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Effects of dance on balance and gait in severe Parkinson disease: A case study

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Running Title: Dance in Severe PD

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## Abstract

**Purpose:** Dance may improve functional mobility in individuals with mild - moderate Parkinson disease (PD), yet dance effects in severe PD remain unexamined. This study's purpose was to evaluate the feasibility and effects of partnered tango classes on balance, endurance and quality of life in an individual with severe PD.

**Design:** Over 10 weeks, the participant attended 20, 1-hour tango classes for individuals with PD. Balance, walking, and quality of life were evaluated before and after the intervention and at a one-month follow-up in this single case design. Caregiver burden was also assessed at all time points.

**Results:** The participant improved on the Berg balance scale, 6 minute walk test, and functional reach. He reported increased balance confidence and improved quality of life as measured by the Parkinson Disease Questionnaire-39 summary index. Gains were maintained at the one-month follow-up. Caregiver burden increased from baseline immediately post-intervention and at follow-up.

**Conclusion:** Twenty partnered tango lessons improved balance, endurance, balance confidence, and quality of life in a participant with severe PD. This is the first report of the use of dance as rehabilitation for an individual with advanced disease who primarily used a wheelchair for transportation.

**Key words:** Parkinson disease, Dance, Exercise

## Introduction

Parkinson disease (PD), a progressive neurodegenerative movement disorder affecting more than 1 million Americans, can cause postural instability and impaired functional mobility, often leading to falls and decreased quality of life. Persons with PD are at 3.2 fold greater hip fracture risk than those without [1]. Balance and gait impairments are not fully addressed by pharmacological agents, thus non-pharmacological approaches are necessary [2].

Rehabilitative programs for postural instability are most effective if they incorporate dynamic balance practice and continual adjustment to environmental demands [3, 4]. Dance is an excellent example of an activity that provides these requirements. Considered enjoyable, motivating and engaging [5, 6, 7] dance may be an excellent way to address motor impairments associated with PD as it likely fosters interest in continued participation. Habitual social dancing over several years is associated with superior balance, gait function and leg reaction times compared to age-matched non-dancers [8, 9]. Older adults who danced were more motivated to pursue healthy, exercise-related behaviors and demonstrated improved balance and functional mobility [10, 11]. Greater balance and complex gait task improvements in elders that participated in tango lessons were noted when compared to a walking group [12]. For individuals with PD, balance and functional mobility improvements after an Argentine tango program exceeded those of traditional exercise after a long duration, moderate dosage program [13, 14]. Improvements in balance and mobility were also demonstrated after a short duration, high dosage tango program [15]. In addition, quality of life improved significantly among individuals with PD who participated in tango, whereas those who participated in Waltz/Foxtrot or Tai Chi had no change [16].

All studies to date have examined the effects of dance on individuals with mild to moderate PD. Very little literature has evaluated the effects of exercise on severely impaired individuals with extremely limited mobility. This study aimed to determine the feasibility and effectiveness of partnered dance classes for an individual with severe PD, who had very limited mobility and used a wheelchair as his primary means of transportation.

## **Method**

The Human Research Protection Office at Washington University in St. Louis approved this work. KV provided written informed consent before participating. KV was an 86-year-old man with Hoehn & Yahr stage IV [17] Parkinson disease and lived in an assisted living facility. His symptoms, which began on the left side of his body, included rigidity, freezing of gait, difficulty with initiating movement, balance impairment and dizziness. He was diagnosed with PD three years prior to his first visit to the laboratory and had experienced very rapid disease progression. He was taking sinemet four times daily. Sinemet, a combination of the dopamine precursor levodopa and carbidopa to prevent metabolism of levodopa to dopamine outside the central nervous system, is a form of dopamine-replacement therapy. He took three 25/250mg (carbidopa/levodopa) tablets at 7am, noon, and 6pm, and two 50/200mg tablets plus one 25/100mg tablet at 9pm. He had an ON medication Unified Parkinson Disease Rating Scale-III (UPDRS-III) [18] score of 54 and was able to walk with walker assistance short distances but was more often in a wheelchair as he needed maximal assistance from another person to rise from a chair. He could communicate well, but his mobility was severely limited. He had the strong and involved support of his daughter and son but they lived far from KV's geographical area. Given his severe mobility limitations, the degree to which he would be able to participate in and potentially benefit from the partnered dance lessons was questionable.

### *Dance therapy intervention*

KV was told he was participating in a tango dance class along with other individuals with PD to further information about dance exercise effects in those with PD. He was blinded to study hypotheses and instructed not to change habitual exercise routines over the course of the study. Progressive partnered tango lessons were taught to individuals with PD and their loved ones by an experienced instructor who was both a professional ballroom dancer and a personal trainer certified by the American Council on Exercise.

Partner classes began with standing warm-ups to samba music. This warm-up consisted of breathing exercises, limbering and increasing range of motion and attention to postural

alignment. After warm-up, the class listened to and danced to commercial tango music selections. Novel step elements were introduced in each class period, and participants practiced new steps with a partner. Then, the instructor had participants travel around the dance floor by walking in various rhythms in synchrony with their partner. Finally, the new step of the day was reviewed and combined with previously learned steps, such that participants danced an amalgamation of several steps, traveling around the room. Both sexes spent equal time leading and following dance steps, all of which were performed in a “closed practice” position, an adaptation of the traditional ballroom frame in which participants hold hands facing one another with bent elbows, maintaining forearms parallel to the floor. Young volunteers, recruited from physical therapy, pre-physical therapy and pre-medical programs at Washington University, served as partners for those with PD. Volunteers were educated about PD-associated posture and gait problems, proper assistance techniques to use for balance loss and methods for monitoring balance and preventing falls.

KV was an enthusiastic participant who attempted to perform every activity to the best of his ability, and very actively participated with the help of his caregiver and a healthy volunteer. He took breaks as needed throughout each 1-hour class. Although many warm-up steps could have been performed in the chair, he would stand through most of the warm-up, while using the walker for balance assistance. Moving to the designated rhythm, he stood practicing his footwork or practiced partnered traveling steps approximately 50% of the hour-long classes, as estimated by the instructor. Steps that the class practiced included toe taps, multi-directional steps, rocking weight-shifts, leg lifts, and decorative embellishment tango-style steps, which often involved single leg support for several seconds. KV could practice these steps with the aid of a partner’s support and the walker, or by performing modified versions while seated in his chair. While seated, KV would clap along to the music, tap his feet and practice his arm positions and footwork. As partnered dance steps are frequently signaled by rotations from the hips and waist he could lead steps from his chair by maintaining his frame, i.e. the arm and torso position which is essential to partnered dance.

### *Testing protocol*

Videotaped assessments of KV were conducted the week before initiation of training (pre-testing), within the week following completion of 20 sessions (post-testing) and again four weeks after post-testing (follow-up). KV self-determined an optimal performance time in the morning for pre-testing and was tested at the same time of day for post-testing and follow-up. Data files were coded for blinded ratings, which were completed by a physical therapy student otherwise not involved in the study. KV was evaluated with the UPDRS-III [18], and his blood pressure and resting heart rate measurements were taken. With a standardized script including specific instructions for each task, KV was assessed on the Berg Balance Scale (BBS) [19], the Functional Reach test [20] and the six minute walk test (6MWT) [21], which he completed with walker assistance. KV also completed the Activities Balance Confidence scale [22] and the Parkinson Disease Questionnaire-39 items (PDQ 39), a disease-specific measure of subjective health status [23]. The PDQ-39 produces a profile indicating PD impact in eight areas of health status and is deemed appropriate to test health related quality of life hypotheses given its extensive usage, and adequate clinimetric properties [24]. Furthermore, the PDQ-39 has effectively revealed improvements in quality of life as the result of physical activity interventions [25]. We were specifically interested in the PDQ-39 Summary Index (PDQ-39 SI), which indicates the global impact of PD on health status, and has been found to be internally reliable and valid [26]. Post-intervention testing also included an exit questionnaire completed by KV to assess program experience, asking him to rank items on a scale of 1-5 (1 = strongly agree, 2 = somewhat agree, 3 = neither agree nor disagree, 4 = somewhat disagree, 5 = strongly disagree). Item 1 asked if he enjoyed participating. Items 2 through 7 asked if he noted improvement in various aspects of physical well-being. Item 8 asked if he would continue with classes if possible. We also asked KV's caregiver to complete the short version of the Zarit Burden Interview (ZBI) at pre-, post- and follow-up testing. The ZBI short version consists of 12 items that characterize the level of burden caregivers face while providing care. Higher scores on the questionnaire indicate greater burden. The ZBI aims to measure change over time as a result of the progression of the care recipient's condition, or from interventions that aim to reduce burden. [27].

## *Results*

Pre-, post-, and follow-up measures are summarized in Table 1. KV improved on nearly all measures, with many of the gains retained at follow-up one month after completing the intervention.

[Insert table 1 about here]

### *Exit questionnaire & caregiver burden*

KV's responses on the exit questionnaire as seen in Table 2 demonstrated that he enjoyed the classes, would continue if possible, and noticed moderate improvement in several aspects of well-being, including walking, coordination and balance.

[Insert Table 2 about here]

In addition to these answers, KV completed open-ended questions about his experience. He commented that he appreciated the routine schedule and regularity of the program and the fact that it was exercise done in a group. He wished the classes could have continued beyond the 10-week period, and would have appreciated more one-on-one time with the teacher. He also commented that he was “especially pleased to stand on my own two feet for a short period and actually dance a step”. His caregiver also indicated that she enjoyed participating in dancing, was happy that KV enjoyed the classes, and she would be interested in continuing to participate. However, caregiver burden as assessed by the Zarit Burden Interview went from 25 at pre-testing to 32 at post-testing and 35 at follow-up, indicating that KV's caregiver experienced increasingly greater burden with time.

## **Discussion**

After 10 weeks of one-hour partnered dance lessons twice per week, a participant with severe H&Y stage V PD improved in measures of balance, balance confidence and quality of life.



Many of the gains were maintained at follow-up one month after completing the intervention. This is the first study to demonstrate the feasibility and potential benefits of dance for an individual with advanced, severe PD.

As KV was not in the habit of regular dance class participation, and his endurance may have been in question, we were interested in the effects of the program on his heart rate and blood pressure. KV experienced a small decrease in resting heart rate from pre to post, which was maintained at follow-up. His blood pressure was stable throughout. In previous work on tango in PD, we noticed an average change of 8 % on the Berg, 16% on the 6MWT and 4% on the PDQ 39-SI from pre to post [15] whereas KV experienced a 131% change on the Berg, a 59% change on the 6MWT, and a 14% change on the PDQ 39 summary index. Likely these changes are a result of KV having much more to gain given his severe impairment, whereas the participants in the former study suffered mild-moderate PD, but this does not diminish these encouraging results. It is noteworthy that KV maintained many of his gains at follow-up. Maintenance of gains is in keeping with results from a separate study examining the effects of an identical partnered tango-based program in a group with mild-moderate PD, where a group of participants demonstrated similar maintenance of gains at a one-month follow-up [28]. Composed of small step elements, tango involves frequent movement initiation and cessation, a range of speeds, rhythmic variation and spontaneous multi-directional perturbations. Participants must focus on step placement, trunk control and stepping strategies, whole body coordination, somatosensory awareness, and attention to partner, path of movement, other dancers and aesthetic qualities of movement. There are also auditory and visual cues provided in tango that may facilitate movement, and prior research has supported the helpful effects of visual and auditory cues for enhancing mobility in individuals with PD [29]. All these characteristics may target PD-related movement impairments, such as bradykinesia and postural instability, and possibly others that were not measured in this study, i.e., multi-tasking, and stride length regulation. At follow-up KV also demonstrated small continued improvements in 6MWT, functional reach and PDQ-39 SI. These improvements may stem from an increased confidence and enhanced motor control engendered from participation in the classes, which carried over into

his daily activities, leading to a more active lifestyle and additional functional improvement one month after the cessation of classes. More research is necessary to examine the effects of such a dance program on the activities of daily living in individuals with severe PD.

The improvement in quality of life, as noted on the PDQ-39 SI, could be especially important to an individual in late stages of PD. Psychological adjustment to the effects of Parkinson disease had a greater effect than disease severity on several aspects of quality of life [30]. Relationship-related goals with partner and family appear to be of utmost importance to those with PD and activities that foster achievable life goals and prevention of life goal derailment are imperative for their mood function and quality of life [31]. The continued improvement noted at follow-up on the PDQ-39 could represent a lasting effect on psychological well-being that was promoted by participation in the program. Previous work has shown that tango improves quality of life not just through gains in mobility but also through enhanced social support [16].

The effects of the dance program had an obviously positive and lasting effect on KV's mobility, balance and quality of life. This result is tempered by the fact that his caregiver's burden may have been exacerbated by the additional stress and responsibility of having to ensure that KV got to classes regularly. As reflected by her responses on the Zarit Burden Interview questionnaire, this was not an easy task, given KV's immobility and his caregiver's need to travel a substantial distance from her home to bring KV to the classes. However, as the caregiver's scores remained high at follow-up, there may have been extenuating factors unrelated to the project, and unknown to the authors that negatively affected the caregiver's perception of burden.

#### *Study limitations and conclusions*

In conclusion, 20 lessons of tango benefited an individual in an advanced stage of PD. KV expressed enjoyment, satisfaction with improved physical well-being and interest in continuing dance classes. A clear limitation of this work is that it describes only a single participant. However, these results suggest that individuals with advanced PD and severely impaired mobility may be able to benefit from participation in a dance class. Because dance interests and engages older individuals, it could be effective and enjoyable over the long-term for individuals with PD.

This is critical, as 60% of American seniors do not engage in the recommended daily amount of physical activity [32] and activity levels in individuals with PD are 15% lower than those of age-matched controls [33]. Future work with larger samples of individuals with advanced PD and longer-term interventions is warranted.

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### ***Declaration of Interest***

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1. Pre-, post- and follow-up measures

<b>Measure</b>	<b>Pre</b>	<b>Post</b>	<b>Follow up</b>
Resting Heart Rate (beats/minute)	76	68	64
Blood Pressure (mmHg)	110/64	110/70	104/60
6 Minute Walk Test (m)	13.4	21.3	26.8
Activities-specific Balance Confidence scale	0	23.8	13.1
Functional Reach (cm)	0	2	11
Berg Balance Scale	8	18.5	16.5
Parkinson Disease Questionnaire 39 Summary Index	55.7	47.8	20.5

Higher scores on the ABC and Berg Balance Scale indicate greater activities-specific balance confidence and better balance function, respectively. Lower scores on the PDQ-39 SI indicate less impact of disease on quality of life.

Table 2: Exit Questionnaire

Item Number	Aspects of Well-Being	KV's responses
1	Enjoyment	1.0
2	Balance	2.0
3	Walking	2.0
4	Mood	2.0
5	Coordination	2.0
6	Strength	2.0
7	Endurance	2.0
8	Continuing	1.0

Values are medians and interquartiles for Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Item 1 asked if participants enjoyed participating, items 2 through 7 asked if participant noted improvement in that aspect of physical well-being. Item 8 asked if they would continue to participate if possible.