepted for patients with COPD because they result in reduced dyspnoea and fatigue and improved mastery [3].

Exercise as a major component of a PRP, is generally well recognised for its clinical utility in the management of patients with COPD. Despite this, many issues remain unresolved, including specific modalities, optimal intensity, and the best strategies for reinforcing regular exercise habits [4,5]. Therefore, alternative forms of exercise training which are widely available, easily implemented (eg require no exercise equipment or a specific training venue) need to be evaluated. The characteristics of Tai Chi make it the perfect candidate.

Tai Chi is a traditional Chinese exercise that consists of slow, continuous movements and incorporates elements of strengthening, balance and relaxation [6].

Studies have demonstrated the benefits of Tai Chi in a variety of health issues, such as the elderly population [7,8], people with co-morbidities [9], cardiovascular disease [10] and osteoarthritis [11,12]. In addition, Tai Chi can regulate breathing, strengthen the upper and lower limbs' function, and especially can improve respiratory muscle and quadriceps muscle strength, which are also essential aspects of COPD management [13].

Tai Chi has been widely applied in the physical rehabilitation of COPD patients. However, these studies convey inconsistent results. Some evidence has reported Tai Chi could reduce symptoms of dyspnoea, alleviate the decline of lung function, enhance exercise capacity, and improve HRQoL for patients [14–16], while some studies have also shown that Tai Chi failed to effectively improve lung function, exercise capacity or HRQL in COPD patients [17–20]. The conflicting findings may be due to wide variations in Tai Chi programs, sample size and different measurements used to evaluate the outcomes [16,21–23]. Therefore, this paper describes the study design of a clinical trial which aimed to determine if a 3-month Tai Chi program improves lung function, exercise capacity, and HRQoL in people with COPD.

Methods

Study Design

This was a single-blind, randomised controlled trial conducted from March 2016 to May 2017 with a total of 50 participants recruited from the outpatient clinics of the Department of Respiratory Medicine, at The First Affiliated Hospital, Zunyi Medical College. Each participant maintained his/her medication regimen during the intervention period. The study was conducted with the approval of the hospital ethics committee.

Participants

Participants were included if they were (1) ≥45 years of age; (2) clinically diagnosed with COPD and FEV1 <80% of predicted, and ratio of FEV1 to forced vital capacity <0.70 [24], and (3) were able to walk independently. Participants were excluded if they had suffered from the following conditions: (1) symptomatic ischaemic heart disease, severe sensory or cognitive impairment, claudication or other physical condition that would preclude a 6-minute walk test; (2) current participation in a conventional pulmonary rehabilitation program or regular practice of Tai Chi.

Sample Size

Sample size calculation was based on previous findings on the medium effect of Tai Chi on exercise capacity using 6-minute walk distance (6WMD) in COPD clients [25].

According to Cohen [26], with a medium effect size of 0.05, a power of 0.80 at a 5% significant level (two-sided), 21 subjects per group were required. In order to cover the potential attrition rate of 15%, 48 subjects (24 per group) were targeted.

Randomisation and Blinding

An allocation bias on cluster level and a sub sampling bias on patient level was considered, so a randomisation took place after the baseline assessment [27]. Participants were randomised to the Tai Chi group or to usual care group, respectively. This was single-blind trial. Given the nature of the intervention, blinding the patients was not feasible and the interventionist knew that all those contacted were in the intervention arm. However, the interventionist and supervisors were blinded to the baseline and follow-up measures, and the statistician was blinded to individual results during the trial.

Intervention

Tai Chi Group

Participants in the Tai Chi group completed a 3-month Tai Chi program, which consisted of three 60-minute sessions per week for 3 months under the instructions of a qualified instructor. Each session included 5 minutes of warm-up exercises, 50 minutes of Tai Chi practice, and 5 minutes of cool-down exercises. The Tai Chi program consisted of 10 forms from classical Yang Style Tai Chi [28] conducted by an experienced Tai Chi instructor. During the practice time, participants were instructed to inhale when the movements involved lifting, stepping forward or opening postures, and exhale when movements involved lowering or closing postures. Each participant aimed to train at a moderate level of breathlessness or exertion, equating to a score of three on the modified Borg (0–10) scale [29]. One-to-two movements were taught each week for 8 weeks. The complete form was practised for the last 4 weeks of the study. In addition to the

three supervised training sessions each week, participants were asked to practice at home for 60 minutes, on the other 4 days of the week. A Tai Chi training booklet and DVD were provided to facilitate home training. Training duration was recorded by participants in the diary provided.

Control Group

Participants in the control group were advised to maintain their routine activities. No extra exercise was recommended.

Outcome Measures

All measures were obtained at baseline and immediately after the 3-month intervention period. Questionnaires and functional assessments were performed by staff who were blinded to subject assignment.

Primary Outcomes

Lung Function

Lung function was tested by spirometry in the same machine and by the same technician following a standard protocol [30]. Parameters included forced expiratory volume in one second (FEV_1), percentage predicted forced vital capacity (FVC) and FEV_1 percentage predicted normal values (FEV_1%).

Exercise Capacity

Exercise capacity was measured with the 6MWD, following American Thoracic Society (ATS) guidelines [31]. The longest distance walked in metres in 6 minutes was recorded.

HRQoL

HRQoL was evaluated using the COPD Assessment Test (CAT) [32]. It comprises eight items, each presented as a semantic six-point (0-5) differential scale, scores of 0-10, 11-20, 21-30 and 31-40 represented mild, moderate, severe or very severe clinical impact [33].

Secondary Outcomes

Compliance With Tai Chi Training

The compliance with the Tai Chi training was assessed by the total number of supervised sessions attended, the unsupervised home practice time per day and the number of days practised out of the four home training days per week.

Adverse Events

Muscle injury, injury from falls, dyspnoea, and induction of cardiovascular diseases were listed for observation.

Statistical Analysis

Data analyses were conducted using the Statistical package for Social Sciences (SPSS) version 18.0 (IBM, Chicago, IL, USA). Descriptive statistics were used to describe the demographic characteristics of the sample. A student t-test was applied to compare the differences of the measures between groups at baseline. The Wilcoxon rank sum test was used where data were not normally distributed. Within-group differences between the post-and pre-test were analysed by paired t-tests. And the differences between the two groups were compared through an independent t-test. The significant level was set at 0.05. The 95% confidence intervals around the mean differences were calculated.

Results

Initially, 50 participants were recruited and 46 participants completed the 3 months post-intervention assessments. Figure 1 shows a flow diagram of recruitment, allocation, reasons for drop-out of participants and follow-up for this study. The demographic data and baseline variables of FEV1, FEV1%, FEV1/FVC (%), 6MWD and CAT are presented in Table 1. The distribution of outcome measurements had shown normal distribution. Both groups did not differ in demographics and baseline variables($p > 0.05$).

Lung Function

Pre- and post- intervention data are shown in Table 2. Paired t-tests analysis showed that there was a significant improvement in FEV_1 ($p = 0.036$), FEV_1% ($p = 0.045$), FEV_1/FVC (%) ($p = 0.041$), in the Tai Chi group, while no changes were found in the control group ($p > 0.05$). Independent t-test showed no significant difference in lung function between Tai Chi and control groups ($p > 0.05$).

Exercise Capacity

Paired t-tests analysis showed that Tai Chi group had a significant improvement in 6WMD (36.87 ± 30.86), which also reached the minimally important differences of 26 ± 2 m [23], suggesting improvement in exercise capacity. In contrast, a significant decline (23.64 ± 51.57, $p = 0.043$) was discovered in the control group. A significant difference in 6MWD ($p = 0.000$) was observed between the Tai Chi and control groups as shown in Table 2.

HRQoL

The Tai Chi group revealed a significant decline in CAT total score (3.63 ± 3.17, $p = 0.000$) while the control group showed a significant increase (4.09 ± 4.30, $p = 0.000$), both changes reached the minimal clinically important difference of two points [34], indicating that the Tai Chi program contributed to improved HRQoL. Table 2 describes the significant differences of HRQL between the two groups ($p = 0.000$).

Compliance and Adverse Events

Overall, participants in Tai Chi group attended a mean of 31 of possible 36 sessions of Tai Chi training (compliance 86%) and no adverse events related to intervention were observed. The reason for absence was mainly due to

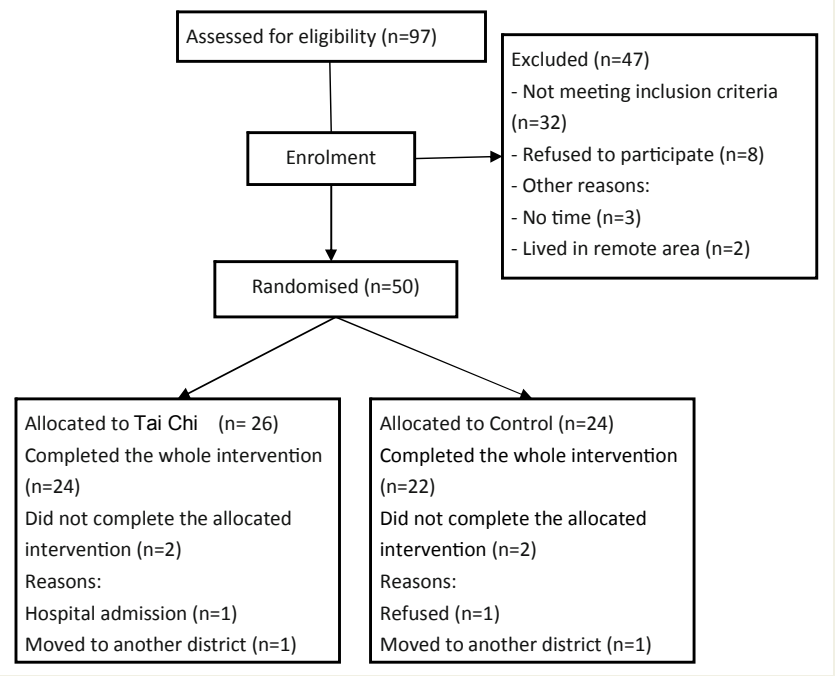

Figure 1 Flow diagram of progress.

exacerbation, family events or some other household affairs. Of the potential 4 days of unsupervised home practice, participants practised for 3.2 days per week. Twenty-two (22) of 26 participants in the Tai Chi group (84.6%) stated they would continue practicing Tai Chi after the program was completed.

Table 1 **Demographic data and baseline characteristics of participants.**

Measured parameter	Tai Chi Group (n = 26)	Control Group (n = 24)
Gender		
Male (%)	23 (88.5)	21 (87.5)
Female (%)	3 (11.5)	2 (12.5)
Age (years)	67.83 ± 5.32	67.86 ± 5.98
Smoking status		
Current smoker (%)	12 (46.2)	10 (41.7)
Never smoker (%)	3 (11.5)	4 (16.6)
Ex-smoker (%)	11 (42.3)	10 (41.7)
Years of COPD	7.60 ± 7.75	8.84 ± 7.18
Stage of COPD		
Stage II GOLD (%)	6 (23.1)	6 (25.0)
Stage III GOLD (%)	11 (42.3)	12 (50.0)
Stage IV GOLD (%)	9 (34.6)	6 (25.0)
Lung function		
FEV_1	1.18 ± 0.04	1.19 ± 0.10
FEV_1(%)predicted	55.46 ± 11.47	62.55 ± 20.18
FEV_1/FVC (%)	53.25 ± 16.34	56.71 ± 18.17
6MWD	451.71 ± 61.39	455.51 ± 71.72
CAT	15.29 ± 5.10	14.86 ± 7.19

NOTE. Values are mean ±SD, unless otherwise indicated. *a for Z- Value* (Wilcoxon rank sum test).
Abbreviations: FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; FEV_1%, Pred FEV_1, percentage predicted normal values; COPD, chronic obstructive pulmonary disease; CAT, COPD Assessment Test; 6MWD, 6-minute walking distance.

Table 2 Comparisons of outcome variables pre- and post- intervention between Tai Chi and Control group.

Parameter	Group				Difference within group #		Difference between group #
	Baseline		Post-3 months		Tai Chi Group (n = 26)	Control Group (n = 24)	
	Tai Chi Group (n = 26)	Control Group (n = 24)	Tai Chi Group (n = 26)	Control Group (n = 24)			
Lung function							
FEV_1	1.18 ± 0.04	1.19 ± 0.10	1.39 ± 0.05	1.08 ± 0.47	0.21 ± 0.15*	−0.11 ± 0.17	0.32 (0.1–0.8)
FEV_1(%) predicted	55.46 ± 11.47	62.55 ± 20.18	59.81 ± 15.09	60.52 ± 17.52	4.34 ± 10.02*	−2.03 ± 13.16	6.37 (10.28–23.42)
FEV_1/FVC (%)	53.25 ± 16.34	56.71 ± 18.17	56.43 ± 17.21	55.47 ± 20.34	3.18 ± 15.76*	−1.24 ± 15.47	4.42 (10.19–22.06)
6MWD	451.71 ± 61.39	455.51 ± 71.72	488.57 ± 61.57	431.87 ± 71.17	36.86 ± 30.86**	−23.64 ± 51.57*	60.5 (30.27–78.69)**
CAT	15.29 ± 5.10	14.86 ± 7.19	11.67 ± 5.17	18.95 ± 8.02	−3.63 ± 3.17**	4.09 ± 4.30**	−7.72 (−8.99 to −3.13)**

NOTE. Values are mean ±SD or mean (95%CI). * $p < 0.05$. ** $p < 0.01$. # month 3 minus month 0.

Abbreviations: FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; FEV_1%, Pred FEV_1percent predicted normal values; COPD, chronic obstructive pulmonary disease; CAT, COPD Assessment Test; 6MWD: 6-minute walking distance.

Discussion

This study was set to evaluate the effect of a Tai Chi program on lung function, exercise capacity and quality of life in COPD patients. Over a 3-month period, the Tai Chi group was compared to the control group with both groups completing the intervention program. Improvements in exercise capacity and quality of life were demonstrated as complementary benefits of Tai Chi training. However, no significant between-group differences were found for changes at 3 months in lung function.

Previous studies have found that patients who underwent a 3-month Tai Chi training had a significant improvement in lung function compared to the control group [35–37].

Unfortunately, this positive effect was not found in our research. However, similar to these previous studies, subjects in the Tai Chi group had a significant improvement in lung function after 3-month Tai Chi training. The mechanism action of Tai Chi in improving lung function may be due to the deep breathing that draws the breath down into the lower tantien (the main energy centre of the body), which increases lung capacity[38]. While a statistical difference does not mean clinical benefit, the minimal clinical important difference (MCID) reflects a true improvement (or deterioration) in an outcome [39] .The MID for FEV1% is 9% [40], in the present study it only increased 3.4% in the Tai Chi group, so the improvement in lung function was not clinically significant. Maybe a Tai Chi trial for a longer period should be conducted to estimate the clinical benefits in lung function for COPD patients.

Patients with COPD have a low exercise tolerance due to multiple factors, such as dynamic hyperinflation and peripheral muscle dysfunction. In this study, a significant improvement of 6MWD (36.86 ± 30.86 m), which also reached the MCID of 26 ± 2 m [29] was observed in the Tai Chi group. This demonstrated that Tai Chi can not only enhance exercise capacity but also bring an actual change in functional status. Our results were better than the findings of Yeh et al. [19] whose study showed non-significant trends of Tai Chi towards improvement of 6MWD, but was consistent with the 33 m of Chan et al. [16] and 37.77 m concluded in an systematic review [41]. The decrease of 6MWD (23.64 ± 51.57 m) in the control group showed that, without timely and effective intervention, the exercise capacity of COPD patients will deteriorate.

HRQoL is an important indicator for assessing the therapeutic effect of Tai Chi in patients with COPD [42,43]. In different studies, quality of life in COPD patients has been assessed by different HRQoL questionnaires, such as St George's Respiratory Questionnaire (SGRQ) [18,44], or Chronic Respiratory Disease Questionnaire (CRQ) [19,45]; our study used CAT. According to the MCID for the CAT total score in COPD patients, which was greater than 2, [34], for the present study the change in CAT scores exceeded the MCID in Tai Chi group compared to the control group.

The findings suggest that Tai Chi produced a statistically and clinically significant improvement in HRQoL in COPD

patients. Similar findings were reported in a meta-analysis by Wu et al. [46]. The reason for this phenomenon may be that Tai Chi is a moderate-intensity aerobic exercise and emphasises the overall adjustment in patients with physical, mental, and psychological status, thereby contributing to further improvement in quality of life for patients [23,47].

Our study also found high levels of compliance with supervised and unsupervised training, and no adverse events related to intervention during the Tai Chi training, which is consistent with an earlier report [14]. Tai Chi as a safe, simple and easy to learn approach may enhance the high levels of compliance. Moreover, Tai Chi has no requirement for equipment or site, patients can practice Tai Chi at home when they want; this may be the main reason for the high compliance with unsupervised Tai Chi training.

Limitations and Implications for Future Work

Our study has some limitations. First, the number of subjects was small, thus it is difficult to conclude a firm statement that Tai Chi can bring such significant improvements. Randomised controlled trials including more subjects should be conducted to draw firmer conclusions. Second, the duration of this study is short. Three (3) months was not long enough to judge whether Tai Chi is effective to sustain the effectiveness and whether it is cost-effective. So, follow-up assessment including a cost-effectiveness analysis should be implemented.

Conclusion

In conclusion, our results provide preliminary data to support Tai Chi as a meditative exercise that may be a therapeutic option for patients with COPD. During the 3-month Tai Chi program, no adverse problems occurred, compliance was ideal and the results showed that 3-month Tai Chi produced a statistically and clinically significant improvement in exercise capacity and HRQoL in COPD patients compared to the control group. However, this is a pilot study and a larger trial is needed to obtain more detailed results. Importantly, a further study is required to clarify whether the change in lung function exceeds the minimum, clinical, important difference compared to the control group.

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Conflict of Interest

All authors declared no conflict of interest.

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