Tai Chi–Based Exercise for Older Adults With Parkinson’s Disease: A Pilot-Program Evaluation

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The primary objective of this study was to provide preliminary evaluation of the feasibility, safety, and efficacy of a newly developed Tai Chi–based exercise program for older adults with Parkinson’s disease (PD). Using a one-group pretest–posttest design, 17 community-dwelling adults (mean age 71.51 years) with mild to moderate idiopathic PD (Stage I, II, or III on the Hoehn and Yahr scale) and stable medication use completed a 5-day, 90-min/day Tai Chi exercise-evaluation program. Outcome measures included face-to-face exit interviews on appropriateness and safety and physical performance (i.e., 50-ft speed walk, up-and-go, functional reach). At the end of this brief intervention, exercise adherence was 100% and the program was shown to be safe. Exit interviews indicated that the program was well received by all participants with respect to program appropriateness, participant satisfaction and enjoyment, and intentions to continue. Furthermore, a significant pretest-to-posttest change was observed at the end of the 5-day program in all three physical-performance measures ($p < .05$). The results of this pilot evaluation suggest that Tai Chi is an appropriate physical activity for older adults with PD and might also be useful as a therapeutic exercise modality for improving and maintaining physical function. These preliminary findings warrant further investigation.

Key Words: physical activity, rehabilitation, aging, older adults

Exercise has often been considered an important component in the treatment of Parkinson’s disease (PD) because, as a neuroprotective add-on to current PD therapies, it helps alleviate PD-related symptoms (e.g., rigidity, tremor, slowness and poverty of movement, postural instability, motor coordination) and improves physical limitations (e.g., loss of flexibility, balance problems, functional limitations) and general physical and mental health (American Parkinson Disease Association,
Studies involving individuals with PD have shown that exercise can be beneficial in improving movement initiation (Bergen et al., 2002), short-step gait (Miyai et al., 2002), flexibility and physical function (Palmer, Mortimer, Webster, Bistevins, & Dickinson, 1986; Schenkman et al., 1998), and quality of life (Baatile, Langbein, Weaver, Maloney, & Jost, 2000; Reuter, Engelhardt, Stecker, & Baas, 1999).

The current study presents Tai Chi as an alternative balance-enhancing exercise program (China National Sports Commission, 1983) that can address specific physical impairments (i.e., impaired balance control) and functional limitations associated with PD. Tai Chi, often described as “a moving meditation,” encompasses both mental and physical elements. The movements of Tai Chi, when performed continuously, involve characteristics such as body and trunk rotation, flexion and extension of the hips and knees, weight shifting, coordinated arm movements, and postural alignment and control (Li, Fisher, Harmer, & Shirai, 2003; Wolf, Coogler, & Xu, 1997). Moreover, regular practice of Tai Chi movements might enhance particular control mechanisms contributing to postural stability. Recent evidence indicates that Tai Chi elicits responses in specific somatosensory and neuromuscular-control pathways involved in postural control (Tsang & HuiChan, 2003, 2004). For healthy older adults, Tai Chi has also demonstrated its utility as a unique program for improving muscle strength (Christou, Yang, & Rosengren, 2003), physical performance, and balance (Li et al., 2001, 2005) and, consequently, reducing the risk of falling (Li et al., 2005; Li, Harmer, Fisher, & McAuley, 2004; Wolf et al., 1996).

Because postural instability is one of the cardinal features of PD, there are a number of characteristics of Tai Chi that make it amenable to PD patients with posture-related instability problems. First, appropriate posture is emphasized in Tai Chi by specifically focusing on alignment of the spine. Long-term practice has the potential to adjust posture that is often affected by neuromuscular or musculoskeletal impairments. Second, in performing Tai Chi, body weight is constantly shifting from one foot to the other in varying directions, which places demands on balance ability. Throughout the sequence of exercises, different parts of the body play the roles of stabilizer and mover, requiring movements to be executed smoothly with due attention to controlling balance and stability. Third, all Tai Chi movements are performed in a slow, even, and continuous flowing fashion. The even, slow tempo and flow of movement are likely to facilitate a sensory awareness of speed, force, and trajectory in the execution of movements for PD patients. In sum, the primary emphasis on controlling balance might make Tai Chi uniquely relevant and appropriate as an alternative therapeutic treatment for mobility and postural instability problems among patients with PD.

To make Tai Chi applicable, safe, and beneficial to patients with PD, careful consideration of the design of a Tai Chi program appropriate for this special population is needed. Indeed, many patients with PD face the challenge of impaired mobility and functional limitations as a direct result of PD or its sequelae, and physical impairments become more severe as the disease progresses. Therefore, standardized forms of Tai Chi are not likely to be appropriate because the multisegmental movement features of standardized Tai Chi create excessive physical and mental challenges for patients with PD. In our preliminary work we found this to be the case. For example, Tai Chi is commonly performed as part of a complete routine
that consists of a series of forms in a recommended sequence (China National Sports Commission, 1983). There is a high task demand involving limb coordination and postural control in performing the sequence of movements or forms in the various Tai Chi styles (e.g., Yang, Wu, Chen, etc.). In addition, from a safety standpoint, not every Tai Chi posture is physically appropriate for patients with PD. For example, the form “Sweep Down” in the simplified 24-form Yang Tai Chi style (China National Sports Commission) involves a squatting-down move with a forward inclination of the upper body while stretching one leg sideways. This movement is physically difficult for many people and increases the possibility of knee injuries or falling for patients with PD. It is therefore evident that an easy, safe, and enjoyable Tai Chi program tailored to the movement limitations inherent in patients with PD is needed. We considered it feasible to design a PD-specific Tai Chi program because previous research has shown that well-designed modifications to standard Tai Chi protocols for various specific populations have produced beneficial outcomes (Chen, 2002; Li et al., 2003; Wolf et al., 1997).

Based on previous Tai Chi trials (Li, Fisher, et al., 2004; Li et al., 2005, 2001), we developed a Parkinson’s-specific Tai Chi–based exercise program for older adults with early-stage PD. The basic premise of the program is to emphasize practicing single forms with repetitions and bilateral stepping with body-weight transfer. The extent to which this specially designed program, based on prior research involving healthy individuals, might be appropriate and safe for the PD population had not been determined. Therefore, the primary objective of this pilot investigation was to evaluate the feasibility and applicability of this special Tai Chi program in a group of older adults with PD. It was anticipated that the modified, simpler Tai Chi program would be appropriate for patients in the early to middle stages of PD. Because our program was designed to challenge balance control, our secondary objective was to evaluate its effectiveness in improving physical-performance outcome measures. As a preliminary program evaluation, we hypothesized that there would be some change in these outcome measures from pretest to posttest.

Methods

Study Design

The design of this pilot study involved a single-arm, unmasked intervention trial using a pretest–posttest within-subjects design. The study was conducted on five consecutive days, with a 90-min Tai Chi practice session per day targeted at individuals with mild to moderate PD. We used a protocol of five consecutive days because it allowed adequate time to address program-related feasibility issues regarding instructional teaching and training and program safety and compliance. We selected a 90-min session length to allow sufficient time for a moderately paced learning environment with adequate rest periods during the exercise session. We evaluated program feasibility issues through in-class performance monitoring and exit interviews of all study participants. To provide preliminary data for a future trial, we also included physical-performance measures as a secondary outcome measure and assessed them at baseline (pretest) and on the day after the last day of the program (posttest) to assess pretest-to-posttest change in physical function. The study was conducted in November and December 2004. The institutional review
board of the Oregon Research Institute approved the study, and all participants gave written informed consent.

Study Participants

Individuals were considered eligible for participation in the study if they (a) had a diagnosis of idiopathic PD with a disease severity rating of Stage I to III on the Hoehn and Yahr scale (Hoehn & Yahr, 1967); (b) were able to ambulate independently; (c) had no severe cognitive impairments (Mini-Mental State Examination score ≥ 24); (d) had no other severe neurological (Stage III or IV PD, Alzheimer’s disease), cardiopulmonary (cardiac and respiratory problems), or orthopedic disorders (recent lower extremity joint replacements); (e) had not participated in a structured exercise program in the preceding 2 months; and (f) had a physician’s clearance to participate. We ascertained PD status at baseline by asking potential participants “Has a doctor or other health care provider ever told you that you had or have Parkinson’s disease?” All individuals who answered affirmatively were then asked whether they currently were being treated for this condition by a doctor. The PD status was further confirmed by a trained research assistant who also classified participants’ stage status per Hoehn and Yahr’s (1967) guidelines: Stage I indicates unilateral involvement only with minimal or no functional impairment, Stage II indicates bilateral or midline involvement without impairment of balance; and Stage III indicates impaired balance with some restriction of functional activities. We purposely targeted our intervention to individuals in these stages of PD because they were considered still able to perform most daily activities independently, although often slowly.

Participants were community-dwelling older adults with mild to moderate PD as defined by the Hoehn and Yahr scale, recruited via promotion at a local Parkinson’s support group or word of mouth.

Study Protocol

A trained research assistant made initial phone contact with those who responded to our study promotion and screened potential participants to determine their interest and eligibility for the study. A total of 20 individuals were screened, and 17 of those met the study criteria. Participants were encouraged to ask any questions they might have with regard to the nature of the study. Individuals who met the study criteria and agreed to participate underwent baseline assessments 1 or 2 days before the class started. To minimize the effects of PD medication on the participants’ physical performance, the time of day of testing remained constant throughout the study and all assessments were performed in the same order. Participants were required to take their medications at the same time of day for all assessment sessions. A trained research assistant who was not involved in the instruction of this exercise intervention recruited the study participants and collected all study measures.

Intervention

Tai Chi Program. The core program consisted of six forms of Tai Chi–based stepping exercises, developed on the basis of the traditional Yang Tai Chi style (China National Sports Commission, 1983). These forms were as follows:
Form 1: Moving Hands Like Clouds (stepping sideways: left and right)
Form 2: Parting the Wild Horse’s Main (stepping diagonally forward: left and right)
Form 3: Stepping Up and Thrusting Downward (stepping sideways: left and right)
Form 4: Striking the Opponent’s Ears With Both Fists (stepping backward: left and right)
Form 5: Repulsing Monkey (stepping backward: left and right)
Form 6: Grasping the Peacock’s Tail (stepping sideways: left and right)

The exercise routine emphasizes the practice of single forms with multiple repetitions and bilateral stepping with body-weight transfer. Because the goal of the exercise was to help PD patients retain postural stability, the exercise protocol was specifically designed to challenge balance control, as reflected in movements such as upright trunk positioning, unilateral weight bearing and balance, and smooth locomotion.

**Movement Description.** After the conventional Tai Chi opening stance, each form began with a series of steps with movements varying in direction (forward, sideways, backward), performed with torso rotations, coordinated arm and leg movements, and alteration of weight bearing on each leg. Movements in each form were repeated three times in each direction (i.e., right and left) and were performed in a steady motion at a self-paced rhythm. Stride lengths varied, depending on each participant’s capability and level of comfort. The cadence of locomotion followed the Yang style Tai Chi: slow, controlled, and self-paced. Although each single movement in a form traditionally requires a coordinated inhale and exhale breathing cycle, natural breathing was encouraged for these participants.

**Exercise Session.** The 90-min exercise session followed a sequence of a warm-up period (~10 min), learning and practicing core Tai Chi forms (~50 min), and a cool-down and activity period (~10 min). After the warm-up exercises (consisting of lightly walking in place and stretching major muscle groups), practice began with 10–15 min of seated Tai Chi with arm movements (e.g., raising, swing, pushing) combined with natural breathing. The exercise sessions consisted of three or four repetitions and were performed at a slow and controlled pace. The sessions then progressed to standing and stepping movements of various forms, with the degree of difficulty gradually increasing as the participants mastered simple to more difficult forms. In each session, participants were first shown the whole form to be practiced, followed by a breakdown of its component parts (i.e., single movements). Participants were then directed to follow the instructor’s movements by replicating them at a slow but controlled pace and rhythm to the best of their ability. During the 5-day practice schedule, an average of two forms were taught per session.

Periodic breaks (5 min each) were provided in each session to allow time for resting and drinking water. Music accompanied each exercise session. From the first class session and at each succeeding session, participants were asked whether they needed any clarification in performing the exercises or understanding instructor-led tasks. Participants were encouraged to practice at home, but no effort was made to monitor home practice. All exercise sessions took place in the morning.
(10:00 a.m.) and were conducted in an exercise room. Class sizes ranged from 3 to 5 people per class ($M = 4$). At the end of the program, each participant was given a videotape of the exercises and encouraged to continue exercises at home and to use the video if needed.

**Class Instructor and Exercise Monitoring.** The principal investigator of this study taught and supervised the 5-day training program. The instructor, certified in first aid and CPR, had over 8 years of teaching and research experience in Tai Chi and modified this program for PD patients. Exercise safety was closely monitored during the intervention. During and after each exercise session, participants were questioned about any adverse effects such as musculoskeletal complaints or discomfort. The training protocol was modified on an individual basis as necessary. Any discomfort reported during the classes was recorded. The instructor also monitored participants for symptoms of any discomfort or signs of falling.

**Study Measurements**

The same assessor collected all study evaluation and outcome data 1 or 2 days before the commencement of the intervention and again 1 day after the termination of the intervention.

**Demographic and Anthropometric Measures.** Demographic information, history of PD, medication use, and anthropometric and health-status information from each participant were obtained at baseline. These included age and gender, age at onset of PD signs and symptoms, duration of disease, medication use, weight and height, and general health status. Weight and height were recorded using a digital scale (Detecto 6800, Webb City, MO) and a stadiometer (Bodymeter, Seca, Culver City, CA), respectively. Body-mass index was calculated as weight in kilograms divided by the square of a participant’s height in meters. Health status was measured with a single Likert-scale item taken from the well-established SF-12 Physical and Mental survey (Ware, Kosinski, & Keller, 1995), with 1 indicating poor health and 5 being excellent health.

**Exit Interview.** At the completion of the intervention, an exit interview specifically developed for this study was conducted by an independent research assistant to detail participants’ reactions to the training program. Specifically, participants were given an opinion survey with 13 questions covering program appropriateness and understanding of movement instructions, level of difficulty in learning and performing, program enjoyment and satisfaction, program safety, confidence, and intent to continue. Each of the survey questions was rated on a 4-point scale (1 = yes, 2 = somewhat, 3 = not sure, or 4 = no).

**Physical-Performance Measures.** The physical-performance measures included the 50-ft speed walk (Reuben & Siu, 1990), up-and-go test (Podsiadlo & Richardson, 1991), and functional-reach test (Duncan, Weiner, Chandler, & Studenski, 1990). We chose these for our study because they are widely reported in the literature, and some have been used to examine physical function in individuals with PD (e.g., Ashburn, Stack, Pickering, & Ward, 2001; Behrman, Light, Flynn, & Thigpen, 2002; Brusse, Zimdars, Zalewski, & Steffen, 2005; Canning, Alison, Allen, &...
The 50-ft speed walk measures the time taken to walk 50 ft. The up-and-go test measures the time taken to rise from a chair, walk 10 ft (3 m), return, and sit down. The functional-reach test, a measure of the limits of stability in the forward direction, assesses the maximal distance an individual can reach forward beyond arm’s length while maintaining a fixed base of support in a standing position. All three measures have satisfactory 5-day test–retest reliability with acceptable stability coefficients: .65 for 50-foot walk, .71 for up-and-go test, and .79 for functional-reach test. For the two time-based tests (50-ft speed walk, up-and-go), participants were instructed to walk or perform the task as quickly as possible. The instructions for all tests were standardized between sessions and between participants. The two time-based measures were followed by the functional-reach test.

Statistical Analysis

The percentage of responses on exit-interview items was tabulated. Given the within-subjects design, paired-sample *t* tests were conducted to determine pretest and posttest differences in physical-performance outcome measures. Analyses were also conducted that stratified by Hoehn–Yahr stage (Stage I vs. Stages II or III). Results were not statistically different; thus, pooled results were presented. The alpha level for all tests was set at .05. A two-tailed test of significance was applied for tests of all outcomes in light of the developmental nature of the study. Statistical analysis of the data was performed using SPSS statistical software (version 12; SPSS Inc., Chicago).

Results

Baseline Participant Characteristics

Table 1 provides baseline characteristics of the study participants. All participants were moderately active with everyday tasks of living but were not involved in structured exercise programs. Although it was not an exclusion criterion for the study, none of the participants had had any prior Tai Chi experience or training. With respect to PD symptoms, most of the participants (12 of 17) were in Stage I PD. During the baseline screening, the presence of the cardinal symptoms of PD (i.e., rigidity, tremor, bradykinesia, and postural instability; Stacy & Jankovic, 1992) were observed in all but 2 patients. Fourteen participants were receiving PD-related medication. There were no reported medication changes in any participants during the 1-week course of the exercise program.

Attrition, Adherence, and Adverse Events

No attrition occurred—all 17 participants completed the 5-day exercise program. Similarly, all participants tolerated the accumulated increases in movement performance over the 5 days of the program. Training safety and adverse events were closely monitored throughout the intervention. No falls or exercise-related injuries were observed by the instructor or reported by the participants.
Program Exit Interviews

Results of exit interviews at the end of the 5-day program are shown in Table 2. No responses of either “not sure” or “no” were observed in the 13-item survey. In general, all participants reported that they enjoyed this brief exercise intervention and felt that the exercise movements were appropriate, easy to learn, and safe to perform. Participants also felt that the exercise program helped improve their balance and confidence and believed it would help them be functionally independent. All participants indicated strong interest in continuing the exercises.

Change in Physical-Performance Measures

Table 3 presents means and standard deviations of physical-performance measures at pretest and posttest. At the end of the 5-day program, a statistically significant change was observed from pretest for the 50-ft speed-walk test, $t(16) = 3.32, p = .002$, pretest–posttest mean difference = $-2.30$ s (a 14% improvement), $SD = 2.86$; the up-and-go test, $t(16) = -2.90, p = .01$, pretest–posttest mean difference = $-1.36$ s (a 14% improvement), $SD = 1.93$; and the functional-reach test, $t(16) = 2.83, p = .01$, pretest–posttest mean difference = $2.95$ cm (a 13% improvement), $SD = 4.30$. 

### Table 1 Participant Characteristics ($N = 17$)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, $n$ (%)</td>
<td>11 (65)</td>
</tr>
<tr>
<td>Age, years ($\pm SD$)</td>
<td>71.51 ($\pm 5.4$)</td>
</tr>
<tr>
<td>White, $n$ (%)</td>
<td>17 (100)</td>
</tr>
<tr>
<td>Hoehn and Yahr stage</td>
<td></td>
</tr>
<tr>
<td>Stage I, $n$ (%)</td>
<td>12 (71)</td>
</tr>
<tr>
<td>Stage II, $n$ (%)</td>
<td>4 (24)</td>
</tr>
<tr>
<td>Stage III, $n$ (%)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Medication</td>
<td></td>
</tr>
<tr>
<td>levodopa, $n$ (%)</td>
<td>12 (71)</td>
</tr>
<tr>
<td>dopamine agonists, $n$ (%)</td>
<td>7 (41)</td>
</tr>
<tr>
<td>other PD medication, $n$ (%)</td>
<td>8 (47)</td>
</tr>
<tr>
<td>Age at PD onset, years ($\pm SD$)</td>
<td>67.8 ($\pm 9.84$)</td>
</tr>
<tr>
<td>Duration of disease, years ($\pm SD$)</td>
<td>5.2 ($\pm 3.5$)</td>
</tr>
<tr>
<td>High school education or higher, $n$ (%)</td>
<td>12 (71)</td>
</tr>
<tr>
<td>Body-mass index, kg/m$^2$ ($\pm SD$)</td>
<td>29.08 ($\pm 5.9$)</td>
</tr>
<tr>
<td>Health status, $M (\pm SD)$</td>
<td>3.02 ($\pm .09$)</td>
</tr>
<tr>
<td>poor, $n$ (%)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>fair, $n$ (%)</td>
<td>6 (35)</td>
</tr>
<tr>
<td>good, $n$ (%)</td>
<td>8 (47)</td>
</tr>
<tr>
<td>very good, $n$ (%)</td>
<td>2 (12)</td>
</tr>
<tr>
<td>excellent, $n$ (%)</td>
<td>0 (0)</td>
</tr>
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</table>
Table 2  Exit Interviews (N = 17)

<table>
<thead>
<tr>
<th>Survey item</th>
<th>% Who responded “yes”</th>
<th>% Who responded “somewhat”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program appropriateness</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Understanding movement instructions</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Program enjoyment</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Program satisfaction</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Easy to learn</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Easy to perform</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Safe to perform</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Made me more confident in walking</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Balance has improved</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Help functional independence</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Help improve confidence</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Intent to continue</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Recommend it to others</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3  Physical-Performance Outcome Measures at Pretest and Posttest (N = 17)

<table>
<thead>
<tr>
<th>Primary measure</th>
<th>Pretest</th>
<th>Posttest</th>
<th>p</th>
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<tbody>
<tr>
<td>50-ft speed walk (s)</td>
<td>16.32 ± 2.65</td>
<td>14.02 ± 1.47</td>
<td>.002</td>
</tr>
<tr>
<td>Up-and-go (s)</td>
<td>9.38 ± 2.68</td>
<td>8.02 ± 2.31</td>
<td>.01</td>
</tr>
<tr>
<td>Functional reach (cm)</td>
<td>22.42 ± 6.17</td>
<td>25.38 ± 7.07</td>
<td>.01</td>
</tr>
</tbody>
</table>

a Lower values indicate improvements.
b Higher values indicate improvements.

Discussion

The primary objective of this pilot study was to provide a preliminary evaluation of a Tai Chi–based exercise program delivered to community-dwelling older adults with mild to moderate PD (Hoehn and Yahr Stages I, II, or III). Although the study was exploratory in nature and limited in scope, the outcome showed preliminary evidence of feasibility in terms of the safety of the program, appropriateness of the program for older adults with PD, and participation adherence and satisfaction. In addition, no physicians withheld permission for their patients to participate, indicating support for their patients’ involvement in this study. From the exit interviews, participants indicated satisfaction and enjoyment with this brief intervention and expressed interest in continuing the activity. Collectively, these outcomes suggest that the program was safe, well received, and appropriate for patients in early-stage PD, thus accomplishing the primary objective of this pilot study.
Beyond the feasibility questions, results from this study showed improvements in physical-performance measures. As hypothesized, after a 5-day brief training program, participants had significant pretest-to-posttest intervention changes in all three measures of physical function. Although the magnitude of the treatment effect cannot be determined in the absence of a true control group, these results are encouraging given that this was a preliminary study with a small sample size. They also suggest that patients with mild to moderate PD, whose movement and mobility are often compromised, might benefit from regular practice of this Parkinson’s-specific Tai Chi exercise program. Although these results are promising, further investigation is required to determine the efficacy of this program and whether observed changes in functional outcomes are clinically significant.

The modified Tai Chi program maintains the essential features of the traditional Yang style, which incorporates movement characteristics of balance, postural alignment, movement continuity, attention and concentration, and breathing, while simultaneously addressing problems of movement deficits, balance, and postural control commonly observed in individuals with PD. The program also follows a gradual, easy to more difficult progression, which might enhance both physical and psychological mastery, as well as challenge movement control during exercise performance. Each of these movements can be performed and practiced repeatedly as a single form, or they can be practiced jointly in a routine. Therefore, regular and routine participation in this exercise program might help patients address PD symptoms such as lack of flexibility, difficulty in walking and changing position, poor posture, and joint and muscle stiffness. Individuals can gradually raise the intensity of their practice by increasing the number of repetitions properly performed. The recommended number of repetitions is two or three per form per session, which can be gradually increased to five. Gradual progression should minimize fatigue, which might adversely affect adherence.

**Study Limitations**

The current pilot study has several limitations. The study design, lacking randomization and a control comparison group, is a major limitation. The use of a pretest–posttest design is known to be susceptible to uncontrolled threats to both internal and external validity. With this design, it cannot be stated definitively that improvements in the study outcome measures were directly related to participation in this exercise program. Although the results could be caused by the intervention, other factors such as maturation, testing effect, or sample selection biases might have influenced the outcomes. For example, the sample consisted of a group of volunteers who enthusiastically agreed to participate in this study and who might also have high expectations (placebo effect) with respect to this new exercise program. Selection biases might occur because the self-selected sample might differ from general PD-population characteristics. Similarly, the improvement in physical performance at posttest might have been the result of the experience with the test at baseline. These validity issues should be addressed through a randomized controlled trial with a larger sample. The use of randomized controlled designs would allow us to determine the efficacy of this exercise program for this population. Finally, the generalizability of the findings might be limited by the small group size (average size of 4 participants) and the unusual practice time frame used in this study (i.e.,
90 min per session for five consecutive days). In light of the preliminary nature of the study and the design limitation, we are cautious in interpreting the results, particularly with respect to measures of physical performance.

**Implications and Conclusion**

Overall, results from this pilot study suggest that this Tai Chi program specialized for patients with mild to moderate PD is a safe and enjoyable form of exercise that can be learned within a reasonably short time. Judging from the exit interviews and interactions with our study participants, the easy-to-perform and fluid movements of this Tai Chi program appear ideal for initiating, promoting, or maintaining a physically active lifestyle among individuals with PD, regardless of their prior Tai Chi or exercise experience. The physical improvements indicate, although preliminarily, that this specially designed Tai Chi program has the potential to improve and maintain physical function.

Because of different study designs, especially different exercise training methods, the results of our study are difficult to compare with those of others (e.g., Baatile et al., 2000; Comella, Stebbins, Brown-Toms, & Goetz, 1994; Palmer et al., 1986; Schenkman et al., 1998). Nonetheless, the preliminary findings from this study are in keeping with other evidence that individuals with early-stage PD can reap benefits from general exercise approaches such as Tai Chi (Farley, 2004). These results join a growing body of evidence that PD-specific exercise protocols can be safe and beneficial in preserving or improving physical performance or physical function in individuals with PD (e.g., Farley, 2002; Schenkman et al.).

The study’s findings warrant further investigation. A large-scale clinical trial should be undertaken to determine whether an intensive training protocol (e.g., a practice schedule of two or three times per week) over a longer study period (i.e., several months) would result in improved clinical and laboratory measures of functional ability or slowing of disease progression. Studies are also warranted to determine whether Tai Chi is more effective than other existing or conventional exercise modalities (e.g., walking) in achieving functional improvements. The benefits from exercise are most likely to accrue with continued participation after formal training has been completed. Therefore, long-term follow-up of outcomes is needed to determine the characteristics of individuals who are most likely to consistently engage in the exercise program.

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**References**


A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation, 83,* 1370-1373.


Ware, J.E., Jr., Kosinski, M., & Keller, S.D. (1995). *SF-12: How to score the SF-12 Physical and Mental Health Summary Scales* (2nd ed.). Boston: The Health Institute, New England Medical Center.

