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Randomized Controlled Trial of Community-Based Dancing to Modify Disease Progression in Parkinson Disease

Ryan P. Duncan, MPT[1] and Gammon M. Earhart, PhD[1]

Abstract

Background. Tango dancing has been effective in improving measures of physical function in people with Parkinson disease (PD). However, all previous studies were institution-based, tested participants on medication, and employed short-term interventions. *Objective*. To determine the effects of a 12-month community-based tango program for individuals with PD on disease severity and physical function. *Methods*. Sixty-two participants were randomly assigned to a twice weekly, community-based Argentine Tango program or a Control group (no intervention). Participants were assessed off anti-Parkinson medication at baseline, 3, 6, and 12 months. The primary outcome measure was the Movement Disorders Society–Unified Parkinson Disease Rating Scale 3 (MDS-UPDRS-3). Secondary outcome measures were the MDS-UPDRS-1, MDS-UPDRS-2, MiniBESTest balance test; Freezing of Gait Questionnaire (FOG_Q); 6-Minute Walk Test (6MWT); gait velocity for comfortable forward, fast as possible forward, dual task, and backward walking; and Nine-Hole Peg Test (9HPT). *Results*. Groups were not different at baseline. Overall, the Tango group improved whereas the Control group showed little change on most measures. For the MDS-UPDRS-3, there was no significant change in the Control group from baseline to 12 months, whereas the Tango group had a reduction of 28.7% (12.8 points). There were significant group by time interactions for MDS-UPDRS-3, MiniBESTest, FOG_Q, 6MWT, forward and dual task walking velocities, and 9HPT in favor of the dance group. *Conclusions*. Improvements in the Tango group were apparent off medication, suggesting that long-term participation in tango may modify progression of disability in PD.

Keywords

Parkinson disease, exercise, gait, balance, rehabilitation

Introduction

To combat mobility-related problems in Parkinson disease (PD), nonpharmacologic tactics such as exercise are needed. Traditional exercise is effective in improving balance, lower extremity strength, and gait speed.[1] Likewise, tango dancing, an alternative form of exercise, improves balance, gait, and quality of life.[2,3] Previous studies examining the effects of dance on those with PD presented some limitations, however. First, participants were evaluated on anti-PD medications. While testing participants on medication may provide insight into how they perform daily activities, some of the deficits caused by PD may go unnoticed.[4] For a more accurate picture of the underlying disease process, and to ultimately determine whether exercise may be disease modifying, testing off medication is warranted. Second, although institution-based dance programs proved effective in prior studies, the Surgeon General's Call to Action encourages researchers and those with disabilities "to jointly develop community-based healthcare and wellness programs for people with disabilities and research their efficacy."[5] Third, prior studies of dance used interventions of 3 months or less. There is a clear need for studies that determine the effects of long-term exercise in PD.[6-8]

The purpose of this study was to determine the effects of a long-term community-based dance program in people with PD, with all evaluations conducted off medication. As evidence emerges suggesting that exercise may positively

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influence multiple dimensions,[9] and with recent animal studies suggesting exercise may have neuroprotective effects in PD,[10] we were interested in the effects of dance on disease progression as assessed by our primary variable, the Movement Disorder Society–Unified Parkinson Disease Rating Scale 3 (MDS-UPDRS-3). We hypothesized that (*a*) the Tango group would demonstrate improvements in disease severity and physical function not noted in the Control group and (*b*) Tango participants would show larger improvements in function at 6 and 12 months compared with 3 months.

Methods

Participants

The principal investigator (GME) recruited individuals with clinically defined "definite PD"[11-13] (Hoehn and Yahr Stages I-IV) from the Washington University Movement Disorders Center and through advertisements in a local PD newsletter. Phone interviews were conducted with potential participants to determine if they should be excluded based on the following: (*a*) serious medical condition, (*b*) evidence of abnormality other than PD-related changes on brain imaging (previously done for clinical evaluations), (*c*) history or evidence of neurological deficit other than PD, or (*d*) history or evidence of musculoskeletal problem. This work was approved by the Human Research Protection Office at Washington University, and each participant provided written informed consent. The trial was registered on ClinicalTrials.gov as "PD4PD: Partnered Dance for Parkinson Disease," NCT01388556.

Study Design

This was a randomized controlled trial where participants were assigned to the Tango or Control group by the principal investigator using an online random number generator. Tango participants attended twice weekly, 1-hour community-based Argentine Tango classes for 12 months. Participants danced both leader and follower roles, changed partners frequently, and learned new steps and/or integrated previously learned steps in new ways at each class throughout the 12 months. The tango paradigm on which classes were modeled has been described in detail.[14] Participants were encouraged to learn and perform the dance to the best of their abilities, but dance performance was not evaluated. Control participants had no prescribed exercise and were instructed to go about their lives as usual.

Baseline evaluations were completed from October to December 2009 and included assessment of physical activity levels (Physical Activity Scale for the Elderly [PASE]).[15] Three-month evaluations were completed from January to March, 6-month evaluations from April to June, and 12-month evaluations from October to December 2010. Participants were off all anti-PD medications for at least 12 hours prior to evaluation; time of day for all evaluations was kept the same for each participant. At each visit, participants were assessed by the same rater, a physical therapist (RPD), who was blinded to group.

Outcome Measures

Disease severity. MDS-UPDRS sections 1-3 were used to measure disease severity.[16] Section 1 examines nonmotor experiences, section 2 covers activities of daily living (ADLs), and section 3 assesses motor symptoms including tremor, rigidity, bradykinesia, gait, and postural instability. Higher scores indicate greater disease severity. The MDS-UPDRS-3 was our primary variable of interest. We conducted additional analyses on the specific motor components assessed within the MDS-UPDRS-3: tremor (sum of MDS-UPDRS-3 items 3.15-3.18), rigidity (sum of items 3.3a-3.3e), bradykinesia (sum of items 3.4-3.8 and 3.14), and postural instability/gait disorder (PIGD, sum of items 3.9-3.13).

Balance. Balance was assessed using the MiniBESTest, a 14-item tool measuring performance of dynamic balance tasks.[17] This test has high interrater and test–retest reliability (intraclass correlation coefficient ≥ .92 and intraclass correlation coefficient ≥ .88, respectively) in PD.[18] Lower scores indicate greater deficits in balance.

Gait. Freezing of gait was quantified using the Freezing of Gait Questionnaire (FOG_Q).[19,20] Higher scores indicate greater difficulty with walking and freezing. The 6-Minute Walk Test (6MWT) was used to measure walking endurance.[21] Individuals were instructed to cover as much ground as possible while walking at a safe, comfortable pace in a 30.48-m hallway.

A 4.87-m GAITRite (CIR Systems, Inc, Havertown, Pennsylvania) was used to measure walking velocity during comfortable forward, fast as possible forward, dual task, and backward walking. Mean velocity for 3 trials of each condition was determined. For comfortable pace forward and backward walking, participants were instructed to walk at a self-determined "normal" speed. For fast as possible forward walking, participants were instructed to walk as quickly as possible without running. For dual task walking, participants were instructed to walk forward at a self-determined "normal" speed while naming as many words as possible that began with a certain letter. The same 3 letters were used for all participants at all time points. Subjects were instructed to begin walking as soon as the letter was provided. Number of correct and incorrect answers on each trial was recorded, and the 3 trials averaged to provide a measure of overall task performance, which was not different between groups and did not change over the course of the study.

Upper extremity function. The Nine-Hole Peg Test (9HPT) was used to evaluate upper extremity function[22,23] to determine whether participation in the intervention might affect variables not directly related to the intervention. Participants performed 2 trials of the 9HPT with each hand. The average of all 4 trials yielded a composite mean value for 9HPT performance.

Procedures

The evening prior to testing, participants received a phone call and were reminded to not take any anti-PD medication for at least 12 hours prior to arrival. On arrival, the order of testing was as follows: (*a*) MDS-UPDRS (1-3), (*b*) MiniBESTest, (*c*) gait, and (*d*) 9HPT. Several measures were included in the test battery to comprehensively evaluate the effects of the exercise intervention on disease progression, balance, gait, and upper extremity function. We deemed all of these to be important areas to include, as few of these have been assessed in long-term exercise intervention studies.

Statistical Analyses

Power analyses based on data from previous published tango studies[2,3,24-26] and the minimal clinically important difference (MCID) in the UPDRS-3[27] indicated a need for approximately 30 subjects per group to have 80% power at $P = .05$. *T* tests compared baseline demographic and disease severity characteristics between groups ($P = .05$). All other data were analyzed using 2-way repeated-measures ANOVAs with group (Tango or Control) and time (baseline, 3, 6, or 12 months) as factors ($P = .05$). When appropriate, Tukey–Kramer multiple comparison post hoc tests were used to determine specific differences between groups within a given time point and within a group across time points. An intent-to-treat analysis with the last observation carried forward was employed with any participants who completed the baseline visit and at least 1 other evaluation. Data analysis was completed in NCSS.[28]

Results

A total of 123 participants were screened, with 62 randomized to the Tango or Control group. Reasons for exclusion included unwillingness to skip medications for the evaluations, failure to meet inclusion/exclusion criteria, and practical issues such as transportation difficulty (see Figure 1). Participants were lost at various time points (Figure 1). The final analysis included 52 individuals. Participants who dropped out at any point after 3 months were still included using the last observation carried forward. There were no significant differences at baseline between the Tango and Control groups for demographic measures (Table 1) and no differences at baseline in physical activity levels as assessed by the PASE (Tango = 124.2 ± 16.3, Control = 115.4 ± 13.9).

Disease Severity

Motor symptoms (MDS-UPDRS-3) improved in the Tango group and did not change in the Control group, resulting in a significant group by time interaction ($F = 9.82$, $P < .001$, Figure 2A). There were also significant main effects of time ($F = 9.40$, $P = .004$) and group ($F = 23.1$, $P < .001$) for motor symptoms. Tango motor symptom scores at 3, 6, and 12 months were significantly better (ie, lower) than Control scores at 3, 6, and 12 months, respectively. Within the Tango group, motor symptom scores were significantly better at 3, 6, and 12 months compared with baseline and significantly better at 6 and 12 months compared with 3 months. Table 2 presents the average MDS-UPDRS-3 values and 95% confidence intervals for each group at each time point. There were no differences in ADLs (MDS-UPDRS-2) or nonmotor symptoms (MDS-UPDRS-1) between groups and no significant changes in ADLs or nonmotor symptoms during the study (Figure 2B and C).

Tremor scores decreased very slightly over time in both groups (Figure 3A), resulting in a significant main effect of time for tremor ($F = 6.70$, $P \leq .001$). There were no differences between groups and no significant interaction for tremor. Rigidity did not change in the Tango group and increased in the Control group over the course of the study, resulting in a significant group by time interaction ($F = 5.31$, $P = .002$, Figure 3B). Rigidity was significantly lower in the Tango group compared with the Control group at 6 and 12 months. There was also a significant main effect of time for rigidity ($F = 11.72$, $P \leq .001$). Bradykinesia decreased substantially in the Tango group and changed little in the Control group, resulting in a significant group by time interaction ($F = 8.35$, $P < .001$, Figure 3C). Bradykinesia was significantly lower in the Tango group compared with the Control group at 6 and 12 months. Within the Tango group, bradykinesia was significantly lower at 3, 6, and 12 months compared with baseline and at 6 and 12 months compared with 3 months. There were also significant main effects of group ($F = 5.65$, $P = .02$) and time ($F = 42.14$, $P < .001$) for bradykinesia. PIGD scores decreased in the Tango group, resulting in a significant group by time interaction ($F = 4.21$, $P = .007$, Figure 3D). PIGD scores in the Tango group were significantly better than the Control group at 6 and 12 months. Within the Tango group, PIGD scores were significantly better at 12 months compared with 3 months.

Balance

Balance improved in the Tango group and worsened slightly in the Control group over the course of the study, resulting in a significant group by time interaction ($F = 11.73$, $P < .001$, Figure 4A). Balance scores in the Tango group at 3, 6, and 12 months were significantly better than

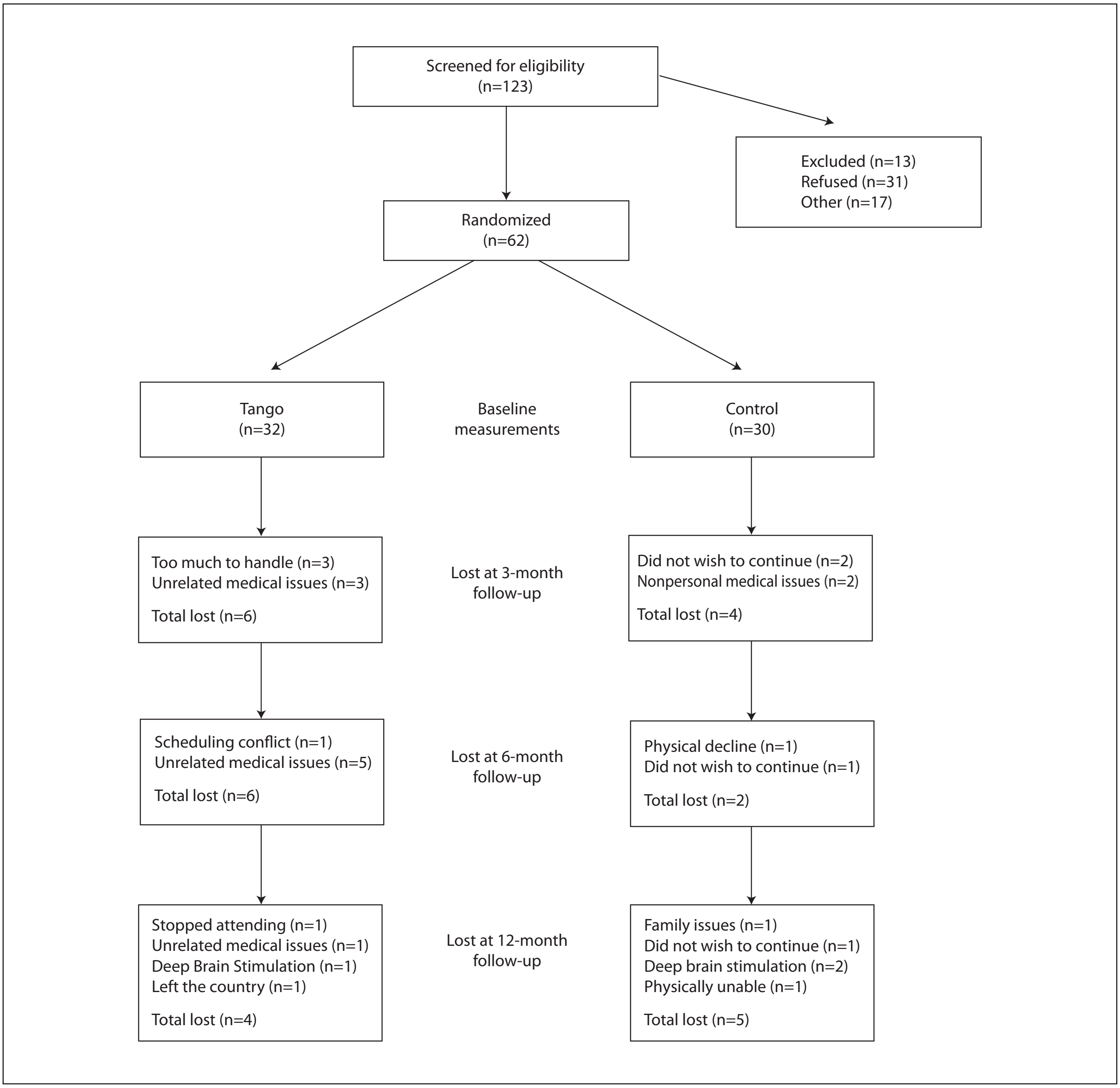

Figure 1. Consort flow diagram illustrating participant recruitment, randomization, and tracking over the course of the study. Note that the final analyzed sample included all participants retained through 3 months, with those who dropped out at 6 or 12 months remaining in the sample through use of a last observation carried forward intent-to-treat analysis.

Control scores at 3, 6, and 12 months, respectively. Within the Tango group, balance scores at 3, 6, and 12 months were significantly better compared with baseline.

Gait

There were no significant differences between groups at any time point for freezing of gait as assessed by the FOG_Q. There was, however, a significant group by time interaction ($F = 4.2$, $P = .006$) for freezing of gait (Figure 4B). Within the Control group, there was significantly more freezing reported at 12 months compared with baseline.

Six-minute walk distance held steady in the Tango group and decreased in the Control group over the course of the study, resulting in a significant group by time interaction ($F = 3.33$, $P = .02$, Figure 4C). Distance walked by the Tango group at 12 months was significantly longer than distance walked by the Control group at 12 months.

Table 1. Participant Demographics[a]

	Tango (n = 26)	Control (n = 26)	Tango Dropped (n = 6)[b]	Control Dropped (n = 4)[b]
Age, y	69.3 ± 1.9 (48-89)	69.0 ± 1.5 (48-81)	76.2 ± 3.6 (60-86)	70.8 ± 6.2 (59-85)
Gender	15 males/11 females	15 males/11 females	4 males/2 females	1 male/3 females
Years with PD	5.8 ± 1.1 (1-20)	7.0 ± 1.0 (1-21)	3.5 ± 1.3 (0.5-9)	6.0 ± 1.5 (2.5-10)
Hoehn and Yahr stage	2.6 ± 0.1 (1-4)	2.5 ± 0.1 (2-4)	2.4 ± 0.2 (2-3)	2.8 ± 0.4 (2-4)

Abbreviations: PD, Parkinson disease; SE, standard error of mean.
[a]Values are means ± SEs (ranges).
[b]These columns provide demographic information for those participants who were lost to follow-up after the baseline visit and prior to the 3-month visit.

In general, walking velocity in all conditions increased over the course of the study for the Tango group and did not change in the Control group (Figure 5A-D). For forward walking (Figure 5A), there was a significant group by time interaction (F = 2.74, P = .04). At 6 and 12 months, the Tango group had significantly higher preferred forward walking velocity than the Control group at 6 and 12 months, respectively. For fastest possible walking (Figure 5B), there were no significant differences between groups and no significant changes in velocity. For dual task walking (Figure 5C), there was an interaction between group and time (F = 3.57, P = .02) as well as a significant main effect of time (F = 3.31, P = .02). At 6 and 12 months, the Tango group had significantly faster dual task walking velocity than the Control group at 6 and 12 months, respectively. Within the Tango group, dual task walking velocity was significantly faster at 6 and 12 months compared with baseline. Finally, for backward walking velocity (Figure 5D), there was a main effect of time only (F = 3.04, P = .03).

Upper Extremity Function

Performance on the 9HPT improved in the Tango group and worsened slightly in the Control group over the course of the study, resulting in a significant group by time interaction (F = 3.83, P = .01, Figure 4D). Tango scores at 6 and 12 months were significantly better than Control scores at 6 and 12 months, respectively. Within the Tango group, scores were significantly better at 12 months compared with baseline.

Participant Adherence

Over the 12-month study, there was a 37% attrition rate in the Control group and a 50% attrition rate within the Tango group. Throughout the 12 months, the 16 Tango participants that attended consistently from start to end came to an average of 78.5 ± 3% of all classes. Following 12 months of participation, 11 of the 16 individuals in the Tango group chose to continue attending classes even though they had formally completed all study requirements and were no longer expected to attend.

Discussion

This study is the first to examine the effects of a community-based exercise program on individuals with PD tested off medication over a 12-month period. Following participation in Argentine Tango dance classes, participants demonstrated a significant reduction in disease severity, as well as significant improvements in gait, balance, and upper extremity function when compared with controls.

Disease Severity

This is, to our knowledge, the first study to report changes in motor symptom severity during a long-term exercise intervention with participants assessed off medication. Given this off medication testing, it is unlikely that improvements noted are due to improved response to pharmacologic interventions. Improvements in motor symptoms over the 12-month study, during which MDS-UPDRS-3 scores decreased by 12.8 points, were larger than previously reported changes of 4.6 and 8 points in the UPDRS-3 in short-term studies examining the effects of tango in participants on medication.[2,24]

Other exercise interventions have yielded improvements in PD motor symptom severity. Improvements of 25% (6-7 points) have been reported following treadmill training[29] and sensory attention focused exercise.[30] However, these studies examined subjects on medication. In the present study, we noted MDS-UPDRS-3 score improvements of 10.3%, 23.1%, and 28.7% at 3, 6, and 12 months, respectively. These off medication improvements in MDS-UPDRS-3 scores suggest that participation in the Tango program may have a disease modifying effect. Examination of specific components of the MDS-UPDRS-3 indicates that tango may have a positive influence not only on balance and gait, as might be expected, but also bradykinesia and rigidity. This supports the idea that tango may have a broad impact on motor symptom progression rather than just targeting the gait and balance aspects specifically practiced in the context of dancing.

Although not significant, the Tango group demonstrated reduced scores on the MDS-UPDRS-1 and -2, indicating

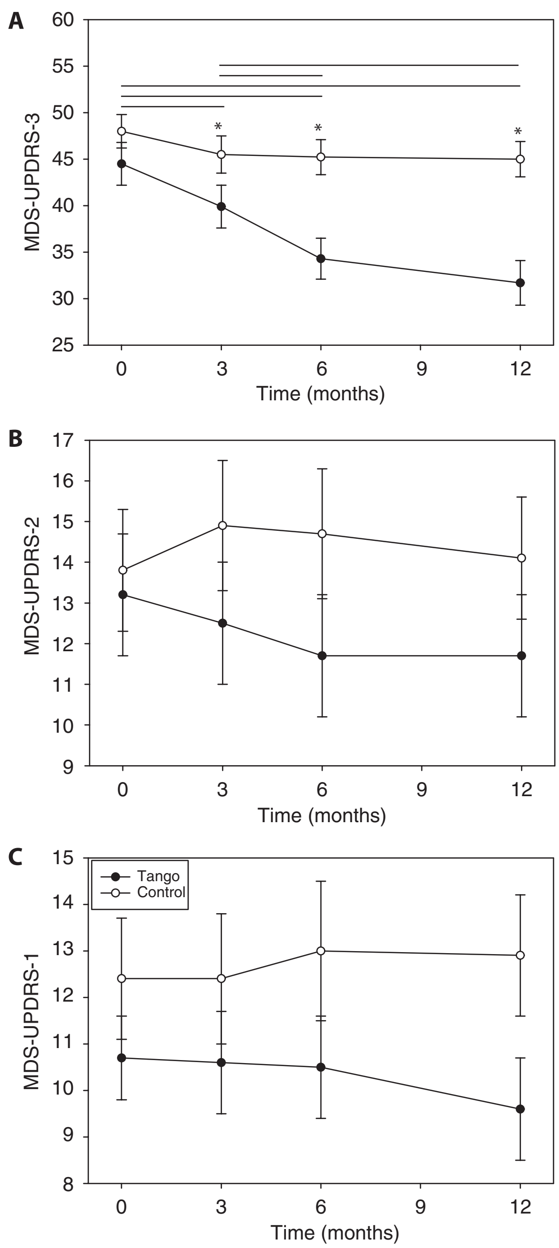

Figure 2. Scores on MDS-UPDRS-3 motor symptoms scale (A), MDS-UPDRS-2 ADLs scale (B), and MDS-UPDRS-1 nonmotor symptoms scale (C) at baseline, 3-, 6-, and 12-month evaluations for the Tango (filled circles) and Control (open circles) groups. Values are means ± SEs. Evaluations were conducted with participants off medication. Asterisks denote significant differences between Tango and Control within that time point. Each horizontal line indicates a significant difference within Tango between the 2 time points spanned by the line. For complete statistical comparison results please see text. Abbreviations: MDS-UPDRS, Movement Disorders Society–Unified Parkinson Disease Rating Scale; ADLs, activities of daily living; SE, standard error of the mean.

Table 2. MDS-UPDRS-3 Means ± SEs (95% CI)

MDS-UPDRS-3	Tango (n = 26)	Control (n = 26)
Baseline	44.5 ± 2.3 (37-53)	48.0 ± 1.8 (45-56)
3 Months	39.9 ± 2.3 (28-45)	45.6 ± 1.8 (38-49)
6 Months	34.2 ± 2.2 (28-38)	45.2 ± 1.9 (41-50)
12 Months	31.7 ± 2.4 (24-36)	45.0 ± 1.9 (39-48)

Abbreviations: MDS-UPDRS-3, Movement Disorders Society–Unified Parkinson Disease Rating Scale 3; SE, standard error of mean; CI, confidence interval.

some improvement in nonmotor symptoms and ADLs, respectively. It is disappointing that larger effects were not seen on these scales, but this was likely due in part to the much larger variability between subjects. This variability may reflect the fact that the MDS-UPDRS-1 and 2 are questionnaires answered by each participant, whereas the MDS-UPDRS-3 was rated by a single trained individual. Additional work is warranted, perhaps using measures in addition to the MDS-UPDRS-1 and -2, to explore the effects of long-term exercise on nonmotor symptoms and ADLs.

Physical Function

Participants in Tango demonstrated significant improvements in balance at 3, 6, and 12 months. At 12 months, the Tango group had an average MiniBESTest score of 21.3 ± 1.0 compared with the Control group, which had an average score of 17.2 ± 1.1 at the same time point. This difference of 4 points is substantial considering that the full MiniBESTest scale is only 32 points. Because the MiniBESTest is relatively new and MCID values are not available, it is not clear if this 4-point difference is clinically meaningful. Previous literature shows that different forms of exercise can have a positive impact on balance for individuals with PD in the short term,[2,31-35] whereas reports on medium-term (6 months) interventions show mixed results. Direct comparison of the present study with previous work is difficult because of the different balance measures used and the fact that we tested participants off medication. However, our results are promising and suggest that balance can improve in the short term (ie, at 3 months), continue to improve out to 6 months, and can be maintained at 12 months with continued exercise participation. Additional work is warranted to determine if long-term participation in exercise modifies fall risk or fall rates.

With respect to gait, those in the Tango group demonstrated improved self-selected walking speed compared with Controls following 6 and 12 months of dance exercise. These findings are in concert with previous work demonstrating improved self-selected walking speed following a shorter dance intervention.[25] Treadmill training studies have reported larger increases in gait speed than those noted

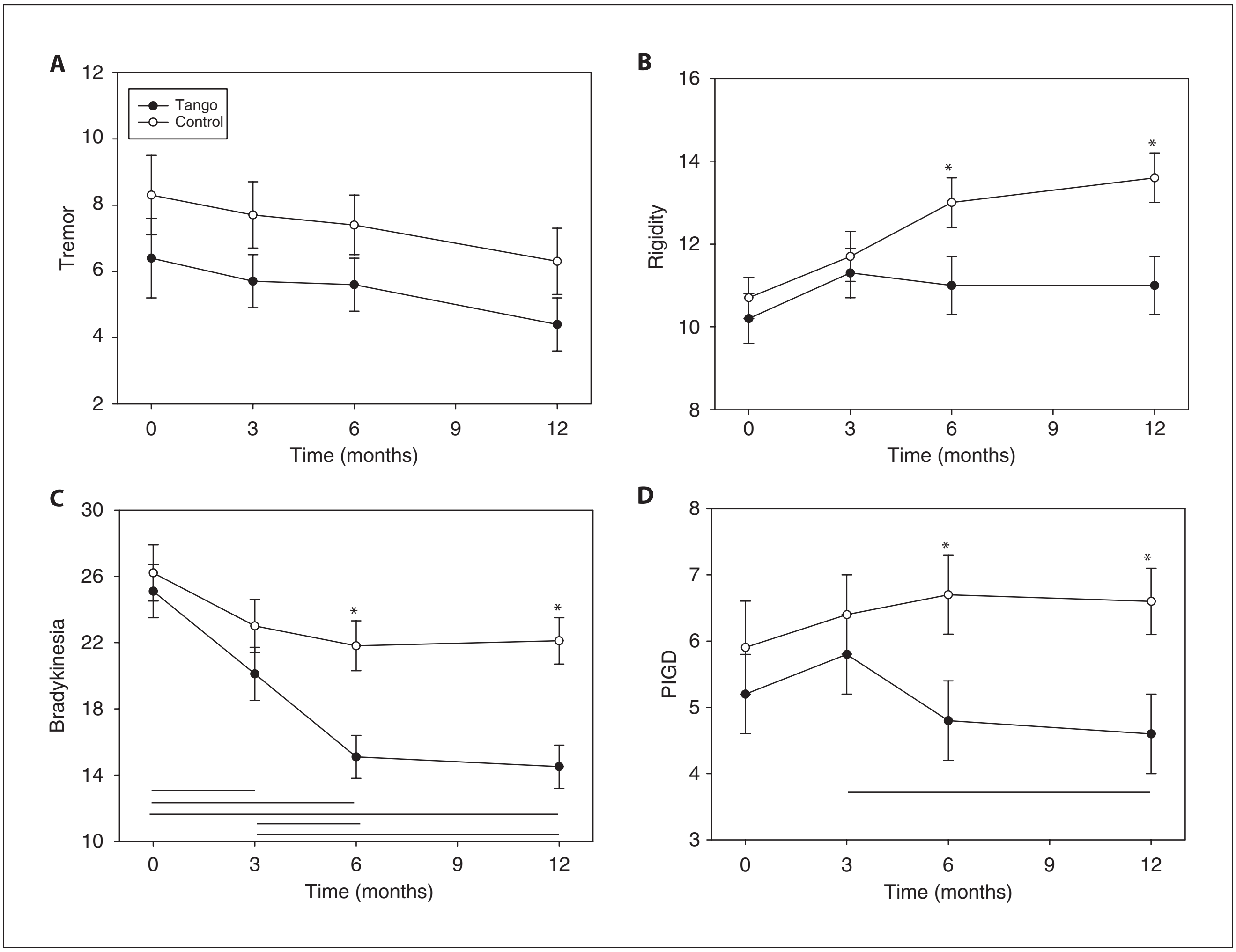

Figure 3. Scores on MDS-UPDRS-3 individual motor components of tremor (A), rigidity (B), bradykinesia (C), and PIGD (D) at baseline, 3-, 6-, and 12-month evaluations for the Tango (filled circles) and Control (open circles) groups. Values are means ± SEs. Evaluations were conducted with participants off medication. Asterisks denote significant differences between Tango and Control within that time point. Each horizontal line indicates a significant difference within Tango between the 2 time points spanned by the line. For complete statistical comparison results please see text. Abbreviations: MDS-UPDRS-3, Movement Disorders Society–Unified Parkinson Disease Rating Scale 3; PIGD, postural instability/gait disorder; SE, standard error of the mean.

in the present study, with gains of approximately 0.15 m/s.[29,36] Tango dancing may not be as intense as treadmill training, possibly accounting for the smaller improvements in gait speed in the present study compared with treadmill training. Nonetheless, the change of 0.09 m/s in gait speed from baseline to 12 months in the Tango group is close to the 0.1 m/s change generally accepted as a functionally meaningful difference.[37]

We also noted a 0.12 m/s increase in dual task walking speed after 12 months of Tango. Improved dual task walking may relate to the task-specific practice of multitasking during dancing. As participants dance, they must execute one movement while planning the next, all while attending to other couples on the dance floor and to the music. This practice of multitasking, coupled with the presence of the music to serve as an auditory cue, may facilitate dual task walking. Improvements in dual task walking have also been demonstrated with cueing,[38] and through specific practice of multiple-task walking.[39] With respect to FOG, within the Control group there was a significant difference from baseline to 12 months. This is not surprising as it is well known that FOG occurs more frequently as PD progresses.[40,41] It is interesting, though, that the Tango group presented no differences in FOG from baseline to 12 months, suggesting that exercise may delay the progression of FOG. This seems feasible, as tango dancing requires many starts, stops, turns,

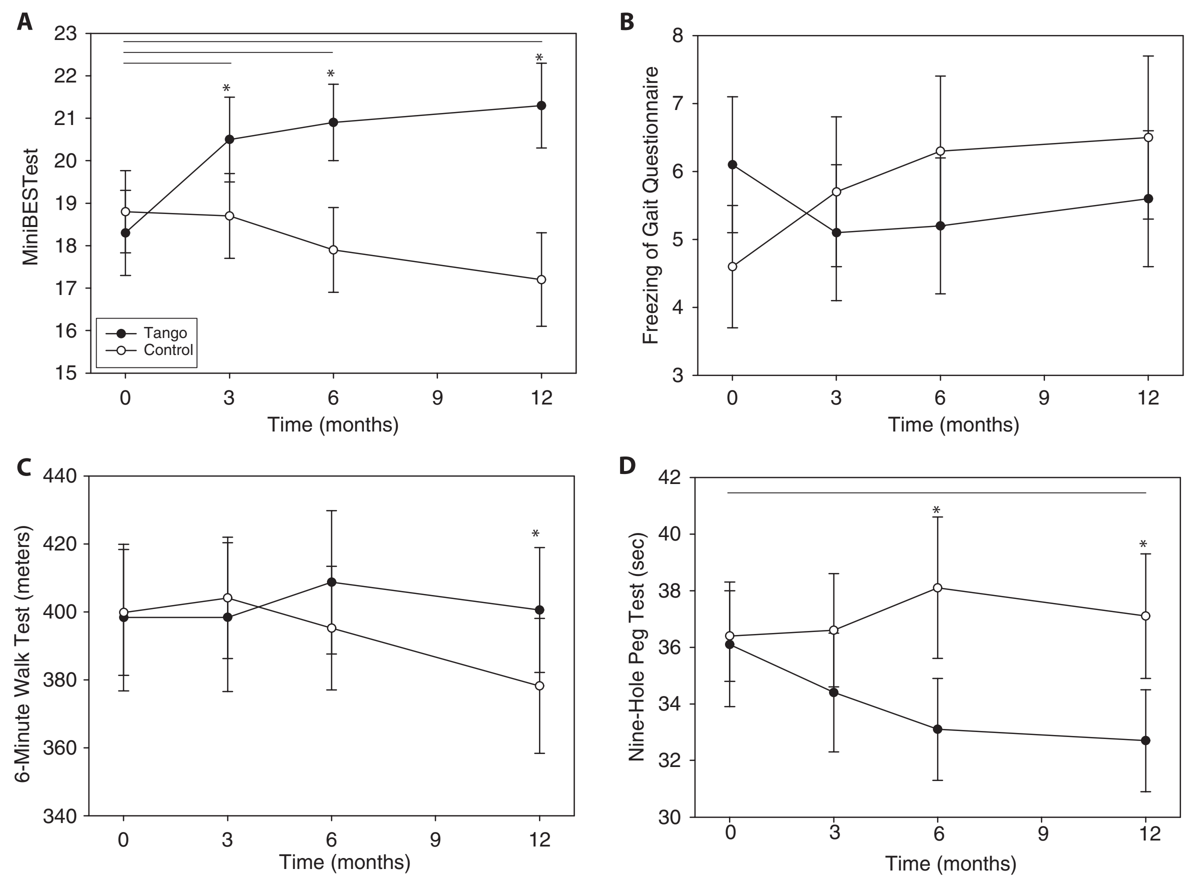

Figure 4. Scores on the Nine-Hole Peg Test (A), MiniBESTest balance test (B), Freezing of Gait Questionnaire (C), and 6-Minute Walk Test (D) at baseline, 3-, 6-, and 12-month evaluations for the Tango (filled circles) and Control (open circles) groups. Values are means ± SEs. Asterisks denote significant differences between Tango and Control within that time point. Each horizontal line indicates a significant difference within Tango between the 2 time points spanned by the line. For complete statistical comparison results please see text. Abbreviation: SE, standard error of the mean.

and movement in confined spaces, thereby incorporating direct practice of walking in the situations that commonly provoke freezing.[42]

The Tango group covered significantly greater distance in the 6MWT compared with Controls at the end of the study. Improvements in 6MWT with shorter tango interventions have been reported previously.[26,43] Improvements in 6MWT have also been demonstrated with other exercise interventions including boxing[44] and treadmill training.[45] As with gait velocity, changes in 6MWT in the present study were much smaller than those reported following treadmill training,[46,47] but it is possible that the low-intensity aerobic exercise provided through dance may have helped Tango participants to maintain 6MWT performance while Control participants declined. Alternatively, or in addition, maintenance of 6MWT distance in the Tango group may be related to improvements in balance, as balance has been suggested to play a significant role in 6MWT performance.[48]

Somewhat surprisingly, we noted significant improvements in 9HPT performance in the Tango group compared with Controls. Whereas a previous exercise study also demonstrated improvements in 9HPT performance, that program included movement exercises for the upper extremities and hands.[49] As there are no specific hand movements practiced with tango dancing, we propose that improved 9HPT performance may be reflective of a global impact of exercise on bradykinesia. This is supported by the improvements in MDS-UPDRS-3 bradykinesia scores and is in keeping with the suggestion that participation in exercise may have disease-modifying effects. This further suggests that the effects of tango dancing may extend beyond the specific types of tasks practiced in the context of the dance.

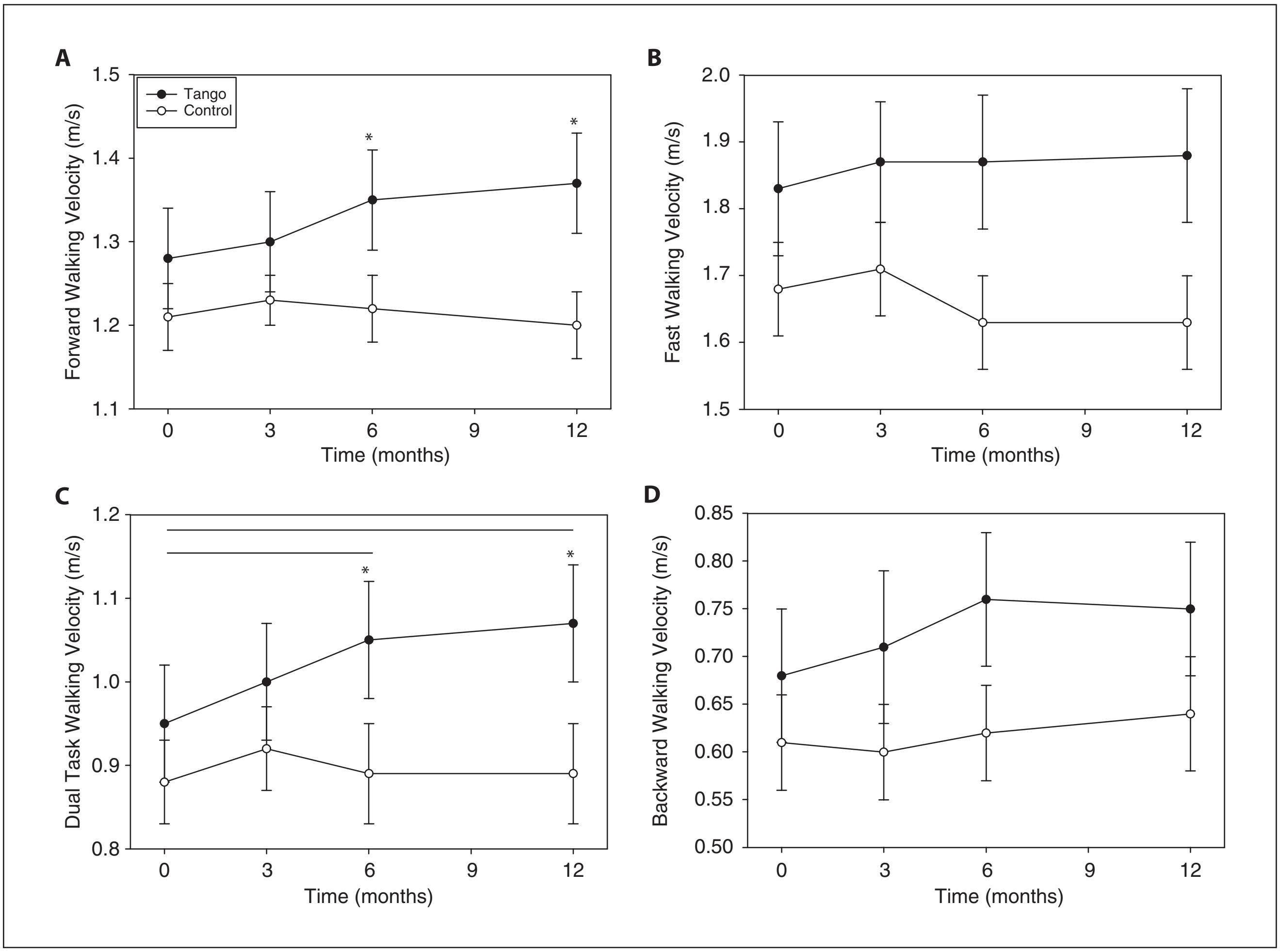

Figure 5. Walking velocities for forward (A), fast as possible (B), dual task (C), and backward (D) walking at baseline, 3-, 6-, and 12-month evaluations for the Tango (filled circles) and Control (open circles) groups. Values are means ± SEs. Asterisks denote significant differences between Tango and Control within that time point. Each horizontal line indicates a significant difference within Tango between the 2 time points spanned by the line. For complete statistical comparison results please see text. Abbreviation: SE, standard error of the mean.

Participant Adherence

The attrition rate within the Tango group was relatively high; however, it is important to note that this study was much longer than previous tango studies.[2,26] The 16 participants completing the full 12 months of the study attended 78% of dance classes. Studies of long-term exercise in older adults without PD have reported attendance rates of 65% over a 6-month period[50] and 58% over a 12-month period.[51] While attendance rates should be cautiously interpreted when comparing this study with the aforementioned studies because of differences in sample sizes, we think the higher attendance rate among those who completed the full 12 months of tango may speak to the high level of satisfaction with the dance classes. However, there was an overall 50% attrition rate in the tango group over 12 months. More than half of the individuals who stopped participating did so due to unrelated medical conditions that developed over the course of the 12 months. Our attrition in the Tango group at 3 months was 18%, which is in line with reported attrition rates of 14% and 23% for traditional 12-week exercise programs.[30] At 6 months, attrition in the Tango group was 37%, which is high compared with a 6-month study of traditional exercise that reported 13% attrition.[35] One possible explanation for our higher attrition rate is the fact that the 6-month study with low attrition required only monthly visits to an exercise class with the other exercise sessions done at home. In addition, our study required participants to be off medication for all evaluations. This may have deterred some people from continuing if the experience of withdrawing from medications was unpleasant or stressful. Finally, the present study was longer than most prior work and as such one would expect higher attrition.

Why Dance May Be Effective

We suggest that tango may be especially helpful compared with other dances because of the specific movements it incorporates, such as backward walking.[26] Tango offers both physical and cognitive challenges, as it incorporates low-level aerobic activity and movements that challenge gait and balance while also requiring high-level multitasking and progressive motor skill learning in the presence of external cues provided by the music and the partner.[52-54]

Study Limitations

This study has several limitations. We only evaluated subjects off medication to eliminate the potentially confounding effects of medication. However, testing both off and on medication is recommended for future studies to increase relevance to everyday functioning. Another limitation is that the Control group received no intervention and no control for attention or socialization. As such we cannot say whether and how the social and attentional aspects of participation contributed to the outcomes. The Control group did enable us to examine the natural history of PD in the absence of a specific intervention. Future work should control for attention and socialization and compare other exercise approaches and intensities.

Conclusion

Long-term participation in community-based dance exercise benefits people with PD. Socially engaging and enjoyable skill-based exercise may help promote long-term participation.

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Declaration of Conflicting Interests

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