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A Comparison of Dance Interventions in People with Parkinson Disease and Older Adults

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Abstract

It is important for our aging population to remain active, particularly those with chronic diseases, like Parkinson disease (PD), which limit mobility. Recent studies in older adults and people with PD suggest dance interventions provide various motor benefits. The literature for dance in PD is growing, but many knowledge gaps remain, relative to what is known in older adults. The purpose of this review is to: 1) detail results of dance intervention studies in older adults and in PD, 2) describe limitations of dance research in these populations, and 3) identify directions for future study. Generally, a wide variety of dance styles have been investigated in older adults, while a more limited subset has been evaluated in PD. Measures vary widely across studies and a lack of standardized outcomes measures hinders cross-studies comparisons. Compared to the dance literature in older adults, there is a notable absence of evidence in the PD literature in outcome domains related to cardiovascular health, muscle strength, body composition, flexibility, and proprioception. As a whole, the dance literature supports substantial and wide-ranging benefits in

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Competing interests

The authors declare no conflict of interest.

Contributors and Roles

All authors were involved in discussing ideas and planning the manuscript. Marie McNeely drafted the review, and all authors were involved in critically reviewing the draft and approving the final version.

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Marie McNeely: Discussed ideas and planned the manuscript, wrote the initial draft, critically reviewed the draft, approved the final version.

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both populations, but additional effort should be dedicated to well-designed comparative studies using standardized outcome measures to identify optimal treatment programs.

Keywords

Parkinson disease; dance; exercise; physical function; gait; balance

1. Introduction

Approximately 60% of Americans over age 65 do not meet physical activity recommendations [1], and physical activity is particularly reduced in people with Parkinson disease (PD) compared to older adults [2, 3]. PD is a progressive neurological disorder characterized by resting tremor, rigidity, bradykinesia, and postural instability. Gait, balance, and mobility impairments are greater in PD than in older adults, increasing their risk for falls and other health problems.

The United States is currently faced with a large aging population, and there are approximately 1.5 million Americans with PD. It is well-documented that traditional pharmacological and surgical therapies do not adequately address all of the impairments in PD [4]. Exercise has been shown to improve motor impairments in aging populations [5–7], and may be especially important for people with PD due to emerging evidence supporting potential neuroprotective effects [8].

Exercise adherence is a challenge and there are many perceived barriers to exercise in older adults, especially people with PD [9]. Dance is an accessible, appealing, and socially engaging mode of physical activity that provides measurable benefits in older adults [10] and people with PD [11]. Dance may be particularly beneficial in PD because it includes music, which can serve as an external cue to facilitate movement, and task-specific training of difficult movements like turning and backward walking. Dance also challenges dynamic balance and targets strength, flexibility, and endurance [11].

There are several reviews on dance for people with PD or older adults, but previous reviews do not comprehensively synthesize or compare literature across these populations. The goal of this review is to compare the dance intervention literature for older adults and people with PD to identify potential gaps in knowledge and opportunities for future investigation.

2. Selection of Studies

We searched PubMed from inception through November 2014, limiting results to articles in English. The terms searched to identify relevant results for PD were parkinson* and danc* (* denotes wildcard character). Search terms for older adults were (elderly or older or senior) and danc*.

For this review, we included peer-reviewed, controlled research studies from the scientific literature reporting the effects of dance interventions on direct measures of physical function in PD and elderly populations without PD. Studies were not included if they only measured cognition, mood, participation, or quality of life.

Our initial search yielded 218 articles in older adults and 55 in PD. Details on exclusion of studies are included in Table 1. Twenty studies in older adults and seven studies in PD were included.

3. Discussion

3.1. Styles of Dance Investigated

The majority of PD dance research has focused on tango [12–17]. Other dance styles examined to a lesser extent include ballroom [14], and Irish Set [18]. Tango was selected in many of these studies because it targets PD-specific impairments including backward walking, turning, varied speeds, and frequently starting and stopping movements. Other dance styles may also be beneficial in PD and perhaps more accessible or appealing based on location and culture.

In contrast, a wider variety of dance styles have been investigated in older adults. Fewer studies focus on Latin dance, including tango [19] and salsa [20], compared to the PD literature. Researchers have also examined the impacts of traditional and folkloristic dance, including Greek [21], Caribbean [22], and Thai [23] traditional dance, as well as Turkish Folkloristic dance [24]. Aerobic [25–27], ballroom [28–30], line [31], creative [32], contemporary [33, 34], and video game based [35] dance programs have also been evaluated. In addition, previous studies have used dance therapy and adapted dance programs of unspecified style that were modified for seniors, including Agilando [36], The Lebed Method [37], and Senile Fancy Gymnastics [38].

Understanding similarities and differences in the impacts of different dance styles on motor function may be important for informing development of community-based dance programs for seniors and people with PD, and providing guidelines for individuals choosing between exercise programs. Since similar benefits in balance and gait were achieved regardless of whether an individual with PD danced with a partner or alone [13], both partnered and unpartnered dance should be evaluated.

3.2. Participant Characteristics

Six of the twenty research studies in older adults included only women [23–26, 31, 38]. Even in some studies that included men, 80–99% of participants were women [27, 28, 34, 35]. In contrast, in the PD literature 20–49% of participants were female. This may limit the generalizability of findings.

The sample sizes for participants included in analyses for studies in older adults ranged from 24 [37] to 97 participants [27]. In PD, sample sizes tended to be smaller, ranging from 10 [17] to 52 participants [16]. Smaller sample sizes in a heterogeneous disease population may have limited the ability to detect smaller effect size benefits that dancing may confer.

3.3. Duration and Intensity

Most dance studies in PD included relatively short-term interventions of 10–13 weeks [12–15, 39]. Studies on dance in older adults included similar short-term interventions of 10–13 weeks [19, 21, 22, 25–28, 30–32, 38], although some were as short as four [33], six [23, 37]

or eight weeks [20, 24]. A few studies in PD have investigated longer intervention periods of six months [18], twelve months [16], or as long as two years [17]. Longer studies in controls included interventions for four months [34] up to twelve months [31, 38].

It was most common for participants with PD to dance twice per week for 60 minutes [12–14, 16, 17], but schedules of once per week for 90 minutes [18] and twice per week for 90 minutes [15] were also used. More variety in training schedules was present for older adults, though training one to three times per week was most common. Dance sessions ranged in length from as short as 10–15 minutes [35] to as long as 90 minutes [19, 32, 33]. There was also a long-term intensive study where participants danced six times per week for 40 minutes [38].

No studies have been conducted to directly compare the benefits of different durations or intensities of dance training. As a result, there are no clear indications or recommendations for which training schedules are most effective in either population. However, it should be noted that of the 27 studies included, only one study in PD [15] and nine studies in older adults [19, 24–26, 29, 30, 32, 33, 38] met recommended CDC guidelines for older adults of at least 150 minutes of exercise per week [40]. Measurements of activity levels have not been collected during the dance classes, so it is unclear whether these dance interventions meet criteria for moderately intense exercise.

3.4. PD-Specific Motor Outcomes

The majority of dance intervention studies in PD focus on motor outcomes, with six out of seven using the UPDRS-III, the gold standard measure of motor sign severity in PD, as an outcome. Motor sign severity improved similarly in tango dance and exercise controls [12], but improved more in tango compared to no-intervention [14, 16, 17] and education-only controls [15]. Superior improvements in UPDRS-III were also reported with Irish dancing compared to physiotherapy group controls [18]. Freezing of gait, defined as the transient inability to generate stepping, is a particularly debilitating and disease-specific impairment in PD. Tango dance did not improve freezing (Freezing of Gait Questionnaire) in people with PD [12, 15–17], but significant improvements were detected after Irish set dancing, compared to physiotherapy controls [18]. Mixed results could be due to the style of dance employed, and this should be investigated with a direct comparison of tango and Irish set dancing interventions using the same administration parameters.

3.5. Functional Strength, Endurance, and Cardiovascular Health

In people with PD, the five times sit to stand test has been used to evaluate functional strength and muscle endurance in dance studies, and performance improved with Turkish Folkloristic dancing [24]. Five times sit to stand also improved in older adults with tango [19] or Thai dance [23].

Similarly, in older adults, ten or thirty second sit to stand test performance improved in aerobic [25, 27] and ballroom [28] dance participants compared to controls. In contrast, isometric squat time did not increase after aerobic dance [26]. Squat repetitions improved with both line dancing or line dancing plus lower limb exercises [31].

Six minute walk test (6MWT) performance improved in PD after tango [13, 14, 16, 17] or waltz/foxtrot [14], compared to controls. The 6WMT also improved in older adults after Turkish Folkloristic [24], traditional Thai [23], or aerobic dance [27]. Increases in aerobic power were also detected in a two minute step test after ballroom dance [28] and in the half mile walk test after aerobic dance, compared to controls [25]. Conversely, an aerobic dance group did not improve significantly in 3 minute walk test distance compared to controls [26]. Overall, evidence supports enhancements in lower limb functional strength and endurance in people with PD and older adults after various dance interventions. In addition, resting heart rate was reduced after aerobic dancing [27]. In contrast, peak oxygen uptake did not improve after participation in Agilando dance [36]. Metrics of cardiovascular health were not reported in PD.

3.6. Muscle Strength and Power

Outcomes for muscle strength and power after dance were not measured in PD. In older adults, grip strength and muscle power (vertical jump force) did not improve following aerobic [26] and salsa [20] dance, respectively. Strength of hip and knee extensors improved after a fancy gymnastics dance program for 8 and 12 months, but improvements were more pronounced in the Tai Chi group [38]. Conflicting results across studies are likely due to differences in muscles evaluated, dance style, or intervention duration. Investigating whether dance improves strength deficits, which are associated with increased fall risk [20, 26, 41], may be particularly relevant in PD.

3.7. Body Composition

The effects of dance on body composition were not reported in people with PD. In older adults, aerobic dance participants had reduced body fat (sum of skin folds) [25]. There were no changes in lumbar or proximal femur bone mineral density, nor in broadband ultrasound attenuation of the calcaneus (predicts fractures) following line dancing (with or without lower limb exercises) [31]. Calcaneus bone mineral density and lower limb skeletal muscle content improved similarly with fancy gymnastics dance and Tai Chi [38]. The impact of dance on bone characteristics relevant to fracture is unclear in older adults. Examining these metrics in PD may be beneficial since disability and immobilization in this population increase their risk for fractures.

3.8. Balance

The majority of dance studies in PD used clinical balance scales, and improvements in balance after dance interventions are consistently supported in the PD literature (Table 2). In older adults, a much wider array of balance metrics have been used, including clinical balance tests, single item balance tests, and precise measures of static and dynamic balance (Table 2). Discrepancies between the effects of dance on multidirectional reach (did not improve) [37] and forward reach (improved) [26] may be attributed to differences in duration, frequency or sample characteristics between studies.

Despite the variability in metrics and analyses employed, quantitative measures of static balance consistently demonstrated improvements in older adults following dance interventions. It may be informative to investigate more precise, laboratory-based measures

of static postural stability and dynamic postural control in PD to better understand balance improvements detected with clinical balance scales following dance interventions.

In older adults, better balance after dance interventions translated to increased balance confidence (Activities-Specific Balance Confidence scale) [19] and reductions in falls [30]. Falls efficacy and concern for falls were similar between an exercise group and an exercise plus video game dance group [35].

3.9. Functional Mobility

Performance of the standard timed-up-and-go test (TUG) did not change after tango [12–15, 17] or Waltz/Foxtrot [14]. In contrast, Irish set dancing participants had greater reductions in TUG time than physiotherapy controls [18]. Performance of TUG with a dual task improved over time in tango participants, while control performance deteriorated [17].

The traditional TUG also improved in older adults with aerobic [27], ballroom [28], Caribbean [22], and line dancing (with or without additional lower limb exercise) [31]. Older adults also demonstrated greater improvements in performance of modified TUG tests (two cones, different cone placement) after aerobic dance versus controls [25, 26]. Further, ballroom dance improved movement-related functional autonomy, measured by an aggregate index including walking 10 meters, standing up from chair, standing from prone, standing up from chair and moving about the room, and putting on/taking off a shirt [29].

Functional mobility is more uniformly improved in older adults after dance interventions. In PD, basic functional mobility does not seem to improve with most dance interventions. It is possible that characteristics of the Irish step dance style make it particularly suitable for improving functional mobility in PD, but this should be confirmed in a direct comparison study. Also, functional mobility in dual task situations may be selectively improved by practicing multitasking during dance interventions; however, the evidence related to this is limited.

3.10. Gait

Impaired gait is a major cause of disability in PD, and improving gait speed is often a target for therapeutic intervention. Various spatiotemporal parameters of preferred pace, dual task, fast as possible, and backward gait have been examined as outcome measures in dance studies in PD, despite receiving relatively little attention in the older adult literature. The results in PD are mixed across metrics and gait tasks. In particular, some studies in PD report significant improvements in comfortable forward [13, 16] gait speed while others found no difference [12, 14, 17]. The presence of significant improvements does not seem to be related to sample size, dance type, or the intensity or duration of training. Similar inconclusive results were observed in dual task [12, 16] and backward gait [14, 16, 17].

Improvements in preferred pace gait speed, stride time, and stride length in older adults were significantly higher for tango participants compared to controls [19, 20]. However, measures of gait variability including coefficients of variation for stride time, stride length, and stride velocity did not change [20]. Participation in an exercise plus video game dance intervention also improved gait compared to an exercise only control, particularly for dual task

conditions [35]. Gait velocity and other parameters did not change in a small pilot study of dance-based therapy [37]. However, only about half of the participants completed all classes. Including lower attendance participants or limiting the data to high attending participants may have reduced statistical power to detect changes in gait following dance. Related to gait performance, stair climb time also improved in individuals who performed Turkish Folkloristic dance compared to controls [24].

Though numerous dance interventions improve aspects of particular gait tasks, the mechanisms and factors that contribute to who experiences gait improvements are not entirely clear, particularly in PD. It is possible that there are subpopulations in PD whose gait will or will not respond to dance therapy, based on differential disease severity or subtype.

3.11. Flexibility

Reports on flexibility were notably absent in dance interventions in PD. In older adults, sit and reach task performance improved more after ballroom [28] and traditional Thai dance [23]. Mixed results were observed for aerobic dance, with improvements [25] or no changes [27] reported. Certain dance programs may emphasize stretching and flexibility more than others. Including metrics to gauge changes in flexibility in people with PD would be valuable, particularly because increased flexibility may counteract stiffness and rigidity that are commonly experienced.

3.12. Proprioception and Tactile Performance

Dance studies in PD did not include measures of proprioception or tactile performance. One study on creative dance in older adults measured proprioception via arm positioning, knee joint position sense, and knee kinesthesia. Arm movement improved more in dance participants, compared to controls, and knee joint position sense, knee kinesthesia, and arm positioning improved in dance participants after intervention [32]. Measures of tactile performance (two point discrimination, haptic object recognition) also improved with Agilando dance [36]. These studies provide some evidence suggesting dance can improve proprioception in older adults. Potential links between proprioception and fall risk support the value of assessing the impacts of dance on proprioception in PD.

3.13. Upper Extremity Motor Control

Despite the use of all limbs and whole body coordination during dance, relatively little attention has been paid to how dance affects upper extremity function. In PD, upper extremity function (9 Hole Peg Test) improved with tango compared to controls. In older adults, improvements were observed in Agilando dancers but not controls in performance of a similar 25 pin board test, as well as fast, fine motor arm movement in a separate task [36]. Additional measures of upper extremity function should be considered in both PD and older adult populations since dance may induce motor system changes that generalize to the upper limbs.

4. Conclusions

Clinically, there is a substantial need for continued evaluation of alternative therapies that can address issues in aging and PD populations. In reviewing the literature for both people with PD and older adults, there is mounting evidence that a wide variety of dance interventions can improve a multitude of motor functions. However, few studies directly compared the effectiveness of different dance interventions in improving mobility and motor impairments in people with PD [13, 14] and no direct comparisons of different dancing styles have been made in older adults. This is a limitation since differing intervention durations and intensities, as well as different outcome metrics, make comparison across studies challenging. Another limitation is that dance is frequently compared to no intervention. In such paradigms, it is difficult to determine whether benefits observed are due to general physical activity or to unique experiences in dance (e.g. social interaction, coordinated movement to music). Well-designed studies are needed to determine the optimal types and parameters (i.e. frequency, intensity, duration) of dance to address specific motor impairments in aging and PD. It is also important to consider an individual's personal, cultural, and social preferences to promote adherence to the program.

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Abbreviations

PD	Parkinson disease
6MWT	six minute walk test
TUG	timed-up-and-go test

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Highlights

We review the effects of dance on motor function in older adults and people with PD.

Knowledge gaps, limitations, and opportunities for further study are identified.

Fewer dance styles and fewer aspects of motor function have been studied in PD.

Overall, dance provides wide-ranging motor benefits in both populations.

Table 1

Selection of Studies and Exclusions

	Healthy Older Adults (n studies)	People with PD (n studies)
Initial Search Results	218	55
Exclusions		
Review articles	23	13
Not conducted in human participants	2	2
Protocols or focus group descriptions	10	3
Case studies	3	3
Irrelevant article types	8	7
No multi-session dance intervention	80	10
Cross-sectional studies	23	0
Single-group study designs	10	4
Not conducted in older adults	26	0
Participants with specific impairments	9	0
Meta-analysis	0	1
No measures of physical function	3	3
Full text article not available	1	2
Included studies	20	7

Table 2

Summary of Balance Measures Across Studies

Reference	Dance style	Intervention Parameters	Balance Outcomes Measures	Results
Articles in People with PD				
2007 Hackney, et al.	Tango	3 months, 2x per week, 60 min sessions	Berg Balance Scale	Improved in the dance group, but not controls in strength/flexibility exercise classes
2009 Hackney & Earhart	Tango	13 weeks, 2x per week, 60 min sessions	Berg Balance Scale	Similar improvement in both dance groups compared to no intervention controls
	Waltz/Foxtrot			
2010 Hackney & Earhart	Tango (partnered and unpartnered)	10 weeks, 2x per week, 60 min sessions	Berg Balance Scale	Similar improvement in both partnered and unpartnered dance
2012 Duncan & Earhart	Tango	12 months, 2x per week, 60 min sessions	Mini-BESTest	Greater improvement with dance compared to no intervention controls
2013 Volpe, et al.	Irish set dance	6 months, 1x per week, 90 min sessions	Berg Balance Scale	Trend toward greater improvement in dance compared to physiotherapy controls
2014 Duncan & Earhart	Tango	24 months, 2x per week, 60 min sessions	Mini-BESTest	Greater improvement with dance compared to no intervention controls
2014 McKee & Hackney	Tango	10–12 weeks, 2x per week, 90 min sessions	Fullerton Advanced Balance Scale	Improved in dance group, but not controls in education classes
Articles in Healthy Older Adults				
1990 Hopkins, et al.	Aerobic dance	12 weeks, 3x per week, 50 min sessions	One leg stance time - eyes open	Greater improvement in dance than no intervention/wait list controls
2002 Shigematsu, et al.	Aerobic dance	12 weeks, 3x per week, 60 min sessions	One leg stance time - eyes open	No change in dance or no intervention controls
			One leg stance time - eyes closed	Improved in the dance group, but not the no intervention controls
			Forward reach	Improved in the dance group, but not the no intervention controls
2005 Federici, et al.	Carribean dance	3 months, 2x per week 30–60 min sessions	Tinetti test	No change with dance despite decline in no intervention controls
			Romberg test	Greater improvement with dance than no intervention controls
			Improved Romberg test	Greater improvement with dance than no intervention controls
2007 Young, et al.	Line dance (dance only, dance plus squats, dance plus squats and stomps)	12 months, 1x per week, 45 min sessions	One leg stance time - eyes open	Similar improvements in dance or dance plus exercise groups

Reference	Dance style	Intervention Parameters	Balance Outcomes Measures	Results
			Velocity of forward stepping to prevent fall	No change in dance or dance plus exercise groups
			Velocity of Lateral stepping to prevent fall	Similar improvements in dance or dance plus exercise groups
2008 McKinley, et al.	Argentine tango	10 weeks, 2x per week, 90 min sessions	Activities-Specific Balance Confidence	Greater improvement with dance compared to walking group
2009 Eyigor, et al.	Turkish folkloristic	8 weeks, 3x per week, 60 min sessions	Berg Balance Scale	Improved in dance group, but not in no intervention controls
2009 Hui, et al.	Low impact aerobic dance	12 weeks, 2x per week, 50 min sessions	Four test balance scale (one leg, tandem, semitandem, and side by side stance)	No change in dance or no intervention controls
2009 Sofianidis, et al.	Traditional Greek	10 weeks, 2x per week, 40–60 min sessions	Various parameters of postural sway in sharpened (tandem) Romberg	No changes in dance or no intervention controls in any measures
			Various parameters of postural sway and trunk kinematics in one leg stance	Greater improvement in some mediolateral sway measures and trunk roll kinematics with dance than no intervention controls
			Various parameters of trunk kinematics in dynamic weight shifting	Greater increase in the range of sagittal and frontal trunk rotation planes with dance compared to no intervention controls
2011 Ferrufino, et al.	Contemporary dance	4 months, 1x per week, 60 min sessions	Various statistic scores in static postures	No changes in dance or fall prevention control groups
			Various diffusion analysis and recurrence quantification analysis metrics in static postures	Some changes in center of pressure displacements with dance compared to the fall prevention control group
2012 Borges, et al.	Ballroom dance	8 months, 3x per week, 50 min sessions	Changes in the distribution of weight during static stance	Greater improvement with dance than no intervention controls
2012 Granacher, et al.	Salsa dance	8 weeks, 2x per week, 60 min sessions	Various measures of center of pressure displacement during static stances	Trend towards greater reduction in anterior-posterior displacement with dance than no intervention controls
2013 Kattenstroth, et al.	Agilando dance	24 weeks, 1x per week, 60 min sessions	Static and dynamic displacements of center of pressure	Improvements in dynamic limits of stability with dance but not in no intervention controls
2013 Krampe	TLM Dance Therapy	6 weeks, 3x per week, 45 min sessions	Multidirectional Reach Test	No change in either dance or no intervention controls
2014 Borges, et al.	Ballroom dancing	12 weeks, 3x per week, 50 min sessions	Changes in the distribution of weight during static stance	Greater improvement with dance than no intervention controls
2014 Coubard, et al.	Contemporary dance	4 weeks, 3x per week, 90 min sessions	Various signal diffusion analysis, recurrence quantification analysis, and detrended fluctuation analysis metrics in static postures	Some changes in center of pressure displacements with dance compared to no intervention controls

Reference	Dance style	Intervention Parameters	Balance Outcomes Measures	Results
2014 Song, et al.	Senile Fancy Gymnastics audio and video products	12 months, 6x per week, 40 min sessions	Time able to step in place with eyes closed within a small circle	Improvement in dance at all timepoints. No improvement in Tai Chi at 4 months. Similar improvements as Tai Chi at 8 months. Less Improvement than Tai Chi at 12 months.
			Deviations of center of pressure during dynamic balance	Improvement in dance at all timepoints. Similar improvements as Tai Chi at 4 and 8 months. Less Improvement than Tai Chi at 12 months.