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RESEARCH PAPER

Effects of Ai Chi on balance, quality of life, functional mobility, and motor impairment in patients with Parkinson's disease*

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ABSTRACT

Purpose: In this study, we aimed to investigate effects of Ai Chi on balance, functional mobility, health-related quality of life, and motor impairment in patients with Parkinson's disease.

***Method*:** This study was conducted as an open-label randomized controlled trial (ISRCTN26292510) with repeated measures. Forty patients with Parkinson's disease stages 2 to 3 according to the Hoehn and Yahr Scale were randomly allocated to either an Ai Chi exercise group or a land-based exercise control group for 5 weeks. Balance was measured using the Biodex-3,1 and the Berg Balance Scale. Functional mobility was evaluated using the Timed Up and Go Test. Additionally, health-related quality of life and motor activity were assessed with the Parkinson's Disease Questionnaire-39 and the Unified Parkinson's Disease Rating Scale-III.

***Results*:** Although patients in both groups showed significant improvement in all outcome variables, improvement of dynamic balance was significantly greater in the Ai Chi group ($p < 0.001$), Berg Balance Scale ($p < 0.001$), Timed Up and Go Test ($p = 0.002$), Parkinson's Disease Questionnaire-39 ($p < 0.001$), Unified Parkinson's Disease Rating Scale-III ($p < 0.001$).

***Conclusion*:** Our results suggest that an Ai Chi exercise program improves balance, mobility, motor ability, and quality of life. In addition, Ai Chi exercise was more effective as an intervention than land-based exercise in patients with mild to moderate Parkinson's disease.

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KEYWORDS
Ai Chi; balance; functional mobility; motor impairment; quality of life; Parkinson's disease

➤ IMPLICATIONS FOR REHABILITATION

- Ai Chi exercises (aquatic exercises) may help improve balance, functional mobility, health-related quality of life, and motor ability in patients with mild to moderate Parkinson's disease more efficiently than similar land-based exercises.
- Ai Chi exercises should be considered as a rehabilitation option for treatment of patients with mild or moderate Parkinson's disease.

Introduction

Gait and balance disturbances are common in Parkinson's disease (PD) and are major contributors to increased disability, decreased health-related quality of life, and survival. Gait and balance abnormalities in PD are notoriously difficult to treat and they are not sufficiently ameliorated by a pharmacological or surgical treatment [1–3]. The existing literature strongly suggests that physical exercise is useful in preventing the onset of PD and slowing its progression. Therefore, many clinicians recommend exercise to physically able patients with PD [4].

The benefits and the feasibility of aquatic exercise in PD have been shown in previous studies [5–7]. Pérez and Cancela [8] reviewed 12 studies employing water-based exercise interventions in patients with PD. The authors reported that water-based exercises positively affected motor symptoms, functional mobility, and quality-of-life measures.

Ai Chi is based on elements of Tai Chi and focuses on balance, strength, relaxation, flexibility, and breathing [9]. Essentially, Ai Chi uses breathing techniques and progressive resistance training in water to relax and strengthen the body [9–11].

Ai-Chi exercise initially focuses on deep breathing patterns. Simple breathing techniques are combined with gentle movement, progressing from the upper extremities over the trunk to the lower extremities. Finally, the movement involves the full torso. Gradually, the base of support is narrowed. Movements are slow and continuous. Special attention is paid to body alignment. Exercises are accompanied by deep diaphragmatic breathing at a rate of 1416 breaths per min and a calm meditative state of mind [10,11]. Ai Chi consists of 16 movements (katas) and is typically practiced standing in shoulder-deep water. The exercise progresses through a series of "regulatory conditions" of increasing difficulty, from static to dynamic, symmetrical to rotatory and asymmetrical movement, and from visual to non-visual (vestibular) control [9]. Ai Chi is practiced standing in shoulder-deep water and in either group classes, one-on-one therapy sessions, or with the patients practice individually. Two previous studies have

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*Trial Registration: The name of the registry is to determine whether Ai-Chi exercises (aquatic exercises) can improve balance, functional status and quality of life in patients with Parkinson's disease and date the trial was registered on 15/02/2016. This study was retrospectively registered. Study was carried out between February 2015 to January 2016 (http://www.isrctn.com/ISRCTN26292510, ISRCTN26292510).

investigated the effects of Ai Chi in PD patients [12,13]. One of these studies evaluated static and dynamic balance. In this previous study, exercises were performed in 20 sessions (twice a week, for a 10-week period). This previous study did not include a control group [13]. The second study investigated the effects of Ai Chi on quality of life, functional mobility, and posture in PD patients [12]. In this intervention, exercises were performed in 24 sessions, twice a week, over a 12-week period.

The number of participants in this study is fairly low. For these reasons, it was necessary to plan further study with the control group and a larger number of patients.

In the present study, we aimed to investigate the effects of Ai Chi on balance, functional mobility, motor impairment, and health-related quality of life in patients with PD and to comparing the control group in this study.

Methods

This study was conducted in the Physical Medicine and Rehabilitation Department Outpatient Clinic. The Declaration of Helsinki protocols were followed. The study was carried out from February 2015 to January 2016. Approval from the local ethics committee was obtained for this study. Written consent was obtained from all participants.

Patients

All patients were diagnosed with idiopathic PD by a neurologist and admitted to the physical medicine and rehabilitation clinic. Inclusion criteria were as follows: (1) ability to follow a stable medication regimen, (2) PD stages 2 to 3 according to the Hoehn and Yahr scale [14], and (3) lack of dementia (Mini-Mental State Examination score $\geq$ 24) [15]. BMIs of all patients were between 18 and 30. Patients were divided into two groups, the experimental Ai Chi group and the land-based exercise control group. Exclusion criteria were as follows: (1) physical therapy in the previous 6 months, (2) fear of water, (3) allergy to chlorine, (4) inability to walk independently, (5) having undergone surgical treatment for PD, (6) history or evidence of neurological deficit other than PD (stroke, neuromuscular disease, etc.), (7) uncontrolled hypertension, (8) diabetes, (9) incontinence, (10) open wounds, (11) osteoarthritis, and (12) osteoporosis at a level that impaired walking and balance.

Covariate adaptive randomization [16] was performed using a computer program for optimal allocation of patients to Ai Chi and land-based exercise groups [covariates: age, gender, and Parkinson's disease stages (according the Hoehn and Yahr scale)]. Cognitive level of patients was assessed at the beginning and end of the program.

Test procedure

Outcome measures were assessed at baseline and at the end of the treatment program. Participants were instructed to follow their normal routine for physical activity and medication during the 6-month intervention period. Assessments were conducted during "on" periods (i.e., when patients' medication was working and symptoms were controlled). To reduce the effects of medication-related fluctuations in performance, exercise programs, and evaluations were performed at standardized times during the medication cycle.

Evaluations

Balance was measured by Biodex-3,1 (Version 3.1, Biodex Medical Systems, Shirley, NY). Dynamic and static balance were evaluated using the Berg Balance Scale (BBS). Mobility was evaluated using the Timed Up and Go (TUG) test. Additionally, health-related quality of life and motor activity were assessed with the Parkinson's Disease Questionnaire-39 (PDQ-39) and the Unified Parkinson's Disease Rating Scale-III (UPDRS-III).

Dynamic Balance: Balance and neuromuscular control were assessed using a commercially available balance device (Biodex, Version 3.1, Biodex Medical Systems, Shirley, NY). Subjects were tested for dynamic stability in all directions (overall balance index), front to back stability (anteroposterior index), and side-to-side stability (mediolateral index). Higher postural sway is reflected in a large variance that is quantified as a higher score on the balance index. The test consisted of three trials with a 25-s inter-trial rest period. The average value of the three trials was calculated for the final balance index score. Participants were first informed about the platform and then given adaptation training. During the test, patients were asked to keep their balance while standing erect with their arms hanging at their sides and to stare at a screen placed in 50 cm distance [17].

Berg Balance Scale (BBS): BBS is a 14-item scale widely used for assessing balance. Items are scored from 0 (unable to execute the task) to 4 (independent) on the basis of the participant's ability to complete a task, with the higher score indicating the degree of independence displayed while performing the tasks [18].

Timed Up and Go (TUG): For the TUG test, participants are asked to sit on a chair, stand up, walk at their preferred walking speed for 3 m, turnaround, return to the chair and sit down again. The time taken to complete the TUG was recorded with a stopwatch. Participants performed this task three times [19].

Parkinson's Disease Questionnaire-39 (PDQ-39): The patients' quality of life was rated using the PDQ-39. This questionnaire is the most commonly used specific measure of health status in patients with PD. The questionnaire is composed of 39 questions covering eight dimensions of quality of life. The PDQ-39 has good internal, construct, and test-retest reliability. Scores range from 0 to 100. Lower scores reflect a better perceived quality of life [20,21].

Unified Parkinson Disease Rating Scale (UPDRS-III) Part III: The motor part (part III) of the Turkish validated version of the Unified Parkinson Disease Rating Scale (UPDRS) was used. The UPDRS provides a comprehensive, efficient, and flexible means to monitor PD-related disability and impairment. UPDRS is the most widely evaluated and reliable clinimetric scale currently available in PD. The UPDRS-III contains a motor skills section including subcomponents of bradykinesia, rigidity, tremor, and postural instability. The test is scored on a 5-point Likert scale from 0 to 4. Zero represents no impairment and 4 represents marked impairment. The total score ranges from 0 (not affected) to 56 (most affected) [22].

Therapy protocol

The Ai Chi group participated in 60-min sessions 5 times a week for 5 weeks (a total of 25 sessions). Patients were given detailed information about Ai Chi exercises. Ai Chi exercises were directed by a physiotherapist experienced in both neurologic rehabilitation and Ai Chi. The Ai Chi program took place in a 1.2-m-deep swimming pool at a temperature of 32 °C. Each session consisted of a warm-up period, a period of Ai Chi exercises, and a cool-down period. The 15-min warm-up included free extremity movements or activities involving tools such as pool noodles and kickboards. The Ai Chi program lasted 30 min and consisted of 16 different movements. Ai Chi exercises were performed in shoulder-deep water with knees slightly flexed. A combination of deep breathing and slow, broad movements of arms, legs, and torso were used to work on balance, strength, relaxation, flexibility, and breathing. The 16 postures were performed in the following sequence: contemplating, floating, uplifting, folding, shooting, gathering, freeing, transferring, accepting, accepting with grace, rounding, flowing, relaxing, and sustaining. The 15-min cool-down program included free walking and stretching [23].

The control land-based exercise group participated in 60-min group sessions 5 times a week for 5 weeks (a total of 25 sessions). The exercise program was developed on the basis of existing exercise literature [24,25]. Each session consisted of warm-up activities, stretching of spine and limbs, articular mobilization, gait exercises, and a cool-down period. During the 10-min warm-up, patients were either sitting or standing and performed light aerobic activity. After the warm-up, patients stretched for 10 min of in a seated position; stretching exercises included side neck bends, head rotations, trunk rotations, trunk mobilizations, butterfly stretching, and hamstring and ankle stretching. Then, lying supine, patients performed arm lifts and spinal rotations. Back extensions were performed in the prone position. Standing up, patients performed shoulder lifts, trunk rotations, forearm shoulder stretches, trunk side bends, and wrist and hand stretches (with or without support). Thirty minutes of balance and gait training encompassed axial and proximal movement displacements in different planes and axes; coordinated movements with upper and lower range and speed; clock reach; and weight shifts in different directions (anterior, posterior, and lateral) using foam, single limb stance, postural reactions, trunk rotation, and head movement (eyes opened and closed, with or without support). Gait training was performed on stable and unstable surfaces (using different sized foam for the unstable surface), functional movements (e.g., standing up from a chair, turning around, and bending over to pick up objects off the floor, etc.) sideways walking, marching. During the 10-min cool down, the rhythm of exercise was slowed down progressively. The cool down included slow walking and breathing exercises associated with free movement of the upper limbs, muscular relaxation, and stretching.

Statistical analysis

IBM SPSS version 20.0 (IBM Corporation, Armonk, NY) software was used for statistical analyses. Normally distributed data are presented as mean ± standard deviation (SD). Non-normally distributed data are presented as median ± interquartile range. Categorical data are presented as percentages (%). Normality of measured data distributions were examined using the Shapiro-Wilk test. To evaluate statistically significant differences, a Student's *t*-test was used if the data were normally distributed; a Mann-Whitney U-test was used if the data were not normally distributed. Qualitative comparisons of the groups were performed using a Chi-squared test. To compare repeated measures for each group, paired *t*-tests were used if the data were normally distributed; a Wilcoxon test was used if the data were not normally distributed. The threshold for statistical significance was set at $p < 0.05$.

A *post-hoc* power analysis was performed using PASS 13.0 software (NCSS, LLC, Kaysville, UT). According to this test, our study had 80.71% power within 0.05 alpha [26,27]. We also used the latest literature about Parkinson's and exercise to determine this effect size [28–30].

Results

Sixty-four patients with idiopathic PD were assessed for eligibility. Forty patients (16 female and 24 male) aged 63.03 ± 6.90 years (range: 4872 years) were enrolled. All participants successfully completed the entire program. Twenty patients were assigned to the Ai Chi group and 20 patients were assigned to the land-based exercise group (Figure 1).

Demographics of the patients are displayed in Table 1. There were no statistically significant differences between the two groups with respect to age ($p = 0.615$), sex ($p = 0.748$), Hoehn and Yahr stage ($p = 0.766$), BMI ($p = 0.714$), and daily levodopa equivalent dose ($p = 0.566$).

Compared to the beginning of the training program, patients in the Ai Chi group improved significantly in terms of dynamic balance performance (anteroposterior index $p < 0.001$, mediolateral index $p < 0.001$, overall balance index $p < 0.001$), BBS ($p < 0.001$), and TUG scores ($p < 0.001$), UPDS-III ($p < 0.001$), and PDQ-39 scores ($p < 0.001$; Table 2).

Similarly, in the final measurements, scores of the land-based exercise group were significantly better than baseline for static balance (anteroposterior index $p = 0.004$, mediolateral index $p = 0.001$, overall balance index $p = 0.006$), BBS ($p = 0.001$), TUG score ($p < 0.001$), UPDS-III ($p < 0.001$), and PDQ-39 scores ($p < 0.001$). However, improvements in scores were significantly higher in the Ai Chi group than in the control group for dynamic balance (anteroposterior index $p < 0.001$, mediolateral index $p < 0.001$, overall balance index $p < 0.001$), BBS ($p < 0.001$), TUG scores ($p = 0.002$), UPDS-III ($p < 0.001$), and PDQ-39 scores ($p < 0.001$). These differences show that improvement was more pronounced in the Ai Chi group (Table 2).

Discussion

In our 5-week study, we found that both types of exercise tested (Ai Chi and a similar land-based exercise) improved final scores for clinical measures of PD. However, for balance, functional mobility, health-related quality of life, and motor ability improvement were more pronounced in the Ai Chi group than in the land-based exercise group at the end of the study.

Ai Chi exercises are performed in water. Water-based exercises have been widely used in physical therapy programs for different diseases [31]. The aquatic environment has unique properties, such as buoyancy, turbulence, hydrostatic pressure, and resistance that can be used to gain a range of exercise benefits [32,33]. Water buoyancy reduces the effects of gravity; in fact, an aquatic environment can be considered a microgravity environment. Many authors have documented modifications of static and dynamic postural control owing to prolonged periods spent in microgravity environments [34]. In particular, modifications in the control of body positions owing to inappropriate signals from the vestibular system under water have been reported. These finding underline the major role of the proprioceptive system for postural control in water environments [35]. An aquatic environment enables balance training in safe conditions, because patients can avoid falls and their fear of falling is reduced [5].

Evidence for the effectiveness of aquatic exercise in the treatment of PD has been shown in previous studies [5,36,37]. The current study provides further evidence that Ai Chi is feasible and safe for patients with PD. According to the European Physiotherapy Guidelines for PD, the main goals of physiotherapy in a rehabilitative program for PD patients should be person-specific and linked to the stage of the disease [38]. Compliance and continuation of the exercise program are of major importance. Previous studies have found an association between restricted activity and fear of falling in patients with PD [39–41]. Therefore, fear of falling may be an important barrier to compliance and/or continuing exercise. Unsurprisingly, choosing an enjoyable and

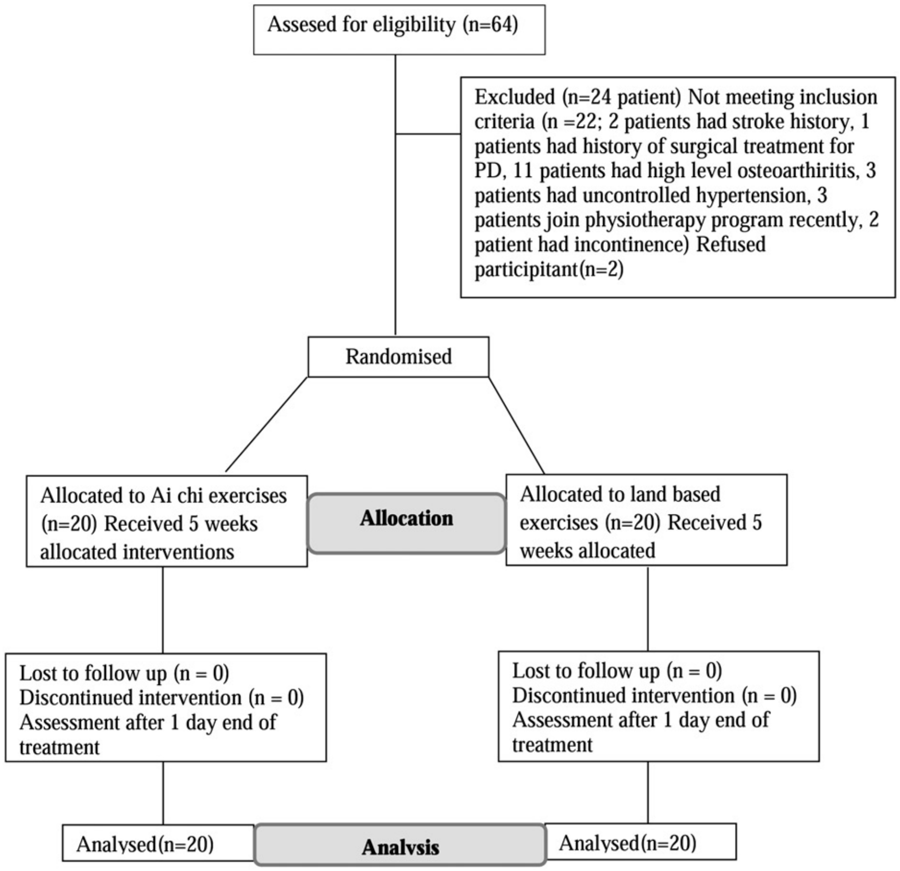

Figure 1. Flowchart of study design.

Table 1. Demographics of both exercise groups and statistical differences between groups (*p* values).

	Ai Chi group (*N* = 20)	Control group (*N* = 20)
Age (year) (Mean ± SD)	62.41 ± 6.76	63.61 ± 7.18
Gender		
Female	9 (45%)	7 (35%)
Male	11 (55%)	13 (65%)
Hoehn and Yahr scale		
Stage 2	9 (45%)	11 (55%)
Stage 2.5	7 (35%)	5 (25%)
Stage 3	4 (20%)	4 (20%)
BMI (kg/m^2) (Mean ± SD)	25.44 ± 2.69	25.17 ± 2.71
Daily Levodopa equivalent dose (mg) (Mean ± SD)	764.36 ± 96.09	742.67 ± 113.64

*$p < 0.05$ indicates statistical significant differences. A Student's *t*-test was used to compare age, BMI, and daily levodopa equivalent dose. A Chi-squared test was performed to compare gender and Hoehn and Yahr scale group differences.

Table 2. Clinical and functional measurements at baseline and at the end of rehabilitation. Additionally, the differences between baseline and end of rehabilitation measurements are shown in the change column (end of treatment − baseline).

	Ai Chi group			Control group		
	Baseline	End of rehabilitation	Change	Baseline	End of rehabilitation	Change
API	2.65 ± 0.73[c]	2.11 ± 0.75[a,c]	−0.50 ± 0.35[b,d]	2.28 ± 0.54[c]	2.12 ± 0.61[a,c]	−0.10 ± 0.13[d]
ML	2.26 ± 0.82[d]	1.93 ± 0.69[a,d]	−0.30 ± 0.30[b,d]	2.00 ± 1.35[d]	1.75 ± 1.37[a,d]	−0.15 ± 0.10[d]
OBI	3.67 ± 1.01[c]	3.2 ± 1.08[a,c]	−0.50 ± 0.35[b,d]	3.72 ± 1.31[c]	3.59 ± 1.28[a,c]	0.12 ± 0.13[d]
BBS	35.00 ± 19.0[d]	41.00 ± 18.00[a,d]	4.41 ± 2.94[b,c]	39.00 ± 6.00[d]	40.00 ± 5.50[a,d]	1.91 ± 1.61[c]
TUG (s)	19.20 ± 5.89[c]	14.19 ± 4.86[a,c]	−5.01 ± 2.76[b,c]	14.00 ± 9.25[d]	13.15 ± 8.97[a,d]	−1.05 ± 0.88[c]
UPDRS-III	30.09 ± 4.88[c]	26.76 ± 4.01[a,c]	−3.29 ± 2.59[b,c]	28.06 ± 5.37[c]	26.16 ± 4.96[a,c]	−1.88 ± 1.02[c]
PDQ-39	73.00 ± 15.0[d]	68.00 ± 13.00[a,d]	−4.00 ± 3.50[b,d]	72.00 ± 14.00[d]	71.00 ± 10.50[a,d]	−1.00 ± 1.25[d]

API: anteroposterior index; MLI: mediolateral index; OBI: overall balance index; BBS: Berg Balance Scale; TUG: Timed Up and Go; UPDS-III: Unified Parkinson's Disease Rating Scale Part III; PDQ-39: Parkinson's disease Questionnaire-39.
[a]Significant difference between baseline and post-intervention measurement ($p < 0.05$); [b]significant difference between the control and Ai Chi groups ($p < 0.05$); [c]mean ± standard deviation (normally distributed data); [d]median ± interquartile range (not normally distributed data). If the data were normally distributed when comparing both groups, Student's *t*-test was employed. If the data were not normally distributed, Mann-Whitney U-test was employed. In repeated measures, paired *t*-test was used. If data were not normally distributed, the Wilcoxon test was used.

stimulating exercise protocol improves patient compliance in rehabilitation programs. Ai Chi, in addition to pharmacological treatment, should be considered as a rehabilitation option in the treatment of patients with mild to moderate PD.

Studies of both land and water-based exercise have shown that exercise can consistently improve both motor and non-motor features of PD [3]. Exercise may increase synaptic strength and potentiate functional circuitry, resulting in improved behavior in patients with PD. Therefore, exercise-induced brain plasticity – the ability of the central nervous system to modify its structure and function in response to external stimuli – is likely to be the neural basis of rehabilitation in PD [42]. In addition, mounting evidence suggests that physical exercise reduces chronic oxidative stress via increased mitochondria biogenesis and autophagy up-regulation. Moreover, physical exercise stimulates neurotransmitter and trophic factor synthesis [43]. Both of these neurochemical phenomena contribute to neuroplasticity [38].

Aquatic exercises have been proven to be appropriate and safe for PD patients [5]. Vivas et al. [36] performed a study on 11 PD patients over 4 weeks to compare the effects of aquatic therapy with a conventional land-based exercise program. Aquatic therapy seemed to be more effective than the land-based protocol for some assessments, specifically BBS and the UPDRS. Our results are in line with a study by Andrade et al. [6]. In this previous study, the authors used a water-based exercise intervention over 4 weeks with seven individuals with PD. The BBS and TUG were used to assess functional balance impairment. The authors reported a significant increase in BBS scores and a reduction in the completion time of the TUG.

Volpe et al. [5] found that a hydrotherapy treatment yielded better scores than a land-based treatment in a balance test, quality of life measurements, and a falls diary. The Ai Chi technique consists of motions similar to Tai Chi. However, Ai Chi is performed in water, whereas Tai Chi is performed on dry land. Rounding and balancing in Ai Chi involve movements in forward and backward directions [23]. The effects of Tai Chi on mild and moderate PD have been previously reported. A meta-analysis suggested that Tai Chi should be considered a valid complementary or alternative therapy for PD. In particular, Tai Chi improved motor function and balance [44,45]. Teixeira et al. [46] have shown that a 6-week Ai Chi program also significantly improved balance in older adults. Several studies have examined the effects of Ai Chi on patients with neurological disorders. Noh et al. [47] investigated the effects of both Halliwick and Ai Chi on stroke patients. The authors found that postural balance and knee flexor strength improved after an 8-week program. Similarly, Castro et al. [48] investigated the effects of Ai Chi and relaxing exercises in multiple sclerosis patients. The authors found a significant decrease in fatigue in the Ai Chi group. Furthermore, Bayraktar et al. [23] reported that Ai Chi might improve balance and functional mobility in patients with multiple sclerosis. Perez-de la Cruz et al. [13] designed a study to investigate the effects of Ai Chi on PD. The treatment program consisted of 3045-min sessions, twice a week, for a 10-week period (20 sessions). They found that Ai Chi was a promising and feasible aquatic treatment improving balance and functional capacity in patients with mild or moderate PD. Our treatment program consisted of 60-min sessions, 5 times a week for 5 weeks (25 sessions). Our results are in line with previous finding reported by Perez-de la Cruz et al. [13]. Furthermore, we show that an Ai Chi exercise program yielded more pronounced improvement than land-based exercises in terms of balance, mobility, motor ability, and quality of life. In accordance with our results, a previous study, including in total 15 patients with PD (stages II and III on the Hoehn and Yahr scale) reported that Ai Chi improves functional activities and quality of life [12].

The current study used the minimal detectable change (MDC) and minimal clinical important difference (MCID) indexes. These indexes have been established previously. Although a 95% confidence level is widely accepted in the research community, one could argue that in clinical practice a lower confidence level would be desirable as a basis for clinical decisions [49]. Therefore, in the current study, we calculated confidence levels of 90 and 80% in addition to 95%. The BBS showed a 90% MDC of 5.5 and an 80% MDC of 4.3. For an 80% MDC, the change in the BBS score of the Ai Chi group was not only statistically significant, but might also be clinically significant. In contrast, changes in BBS scores between baseline and the end of the rehabilitation period in the land-based exercise group were not clinically significant. MDCs of TUG times in patients with PD have been reported previously. However, results vary extensively (2–11 s) [50–52]. Huang et al. [53] defined, an MDC of 3.5 seconds as a high standard of random error for the TUG. Using this standard, changes in TUG times of the Ai Chi group at the end of the exercise program may be accepted as clinically significant. However, changes in TUG times between baseline and the end of rehabilitation in the land-based exercise group were not clinically significant. MDC of 7 [54] and MCID of 5 were observed [55] for the UPDRS-III. Although the changes on the UPDRS-III scale were statistically significant in both group, they were not clinically significant. Peto et al. [56] reported that MCID varies across the dimensions of the PDQ-39 and that the smallest change in scores may be meaningful. The authors recommend calculating the effect size $\frac{(mean(t_1)-mean(t_2))}{SD(t_1)}$ for each measurement. (0.2, 0.5, and 0.8 represent small, moderate, and large effect size, respectively). Moreover, the effect size reflects a meaningful change on the PDQ-39. We calculated the effect size of the change in PDQ-39 scores of the Ai Chi group. We found a moderate effect size of 0.6. In contrast, changes in PDQ-39 scores between baseline and the end of rehabilitation in the land-based exercise group were not clinically significant.

A few limitations of our study have to be considered when interpreting the results. Firstly, we did not evaluate long-term effects of exercise interventions. Secondly, the number of participants who agreed to join the Ai Chi exercise program was small and consequently, the sample size was small. Thirdly, the Ai Chi exercise program was only compared with one land-based exercise program.

In conclusion, our results suggest that Ai Chi provides an alternative aquatic exercise program that may be a rehabilitation option to improve balance, functional mobility, quality of life, and motor ability in patients with mild to moderate PD. Future studies with longer follow-up periods and larger sample sizes are needed in order to compare the results with other land-based and/or aquatic exercise programs and evaluate whether the participants' well-being persists over time.

Disclosure statement

The authors report no conflict of interests to declare.

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