Am J Dance Ther (2014) 36:160–175
DOI 10.1007/s10465-014-9181-6

Examining Dance as an Intervention in Parkinson's Disease: A Systematic Review

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Published online: 4 November 2014

Abstract Recently, dance has become a therapeutic and rehabilitative intervention for individuals with Parkinson's disease (PD). Compared with traditional gait training or other rehabilitative interventions, dance appears to be a safe, fun, and an alternative way to achieve functional changes and improvements in mobility, gait, balance, and quality of life. This paper reviews literature regarding dance and PD in terms of enrollment size, dosage and frequency of intervention, class size, comparison or control groups, outcome measures, and effect size. A search was conducted on PubMed, Web of Sciences, Cochrane Library, and Google Scholar using the terms "dance" and "Parkinson's disease." Ten papers were included in this review: seven of which examined walking speed, nine that included measures of balance, one study that examined upper extremity function, eight studies that measured disability rating, and one study that examined falls. Only five studies had control groups, three of which were active control groups. Various studies have clinical design issues such as inclusion of a control group, outcome measures or the way in which the intervention was administered. Essential outcome measures to include are safety, tolerability, quality of life, and falls. These measures determine information on treatment effects, adverse event rates, and dropout rates.

Keywords Parkinson's disease · Dance · Rehabilitation · Exercise · Quality of life · Review

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Introduction

Over the past decade, dance has emerged as a potential intervention for those struggling with various health conditions including neurological disorders such as Parkinson's disease (PD). Among the various patient populations, dance for PD has grown to be of particular interest. There are various community dance programs, such as Mark Morris (Brooklyn, NY, http://markmorrisdancegroup.org/), a non-profit dance group that started a dance program for PD, but the body of literature supporting dance as a therapeutic intervention has been small and merits examination.

The use of dance as a therapy has a long history. The earliest use of dance/movement therapy (DMT), as developed by Marian Chace, was provided as an alternative to speech language therapies with severely disturbed patients (Chaiklin, 1975). Unlike music or speech therapy, dance has elements of representation and imitation, suggesting that dance may have served as an early form of language (Brown & Parsons, 2008). Dance is associated with group rituals (Farnell, 1999; Sachs, 1937) and may be as old as the human capacities for bipedal walking and running, which date back 2–5 million years ago (Bramble & Lieberman, 2004; Ward, 2002). Dance is a fundamental form of individual and group human expression. On an individual level, dance organizes body movements into a sequence of spatial patterns that forms a trajectory map of the body in exocentric space (Longstaff, 2000) and a kinesthetic and visual map of the body schema in egocentric space (Haggard & Wolpert, 2005). As a synchronized group practice, dance demands an interpersonal coordination in space and time. Due to the intricacies of movements coordinated over space and time that dance has to offer, it has been an interesting topic of exploration.

A developing area of exploration is DMT with individuals with neurological diseases, especially the use of dance for specific neurological and mobility improvement. Dance has demonstrated success as a rehabilitative method used in a variety of neurological disorders including traumatic brain injury, spinal cord injury, stroke, autism, and sensory loss (Berrol, 1990; Wise, 1981). While most studies have been exploratory in nature, there is data to suggest the use of dance as a novel and perhaps more socially engaging alternative to conventional physical therapy and gait training. Improvements in mobility, motor learning, balance, spatial integration, and executive functioning have been documented in various populations (Stevens & McKechnie, 2005).

Therefore, the purpose of this article is to review the current evidence of dance in the PD population and to critically examine the data available supporting dance as an intervention. This article reviews all of the studies in terms of enrollment size, dosage and frequency of intervention, class size, comparison or control groups, outcome measures, and effect size.

Method

A computerized search of PubMed, Web of Sciences, Cochrane Library, and Google Scholar was performed using the search term *dance* in combination with *Parkinson's disease*. Combination words with dance were included such as *dance* *therapy* and *dance movement*. This search yielded 20 articles, which were further screened. Articles were not included in the final selection if they were review papers or if they contained a mixed population (e.g., traumatic brain injury, stroke, and PD). The earliest paper describing the use of dance in a segregated population based on disease type (PD) dated to 1989 (Westbrook & McKibben). Since 1989 until October 2013, there have been 10 articles concerning dance and Parkinson's disease.

Included in this review were studies on adult (+18 years) persons with Parkinson's disease. Subjects with Parkinson's diagnosis were included, regardless of the disease type, grade, or duration. Types of dance included modern dance, Argentine tango, ballroom tango, general American ballroom, improvisation, and dance/movement therapy.

Ultimately, ten articles (Table 1) were included in this systematic review (Batson, 2010; Duncan & Earhart, 2012; Hackney & Earhart, 2009a, 2009b, 2010; Hackney, Kantorovich, & Earhart, 2007; Hackney, Kantorovich, Levin, & Earhart, 2007; Heiberger et al., 2011; Marchant, Sylvester, & Earhart, 2010; Westbrook & McKibben, 1989). Out of the ten studies chosen, three studies (30 %) were true experimental randomized controlled trials (Duncan & Earhart, 2012; Hackney & Earhart, 2009a; Hackney et al., 2007). Out of the ten studies, three (30 %) were randomized to comparison groups (Hackney & Earhart, 2010; Hackney et al., 2007; Marchant et al., 2010). Out of the ten studies, two studies (20 %) had an active control group (Hackney et al., 2007a; Hackney et al., 2007b). Two out of the total number of studies (20 %) had a usual care or no intervention comparison group (Duncan & Earhart, 2012; Hackney & Earhart, 2009a), and one had a crossover design study (Westbrook & McKibben, 1989). Four studies (40 %) did not have a comparison or a control group (Batson, 2010; Hackney & Earhart, 2010; Heiberger et al., 2011; Marchant et al., 2010).

Reported effect sizes were extracted and used in this analysis and unreported effect sizes were calculated (Table 2). The effect sizes were calculated by comparing pre- and post-test performance means. On an individual level (each participant), there were differences at baseline; however, the effect size was not calculated with baseline differences in mind. The reason that baseline differences were not taken into account was because some papers did not have t-values or the standard deviations of the difference scores for the individuals. Therefore, the calculations have been standardized across all papers and include only the pre-post changes.

Results

A total of 295 persons with PD participated in the different studies (patients characteristics such as gender and Unified Parkinson's Disease Rating Scale [UPDRS] score were reported). In total, 44 PD dropouts were described (15 % dropout rate). Some of the reasons for dropout included weather issues, medical complications, family issues, and transportation issues. The relatively larger studies were selected for more in-depth description to provide better insight into specific

Table 1 Clinical design of studies

Author	Dance intervention	N	Control group	Active control	Random-ization	Blinded	Design	Minimal clinically important difference	Power	Safety outcome	Intention to treat
Batson (2010)	Modern dance	11	No	No	No	Yes	Pre-post longitudinal	No	No	No	No
Duncan and Earhart (2012)	Argentine tango	52	Yes	No	Yes	Yes	Pre-post longitudinal	Yes	Yes	No	Yes
Hackney, Kantorovich, and Earhart (2007)	Argentine Tango	38	Yes	Yes	Yes	Yes	Pre-post longitudinal	No	No	No	No
Hackney, Kantorovich, Levin, and Earhart (2007)	Argentine Tango	19	Yes	Yes	Yes	Yes	Pre-post longitudinal	No	No	No	No
Hackney and Earhart (2009a)	Argentine Tango & Waltz/Foxtrot	58	Yes	No	Yes	No	Pre-post longitudinal	Yes	No	No	No
Hackney and Earhart (2009b)	Argentine Tango	14	No	No	No	No	Pre-post longitudinal	No	No	No	No
Hackney and Earhart (2010)	Argentine Tango (Partnered vs. Unpartnered)	39	No	No	Yes	Yes	Pre-post longitudinal	No	Yes	No	No
Heiberger et al. (2011)	"Dance for PD Class"	11	No	No	No	Yes	Pre-post longitudinal	No	No	No	No
Marchant et al. (2010)	Contact Improvisation (Partnered Modern)	11	No	No	No	No	Pre-post longitudinal	No	No	No	No
Westbrook and McKibben (1989)	Dance/Movement Therapy & Exercise	42	Yes	Yes	No	No	Crossover	No	No	No	No

methodological design. The four studies were selected for in-depth analysis because they had a sample size larger than $n = 30$.

Randomized Controlled Trial of Community-Based Dancing to Modify Disease Progression in Parkinson's Disease (Duncan & Earhart, 2012)

This study examined the effect of an Argentine tango intervention in PD participants. A large number of participants were screened ($n = 123$) and 50 % were excluded from the study with only 62 individuals ultimately participating. Reasons why 50 % of participants screened out of the study initially included unwillingness to skip medications for evaluations, failure to meet inclusion/exclusion criteria, and transportation difficulties. This study not only had a 50 % screen out rate but had a 50 % overall attrition rate in the tango group over 12 months. The attrition rate at 3 months was 18 %, and at 6 months of the study the attrition rate was 37 %. Reasons PD participants dropped out throughout the course of the study included: three because the intervention was "too much to handle," nine due to unrelated medical issues, one due to a scheduling conflict, one stopped attending, one had Deep Brain Stimulation surgery, and one left the country (p. 135).

Participants danced two times per week for 1 hour each session over the course of 12 months. A no intervention control group existed. Follow-up visits occurred during 3, 6, and 12 months. Outcome measures assessed disability (Movement Disorder Society-Unified Parkinson's Disease Rating Scale-3 [MDS-UPDRS-3]), balance (Mini Balance Evaluation Systems Test [Mini-BESTest]), gait (Freezing of Gait Questionnaire [FOG-Q], 6 min walk test [6MWT], GAITRite walking tests: comfortable forward, maximal speed, dual task, backward walking), and upper extremity function (9-Hole Peg Test [9HPT]). Statistical significance was reached in the outcomes of MDS-UPDRS-3, Mini-BESTest, walking velocity, and 9HPT.

Strength of this study was that it was the first study that reported changes in motor symptom severity during a long-term exercise intervention with participants assessed off medication. Other interesting findings were that this was the only study out of the ten reviewed that had an upper extremity outcome measure *and* they found it statistically significant. The researchers hypothesized that although Argentine tango does not target upper extremity directly, there may be an indirect effect that decreases overall bradykinesia.

Some crucial limitations of the study included that the participants were only tested off medication, which limited the data set. Also, the control group was a no intervention group, and there was no control for attention or socialization. The investigators stated that Argentine tango was the intervention. However, they did not explicitly state the rate at which the participants learned the steps or which steps were specifically learned during the class. Therefore, the protocol is virtually irreproducible. Additionally, dance performance was not evaluated, so mastery of the steps was not assessed.

A key limitation in outcome measures and data collection was that three of the participants dropped out of the study because they found the intervention to be "too much to handle" (p. 135). This is an interpretive statement that does not fully

Table 2 Effect size calculations

Article	Outcome measure	Effect size
Batson (2010)[a]	Fullerton Advanced Balance Scale	1.12*
	TUG	.26
Duncan and Earhart (2012)	MDS UPDRS-3	−1.07
	Mini-BESTest	0.77
Hackney, Kantorovich, and Earhart (2007)[b]	Philadelphia Geriatric Center Morale	−0.08*
	Walking velocity	0.17
Hackney, Kantorovich, Levin, and Earhart (2007)[c]	UPDRS	−2.05*
	BBS[d]	1.27*
	Walking velocity	0.17
	Dual-task velocity	0.10
Hackney and Earhart (2009a)[e]	UPDRS	−0.64 *
	BBS	0.84*
	Gait Stance % (FW)	−0.97*
	Gait Stance % (BW)	0.11
	TUG	−0.38
	6MWT	0.36
	Walking velocity (FW)	0.50
	Walking velocity (BW)	0.40
	Functional ambulation profile (FW)	−0.07
	Functional ambulation profile (BW)	0.48
	Step length (FW)	0.0
	Step length (BW)	0.67
	Swing % (FW)	0.88
	Swing % (BW)	−0.11
Hackney and Earhart (2009b)	UPDRS	0.19
	BBS	0.92*
	TUG	0.45
	6MWT	0.63*
	FOG-Q	0.18
	Gait Velocity (FW)	0.35
	Gait Velocity (BW)	0.33
	Stride length (FW)	0.36
	Stride Length (BW)	0.57*
	Single Support time (FW)	0.21
	Single Support time (BW)	0.41
Hackney and Earhart (2010)	Berg Balance Scale (partnered)	0.42*
	Berg Balance Scale (unpartnered)	0.62*
	Tandem (partnered)	0.40*
	Tandem (unpartnered)	0.40*
	1-Leg (partnered)	0.66*
	1-Leg (unpartnered)	0.13*
	TUG (partnered)	−0.044
	TUG (unpartnered)	0.03
	Cadence (partnered)	0.40*
	Cadence (unpartnered)	0.33*

Table 2 continued

Article	Outcome measure	Effect size
	Fast cadence (partnered)	0.31*
	Fast cadence (unpartnered)	0.49*
	Swing % (partnered)	0.08
	Swing % (unpartnered)	0.15
	Fast swing % (partnered)	0.59*
	Fast swing % (unpartnered)	1.17*
	Double support % (partnered)	−0.08
	Double support % (unpartnered)	−0.18
	Fast double support (partnered)	0.00 *
	Fast double support (unpartnered)	−0.078*
	Stride length (partnered)	0.04
	Stride length (unpartnered)	0.10
	Fast stride length (partnered)	0.03
	Fast stride length (unpartnered)	0.24
Heiberger et al. (2011)	UPDRS	−0.77*
	TUG	−0.35
	Semitandem Test	−0.33
Marchant et al. (2010)[f]	UPDRS	0.63*
	BBS	0.83*
	6MWT	0.35
	TUG	0.38
	Gait velocity (FW)	0.38
	Fast gait velocity (FW)	0.22
	Gait velocity (BW)	0.70
	Step length (FW)	0.13
	Fast step length (FW)	0.15
	Step length (BW)	0.42
	Cadence (FW)	0.40
	Fast cadence (FW)	0.12
	Cadence (BW)	0.66
	Stance % (FW)	0.48*
	Fast stance % (FW)	0.33
	Stance % (BW)	0.14
	Swing % (FW)	0.49*
	Fast swing % (FW)	0.33
	Swing % (BW)	0.05

[a] Effect sizes were calculated using repeated measures formula

[b, c] Walking velocity was calculated using an independent *t* test formula

[d] BBS effect size reported in Hackney et al. (2007) study is different than when calculated according to independent t-test

[e, f] Tango was used for effect size calculations

* Statistically significant values. Designation of value for significance was according to what was defined within each paper. All effect sizes were calculated using Cohen's d

describe the reasons that they exited the study. A drop-out survey or exit survey could have provided additional information to determine the safety, tolerability, and intensity/difficulty of the intervention. Feedback from participants could have provided ways to adapt the administration of the intervention. Furthermore, outcome measures such as quality of life, social participation, and physical activity were not assessed throughout the study, which could have provided additional background information.

Effects of Dance on Movement Control in Parkinson's Disease: A Comparison of Argentine Tango and American Ballroom (Hackney & Earhart, 2009a, b)

This study examined the effects of a comparison between Argentine tango and American ballroom in PD participants. This study enrolled 58 individuals with mild-moderate PD, and 10 individuals dropped-out (17 % dropout rate). One participant dropped out after personal problems, one reported knee pain, three had transportation/travel issues, one had medical treatment during the intervention, and one had an injury at home. Participants were randomly assigned to the waltz/foxtrot, tango, or the no intervention control group. Dance classes were 1 hour each twice per week for 20 lessons that occurred within 13 weeks. Outcome measures assessed disability (UPDRS and FOG-Q), balance (Berg Balance Scale [BBS] and timed up and go [TUG]), gait (6MWT, forward and backward gait on GAITRite), and an exit questionnaire assessed experience and enjoyment of the dance program. Significance through statistical analysis demonstrated that the tango and the waltz/foxtrot groups had significant changes on BBS, 6MWT, and backward stride lengths when compared to those of the control.

Strength of this study included the exit questionnaire outcome assessment. The exit questionnaire asked participants 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 agree*). Item 1 in the questionnaire discussed enjoyment in participation, Items 2–7 addressed physical well-being, and Item 8 asked about long term continuation in dance classes if the opportunity would be provided. Results stated that all groups reported enjoying the classes and noted improvements, and many indicated that they would continue participating if possible. This study also had relatively good compliance with 20 % of participants dropping out.

However, there were some limitations to this study. The first notable limitation was a combined waltz/foxtrot group. Waltz and foxtrot are distinct dance forms with different steps, combinations, tempos, and dance positions. What was the ratio of waltz compared to foxtrot during the classes? Throughout the article, we do not know what steps were taught in terms of the tango, foxtrot, or waltz protocols. This makes it irreproducible to other dance instructors. In addition, changing roles in terms of leaders and followers throughout a class could have provided added difficulty to PD participants who already had cognitive deficits and difficulty ambulating.

Other limitations of the study were the small sample size and the fact that the data did not include information about the transfer of the dance class effects to activities of daily living. Furthermore, most individuals indicated in the exit questionnaire that they would like to continue participating if possible. How did the authors address translating these results to a longer study or to the community? Lastly, there were no follow-up visits, so it is unclear the effective long term carry-over results of the intervention.

Effects of Dance on Gait and Balance in Parkinson's Disease: A Comparison of Partnered and Nonpartnered Dance Movement (Hackney & Earhart, 2010)

This study examined the effects of partnered vs. nonpartnered Argentine tango on PD participants. One hundred participants were assessed for eligibility, but 39 ended up participating (61 % screen-out rating). Reasons for screen failures included that they lacked a desire to participate ($n = 31$) and had transportation issues ($n = 30$). Out of the 39 that were randomized to either partnered or nonpartnered groups, 12 individuals dropped-out during enrollment. Reasons for drop out included one individual that had progressive decline in mental status, two individuals had excessive traveling, one individual felt that the classes were too fatiguing, one individual lacked interest, one individual started a new job, one individual had unrelated medical problems, one individual had scheduling problems, and four individuals were unable to return for follow-up measures. Participants danced for 1 hour twice a week for 20 lessons within 13 weeks. Outcome measures assessed disability (UPDRS), balance (BBS, tandem stance, 1-leg stance, TUG), gait (6MWT, comfortable and maximal speed on GAITRite), and an exit questionnaire was used to assess overall program experience and satisfaction. Statistical significance included improved BBS scores, comfortable walking velocity, maximal velocity, 1-leg stance, tandem stance, cadence, and double support percentage. The 6MWT reached significance at follow-up. None of the participants took dance classes during the post testing and follow-up.

Strength of this study was that 80 % of those originally recruited completed the intervention. This was also the first study to demonstrate maintenance of gait and balance in persons with PD beyond the week immediately after completing a rehabilitative program. The exit questionnaire was a useful and important tool in determining study drop out reasons.

The major limitation to this study was the fact that the leader and follower roles were both danced and participants in the study switched back and forth. There are inherent differences between these roles within dance, which could have prompted confusion within this study when participants were switching. Leaders generate movement internally to determine step length, single support time, velocity, timing, and partner unit trajectories. Followers respond to leader's external cuing. Proper following involves focus on simpler concepts of direction, rotation, distance, and speed, which allows the follower to respond to the smallest movements of the leaders by reacting to multidirectional perturbations from moment to moment. Individuals with PD may already have cognitive problems, and role reversal in partnered dance may add an increased difficulty.

Furthermore, individuals with PD were also tested only on medication that limited the data size, and there were not controls for the medication treatment effects. Also, no tolerability, safety, or quality of life outcomes were included.

However, one participant dropped out for fatigue issues. Was there a fatigue outcome questionnaire? Did other participants express fatigue? Such information is important in order to evaluate how the intervention must be adapted for implementation.

Dance/Movement Therapy with Groups of Outpatients with Parkinson's Disease (Westbrook & McKibben, 1989)

This cross-over study examined the effects of a 6 week DMT session with a 6 week exercise intervention on PD participants. Out of the 42 participants who consented, five patients did not participate regularly and were excluded from the analysis (12 % exclusion/drop-out rate). Participants danced for 6 weeks for 1 hour sessions and then participated in an exercise group for 6 weeks for 1 hour sessions. The article does not specify the dosage per week. Outcome measures assessed disability (UPDRS, Hoehn & Yahr's method and Archimedes spiral) and mood (Beck Depression Inventory). Statistical significance showed a difference in "walking times" as measured by the disability rating scale.

This study had a decent sample size, but lacked a lot of information. Given the year that this article was published (1989), this could be the reason. First, the DMT protocol and exercise protocols are not well described. For example, were the DMT sessions seated? The authors stated that family members could watch and participate; did they? How did this affect adherence? In addition, the number of minutes per week of the intervention or the dosage is not stated. These two items make it difficult for future studies to replicate. Outcome measures did not address gait, balance, tolerability, safety, or quality of life. The Beck Depression Inventory did not yield statistically significant results, and the authors did not describe why they predicted that it would. The authors also did not indicate if the assessments occurred on or off medication. This could affect the outcome measures.

The authors stated that movement initiation (essential to PD) can be a sensitive indicator of movement and impairment. The authors found statistically significant improvements in the speed of walking during the dance group. However, since this study was completed in 1989, and the timed 32 ft walk was used, it is unclear whether this test was a reliable and accurate measure of walking initiation (Table 1).

Outcome Assessment Review

Gait

Seven studies included measured walking speeds: five studies used the 6MWT (Duncan & Earhart, 2012; Hackney & Earhart, 2009a, 2009b, 2010; Marchant et al., 2010), one used a 32 ft walk (Westbrook & McKibben, 1989), and one used motion to measure gait velocity (Hackney et al., 2007). Of the seven studies that included measures of walking speed, only one reported a significant improvement in at least one outcome of walking speed (Hackney & Earhart, 2009a).

Balance

Nine studies included measures of balance: six studies used the TUG test (Batson, 2010; Hackney & Earhart, 2009a, 2009b; Hackney et al., 2007; Heiberger et al., 2011; Marchant et al., 2010), five studies used the BBS (Hackney & Earhart, 2009a, 2009b, 2010; Hackney et al., 2007; Marchant et al., 2010), one study used the Fullerton Advanced Balance Scale (Batson, 2010), one study used the Mini-BESTest (Duncan & Earhart, 2012), two studies used a tandem test (Hackney & Earhart, 2010; Heiberger et al., 2011), two studies used the Activities-specific Balance Confidence (ABC) Scale (Hackney et al., 2007; Marchant et al., 2010), two studies used the 1-leg stand (Hackney & Earhart, 2010; Hackney et al., 2007), and one study used the sit-to-stand test (Marchant et al., 2010). Of the nine studies that included measures of balance, seven reported significant increases in at least one balance outcome (Batson, 2010; Hackney & Earhart, 2009a, 2009b, 2010; Hackney et al., 2007; Hackney et al., 2007; Marchant et al., 2010).

Upper Extremity Function

One study measured upper extremity function using the 9HPT. The study yielded statistically significant results (Duncan & Earhart, 2012).

Disability Rating

Eight studies included measures of disability and used the UPDRS or neurological assessment (Duncan & Earhart, 2012; Hackney & Earhart, 2009a, 2009b, 2010; Hackney et al., 2007; Heiberger et al., 2011; Marchant et al., 2010; Westbrook & McKibben, 1989). Four studies used the FOG-Q (Duncan & Earhart, 2012; Hackney & Earhart, 2009a; Hackney et al., 2007; Marchant et al., 2010). One study used the 39 Item-Parkinson's Disease Questionnaire (PDQ-39) (Marchant et al., 2010). Of the eight studies that included measures of disability, three studies reported significant results in at least one outcome measure of disability (Hackney & Earhart, 2009b; Heiberger et al., 2011; Marchant et al., 2010).

Falls

Out of the ten studies, only one study measured falls using the Modified Falls Efficacy Scale (Hackney et al., 2007). This outcome measure was found to be statistically significant in the PD Argentine tango group.

Quality of Life

Three studies measured quality of life with one using the Philadelphia Geriatric Center Morale Scale (Hackney et al., 2007), one using the Beck Depression Inventory (Westbrook & McKibben, 1989), and one using the Oregon Health and Sciences Quality of Life Questionnaire (Heiberger et al., 2011). The Beck Depression Inventory was not found to be statistically significant. The Philadelphia

Geriatric Center Morale Scale demonstrated that individuals with PD had lower morale than controls at the outset of the study (mean values: Controls = 14.94 [1.68], PD = 11.37 [2.79]). Upon completion of the study there was little overall change between controls and individuals with PD (mean values: Controls = 14.42 [1.90], PD = 11.11 [3.71]).

Drop-Out/Exit Survey

Three studies measured the reasons that individuals dropped out or exited the study (Hackney et al., 2007; Hackney & Earhart, 2009a, 2010). The exit questionnaire asked 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 agree*). Item 1 discussed enjoyment in participation, Items 2-7 addressed physical well-being, and Item 8 asked about long term continuation in dance classes if the opportunity would be provided. Results stated that all groups reported enjoying the classes and noted improvements and many indicated that they would continue participating if possible.

Safety and Tolerability

No study examined safety or tolerability as an outcome measure. However, a number of studies had participants drop out of the study because they had fatigue or found the intervention too difficult (Duncan & Earhart, 2012; Hackney & Earhart, 2010) (Table 3).

Discussion

Through this review paper, we have identified essential components for intervention studies on dance for Parkinson's disease. Study design should include an active randomized controlled group, a blinded evaluator, power analysis, minimally important difference, and intention-to-treat analysis. It has been identified that there are important outcome measures to assess the full effects of a dance intervention on Parkinson's disease. The essential outcome measures need to target the following areas: disability, gait, balance, upper extremity function, falls, quality of life, tolerability/safety, and include a drop-out/exit survey. In addition, because dance can affect mood and mental health, systematically collecting psychological outcome measures to assess mood, cognitive ability, emotional functioning, and personality is worth exploring, especially when examining dance in individuals with neurological disease with and without cognitive manifestations.

Dance is a fun form of exercise and physical activity with a relatively high retention rate and adherence, with only a 15 % drop-out rate. It is based on a set of structured steps and involves mental rehearsal and external cueing, both of which may aid in improving functional mobility. Throughout dancing, balance must be dynamically controlled forward, backwards, and laterally, and one must respond to perturbations within the environment (Earhart, 2009). Functional improvements in

Table 3 Outcome Measures Collected During Each Study

Author	Disability	Gait	Balance	Upper extremity	Falls	Quality of life	Drop out survey	Safety/ Tolerability
Batson (2010)	No	No	TUG, Fullerton	No	No	No	No	No
Duncan and Earhart (2012)	UPDRS, FOG-Q	6MWT	Mini-BESTest	9HPT	No	No	No	No
Hackney, Kantorovich, and Earhart (2007)	No	No	1-Leg Stance, Functional Reach Test, ABC	No	Modified Falls Efficacy Scale	Philadelphia Geriatric Center Morale	Yes	No
Hackney, Kantorovich, Levin and Earhart (2007)	UPDRS, FOG-Q	Gait Velocity	BBS, TUG	No	No	No	No	No
Hackney and Earhart (2009a)	UPDRS	6MWT	BBS, TUG	No	No	No	No	No
Hackney and Earhart (2009b)	UPDRS, FOG-Q	6MWT	BBS, TUG	No	No	No	Yes	No
Hackney and Earhart (2010)	UPDRS	6MWT	BBS, TUG, Tandem Stance, 1-Leg Stance	No	No	No	Yes	No
Heiberger et al. (2011)	UPDRS	No	TUG, Semitandem Test	No	No	Oregon Health and Sciences Quality of Life Questionnaire	No	No
Marchant et al. (2010)	UPDRS, FOG-Q, PDQ-39	6MWT	BBS, TUG, Sit-to-Stand, ABC	No	No	No	No	No
Westbrook and McKibben (1989)	Neurological Assessment	32 Ft.	No	No	No	Beck Depression Inventory	No	No

forward and backward walking have been found after only 2 weeks of dance training in the PD population (Hackney & Earhart, 2009b). Backward dance movements give participants the opportunity to practice and become comfortable with movement in that direction, which is relevant to balance, postural control, and falls. It is also speculated that because dance requires a number of neural pathways, particularly those requiring cognitive engagement with motor skill, dance has the potential to improve the coordination of motor patterns with cognitive rehearsal and planning even more so than traditional gait and balance training.

Dance is thought to involve multiple neural networks that involve motor learning, balance, and spatial integration, as well as executive functioning, as it requires the memorization of complex movement sequences through observation, repetition, and transferring of visual and verbal information into motor actions (Stevens & McKechnie, 2005). In a Positron Emission Tomography (PET) study examining neural activity in amateur dancers, a wide variety of structures revealed activation, including areas typically active during motor tasks (bilateral motor, somatosensory, and premotor areas), as well as specific areas unique to dance (parietal lobe, basal ganglia, and cerebellum). Different subsystems were activated during the various types of actions performed, alluding to a coordination of multiple neural pathways. It was also theorized that patterns may change when learning a new dance as a result of reorganization and redistribution of neural processes that, with time, become routine (Sacco et al., 2006). For example, it has been shown that as dancers became more proficient in a specific routine, neural activity increased concurrently with perceived performance ability (Cross, Hamilton, & Grafton, 2006). These results suggest that motor learning over a short period of time may result in measurable cortical changes. Due to the number of neural networks involved in dance, its role as a rehabilitative intervention for PD patients has the potential to improve the coordination of motor patterns and benefit cognitive processes such as memory, planning, and integration of information.

Two recent studies, published after the analysis for this review paper had been drafted, also examined the relationship between dance and PD, further demonstrating the importance of research in this promising area. One study conducted a pilot study of 24 individuals to compare the feasibility, safety, and effectiveness of standard physiotherapy versus Irish step dancing once per week for 6 months on individuals with Parkinson's disease (Volpe, Signorini, Marchetto, Lynch, & Morris, 2013). They found that both options were feasible and safe. The results demonstrated that the dance group had statistically significant results to those of the standard physiotherapy for the UDPRS and in the areas of balance, motor disability, and freezing of gait. There were no differences between groups in relation to the rate of adverse events such as falls and serious injuries. Another study examined the impact of a community-based Argentine tango program on individuals with PD in a 12 month randomized study, with an Argentine tango group and a no intervention control group (Foster, Golden, Duncan, & Earhart, 2013). At the end of the study, the tango group showed higher rates of participation and activity retention as well as greater increases from baseline for these two measures than the control group. The tango group also showed significant gains in new social activities while the control group did not.

This review paper serves to identify important aspects of study design, methodology, and interpretation of results in dance studies for individuals with Parkinson's disease. All of 10 studies reviewed had irreproducible protocols in terms of the dance steps learned and all studies lack specificity, and neither of the newer studies from Volpe et al. (2013) and Foster et al. (2013) described the specific sequences of dance steps for Irish step dance or Argentine tango.

Future studies in this area may wish to include a dance syllabus of the steps, the rate at which the dance steps are learned, and further protocol details. In addition, essential outcomes addressing disability, gait, balance, upper and lower extremity function, falls, quality of life, tolerability/safety, and a drop-out/exit survey should exist to evaluate the full effects of dance for Parkinson's disease.

Acknowledgments The authors wish to acknowledge Yen Jay Tran for his assistance with copyediting and reference management.

Conflict of interest Rosalind Mandelbaum declares no conflicts of interest. Albert Lo declares grants from the VA, National MS Society, and Acorda Therapeutics as well as travel reimbursement from the VA, National MS Society, Acorda Therapeutics and Paralyzed Veterans of America. Both Rosalind Mandelbaum and Albert Lo are government employees.

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