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Impacts of dance on non-motor symptoms, participation, and quality of life in Parkinson disease and healthy older adults

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Abstract

Evidence indicates exercise is beneficial for motor and non-motor function in older adults and people with chronic diseases including Parkinson disease (PD). Dance may be a relevant form of exercise in PD and older adults due to social factors and accessibility. People with PD experience motor and non-motor symptoms, but treatments, interventions, and assessments often focus more on motor symptoms. Similar non-motor symptoms also occur in older adults. While it is well-known that dance may improve motor outcomes, it is less clear how dance affects non-motor symptoms. This review aims to describe the effects of dance interventions on non-motor symptoms in older adults and PD, highlights limitations of the literature, and identifies opportunities for future research. Overall, intervention parameters, study designs, and outcome measures differ widely, limiting comparisons across studies. Results are mixed in both populations, but evidence supports the potential for dance to improve mood, cognition, and quality of life in PD and healthy older adults. Participation and non-motor symptoms like sleep disturbances, pain, and fatigue have not been measured in older adults. Additional well-designed

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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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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

studies comparing dance and exercise interventions are needed to clarify the effects of dance on non-motor function and establish recommendations for these populations.

Keywords

Parkinson disease; dance; exercise; mood; cognition; Quality of Life

1. Introduction

According to the U.S. Department of Health and Human Services, there were 39.6 million people in the United States over the age of 65 in 2009, and this is expected to grow to 72.1 million by 2030 (19% of the population) [1]. Parkinson disease (PD) is a common neurodegenerative disorder that predominantly occurs in older adults, and over 1 million Americans have PD. People with PD experience various motor and non-motor symptoms, and there is substantial overlap in the symptoms and co-morbidities experienced by PD and aging populations.

Despite considerable evidence that exercise provides important benefits in older adults [2-4] and PD [5-7], 60% of Americans over 65 years old do not achieve the recommended amounts of physical activity [8]. In PD, physical activity is further reduced compared to healthy older adults [9, 10]. Current pharmacological and surgical therapies do not sufficiently address all motor and non-motor deficits in PD [11], and non-motor symptoms in particular tend to be overlooked or undertreated [12]. Exercise may serve as an important adjunct therapy to confer additional benefits.

Barriers to exercise in older adults include discomfort in social situations, dependence on an instructor, physical discomfort, fear of falling, comorbidities, affordability, competing priorities, apathy, and belief that exercise was not needed and not beneficial [13]. Social interactions, encouragement, and belief that exercise could improve independence, physical health, and mental well-being are facilitators of exercise in this population [13]. Beliefs that exercise would not be beneficial, a lack of time, and fear of falling are barriers to exercise in PD [14]. Dance is an accessible and appealing form of exercise. The supportive, social nature of dance classes and use of dance instructors are important features that help overcome some of these barriers in older adults.

Prior review articles summarize the effects of dance in PD or older adult populations separately. However, few comparisons have been made between these two bodies of literature despite the potential for identification of relevant metrics and translation of findings. One previous review on dance in PD and older adults focused on motor outcomes but did not cover important non-motor symptoms such as mood dysfunction, impaired cognition, reduced participation, and lower quality of life (QoL) [15]. In this review, we synthesize results from dance interventions in PD and healthy older adults to determine literature gaps and inform future study.

2. Selection of Studies

We searched PubMed from inception through July 2015. To identify articles in PD, we searched for the terms parkinson* and danc* (* denotes wildcard character) within the article text. For healthy older adults, the search terms were (elderly or older or senior) and danc*. We included peer-reviewed, controlled studies in English. We limited this review to studies reporting the effects of dance interventions on mood, cognition, other non-motor functions, participation, and QoL in PD and/or healthy older adults. An initial search returned 240 articles in older adults and 68 articles in PD. Excluded studies are detailed in Table 1. Ten articles in PD and ten articles in older adults were included in this review (Table 2).

3. Discussion

3.1. Dance Intervention Parameters

In PD, tango was most frequently chosen for interventions [16-21]. Ballroom [16], Irish Set [22], video game-based [23], and programs with various dance styles [24, 25] were also examined. Though tango targets impairments in PD including backward walking, turning, and changing speeds, other dance styles may also be beneficial for addressing impairments in mood, cognition, participation, and quality of Life. Interventions ranged from six weeks to two years, from 30 minutes to 90 minutes per session, and from one to five days per week.

Older adult studies used various dance styles, including salsa [26], Caribbean traditional [27], Turkish folkloristic [28], aerobic [29], ballroom [30], square [31], contemporary [32], creative [33], and video game-based [34] dance, as well as modified dance for seniors [35]. Interventions in older adults were between 8 weeks and eighteen months, 30 minutes to 75 minutes per session, and one to seven days per week.

Certain dance programs may be optimal for addressing specific non-motor impairments in older adults and PD, and further investigations directly comparing different types of dance in both populations are warranted. The ideal dance intervention parameters for individual class duration, training frequency, and length of overall program are unknown for both populations, and direct comparisons of interventions of different intensities and durations will be necessary to develop recommendations.

3.2. Evaluation Parameters/Study Design

In PD, participants maintained normal medication schedules during the intervention. In some studies, evaluations were conducted with participants on their normal anti-parkinson medications [16, 17, 21, 22], while others evaluated participants off medication (12 hours withdrawal from anti-parkinson medication) [18-20]. Medication status during evaluations was not explicitly stated for three studies [23-25]. This limits the generalizability of findings across studies and is particularly relevant for cognitive measures because dopamine differentially affects aspects of cognition [36].

Comparison groups differed widely across studies. In PD, general exercise classes [25], self-directed exercise [21], Tai Chi [16], another dance style [16], physiotherapy [22], neurodevelopment treatment and functional electrical stimulation [23], health education [17], no intervention [18-20, 25], or healthy older adults in the dance intervention [24] were used as controls. Only one study in PD directly compared the effects of different dance interventions on non-motor measures in PD, and superior results were seen with tango dance compared to ballroom [16].

For older adult dance interventions, Tai Chi [31, 32], fall prevention training [32], no intervention [26, 28-31, 33-35], social and recreational activities [27], swimming [31], running [31], and brisk walking [34] control groups were used. Establishing the merits of a particular style of dance relative to other forms of exercise has been challenging due to varied intervention parameters and control group comparisons.

Adverse event frequency in PD was similar for Irish Set dance and physiotherapy exercise [22], and none were reported in older adults [26-28]. No falls occurred while PD participants were under observation in tango, ballroom, and Tai Chi interventions [16]. Fall frequency did not differ between tango and self-directed exercise [21]. The number of fallers was similar for tango and education controls, but more participants in the education group experienced an increase in falls [17]. Fall frequency in older adults differed from baseline to post-test in a Turkish folkloristic dance intervention (not in controls), but the direction of the change was not stated [28]. Most studies did not explicitly report adverse events, including falls.

All studies included in this review evaluated participants at least once before and once after dance interventions. Only one study in PD included follow-up testing sessions after the post-test to determine whether benefits persisted [17]. Improvements in spatial working memory, motor sign severity, and balance after completing twelve weeks of tango were maintained after ten to twelve weeks without dancing [17]. No studies in older adults included follow-up testing sessions. Additional follow-up data should be collected to determine retention of benefits and if retention differs across measures. Knowledge of whether benefits persist after training is important since community classes may not be continuously available. In addition, three articles in PD [18-20] and two in older adults [31, 33] included intermediate testing sessions during the intervention. These provide valuable information on the rate of acquisition of benefits and could inform future studies that have the goal of optimizing intervention parameters.

3.3. Psychiatric and Mood Outcomes

Mood disturbances and depression are among the non-motor symptoms experienced in PD [37]. Incidence of depression may be as high as 5.1% annually [38], and prevalence of depressive features ranges from 2.7% to 89% [37].

Mood (Profile of Mood States and Brunel University Mood Scale) improved in PD and older adults after mixed styles dance, with greater reductions in anger in older adults than in PD. This study did not include a sedentary or alternative intervention controls for comparison [24]. In another study in PD depressive symptoms (Beck Depression Inventory,

BDI) improved after video game-based dance but not in non-dance controls [23]. Apathy (Apathy Scale) and depression (Self-rating Depression Scale) improved more with dance than with an exercise intervention or no intervention [25]. Conversely, neither depressive symptoms (BDI) nor apathy (Apathy Scale) improved significantly following tango or self-directed exercise interventions, but on average both groups improved slightly [21].

Turkish folkloristic dance did not impact depression (Geriatric Depression Scale) in physically active older adults without diagnosis of major depression [28]. However, depressive symptoms (Geriatric Depression Scale) were reduced after ballroom dance in older adults in a nursing home [30]. Anxiety and depression (Hamilton Scales) improved with square dancing, compared to controls with no intervention [31]. Improvements in these scales were highest with square dancing compared to separate swimming, running, and Tai Chi interventions, but these groups were not compared statistically.

These results suggest dance may not improve mood in healthy, active older adults without depression but may benefit people with PD, non-community dwelling older adults, or older adults with mood impairments. More research is needed to form definitive conclusions. Further, no studies in PD to date examine the effects of dance on other psychiatric disturbances that are common in PD such as anxiety, anhedonia, apathy, and impulse control disorders. In particular, prevalence rates of anxiety disorders in PD range from 19.8% to 67%, and risk factors include depressive symptoms, disease severity, postural instability, and gait dysfunction [37] which dance may help alleviate [15]. People with PD with psychiatric morbidity tend to have poorer outcomes [37], so it is important to identify interventions to address these concerns in addition to motor symptoms.

3.4. Cognition Outcomes

Cognitive deficits occur in PD, particularly as the disease progresses [39], and prevalence rates of mild cognitive impairment in PD range from 18.9% to 55% [37]. However, the effects of dance on cognition in PD were sparsely investigated. Global cognition and executive function (Montreal Cognitive Assessment) showed a trend towards greater improvement for tango compared to self-directed exercise [21]. The effects of mixed styles of dance on executive function was also measured using the Frontal Assessment Battery at bedside (FAB), and greater improvements occurred with dance compared to exercise or no intervention controls [25]. Further, participants in mixed styles dance improved more in response time for a mental rotation task [25]. Similar improvements in global cognition/executive function (Montreal Cognitive Assessment) and visuospatial memory (Reverse Corsi Blocks) were reported with tango and education controls, but spatial working memory (Brooks Spatial Task) improved with tango only [17].

In older adults, the effects of dance on cognition were more widely evaluated. Task switching (rule shift card test) improved following contemporary dance, but not Tai Chi or fall prevention interventions. However, none of the interventions affected suppressing or setting attention (stroop test, arithmetic word problems) [32]. Cognition (Frankfurt Attention Inventory and Repeatable Battery of Neuropsychological Status) and reaction time improved only with Agilando dance [35]. Fluid intelligence (Raven Standard Progressive Matrices) did not change in either group [35]. Further, cognitive function (Scale of Elderly Cognitive

Function) improved and changes were detected in the P300 event-related potential wave (related to cognitive information processing [40]) with square dancing, compared to controls without intervention [31].

Response accuracy during a flanker task (measures selective attention) was not affected by video game-based dance, but reaction times were shorter in older adults after video game-based dance as well as brisk walking, compared to no intervention [34]. Cortical event-related potentials were measured, and the N2 (related to stimulus identification) and P3 (related to the speed of stimulus classification) peak latencies improved similarly with video game-based dance as well as brisk walking, compared to no intervention [34]. There were no differences between groups for changes in amplitude of these peaks [34].

Evidence from studies in PD and older adults suggests that certain aspects of cognition may improve with dance. Longer dance interventions may be needed to impact cognitive abilities that did not improve with shorter term interventions, such as executive function, visuospatial memory, or fluid intelligence [17, 35].

3.5. Outcomes for Other Non-Motor Symptoms

The Movement Disorder Society Unified Parkinson Disease Rating Scale (MDS-UPDRS I) subsection I measures common non-motor symptoms in PD, including sleep disturbances, pain, gastrointestinal issues, dizziness, and fatigue [41]. No differences in UPDRS-I scores were detected in participants in a year-long tango intervention and controls [18]. However, a small sample of PD participants who danced tango for two years demonstrated improved non-motor symptoms compared to controls [19]. There were also trends towards an improvement in fatigue specifically (Krupp Fatigue Severity Scale) following a twelve week tango intervention [21]. It is possible that longer duration dance interventions are required to impact certain non-motor symptoms.

Non-motor symptoms are often not considered in determining the outcomes of dance interventions, but these symptoms can have a large impact on many patients' daily life. For example, sleep disorders are related to other non-motor symptoms including reduced QoL, fatigue, depression, and cognitive decline, and prevalence in PD ranges from 0% to 87% [37]. The effects of dance interventions on general assessments of non-motor symptoms were not evaluated in older adults.

3.6. Participation Outcomes

Self-report regarding performance of activities of Daily Living (ADLs) in PD was assessed before and after dance using the MDS-UPDRS II [18, 19]. Findings varied, with no differences detected between a year-long tango group and controls [18], while improvements occurred after dancing for two years, compared to controls [19]. People with PD in the year-long tango program increased participation (Activity Card Sort) in instrumental, leisure, and social activities, particularly low-demand leisure activities, compared to controls [20]. Activity retention and adoption of new activities also increased in tango participants [20]. The Activity Card sort may be a more sensitive measure of participation than the MDS-UPDRS II, or longer duration interventions may be needed to provide clinically relevant improvements in MDS-UPDRS II. In contrast, in a six week

study on video game-based dance ADLs (Modified Barthel Index) improved in dance participants, but not in non-dance controls [23]. It is not clear whether the differential effect of dance on ADLs is attributable to the dance style, difference in training schedule, or the measure used to capture ADLs. Further studies should be done to clarify since participation in ADLs is reduced in PD compared to healthy older adults, and it is related to cognitive function and QoL [42].

In older adults, participation was only measured at baseline using the Barthel Index [30] or the Everyday Competence Questionnaire [35], so it is unclear whether participation changed following the dance interventions. Considering the mixed results in PD and the absence of measures pre and post intervention in older adults, future studies are needed to determine the effects of dance on participation in these populations.

3.7. Quality of Life Outcomes

Quality of life was predominantly measured in PD using the disease-specific Parkinson's Disease Questionnaire-39 (PDQ-39) [16, 17, 21, 22], and results were mixed. Superior improvements in QoL were achieved with Tango compared to ballroom, Tai Chi, and controls [16], but other studies reported similar changes with dance and non-dance groups [17, 21, 22]. The PDQ-39 includes relevant items for individuals with PD but it is difficult to compare results to healthy older adults. Using a more widely applicable scale in PD, neither tango nor the control education program impacted general health and QoL (Short Form Health Survey (SF-12)) [17].

Quality of life body pain and general health sub-measures (Short Form Health Survey (SF-36)) improved with low-impact aerobic dance in older adults over controls [29]. Turkish Folkloristic dance also improved QoL (SF-36), particularly the physical functioning, general health, and mental health subscales [28]. Improvements in QoL (FLZ Life Satisfaction Questionnaire) also occurred with Agilando dance, but not controls [35]. Life satisfaction (Satisfaction with Life Scale) improved following 12 or 24 weeks of creative dance, but not in controls without intervention [33]. Despite inconclusive results in PD, evidence suggests QoL improves in older adults after various dance interventions.

4. Conclusions

The population of older adults and people with PD is growing in number and there is greater urgency than ever before to address the multitude of health concerns in these groups. In addition to altered mobility and motor function, people with PD and healthy older adults often experience changes in mood, cognition, other non-motor symptoms, participation, and QoL that are not sufficiently alleviated with conventional care.

Non-motor symptoms have received less attention in dance and exercise literature than motor performance, and the results are less consistent. In PD, dance intervention effects on cognition, other non-motor symptoms, participation, and QoL were mixed. Participation and non-motor symptoms like sleep disturbance, pain, and fatigue have not been measured in dance interventions in older adults. Aspects of mood including depression and apathy seem to improve with dance interventions in PD and may improve in other subsets of older adults.

The effects of dance on cognition were inconsistent, but evidence is mounting that dance may improve cognitive functions such as spatial tasks, task switching, and stimulus processing. Quality of life improvements were consistently demonstrated in the healthy older adult literature.

Because studies that directly compare different forms of dance are lacking, future research should compare different dance programs to see if varying styles or other intervention parameters may provide greater benefits.

The variability of the dance intervention parameters (i.e. dance style, control group, frequency, duration, intensity) as well as outcome measures used makes it challenging to determine whether observed differences between groups (or lack thereof) are due to characteristics of the interventions, general physical activity, or social support/education provided in group settings. However, there is a growing body of evidence supporting improvements in non-motor function with dance, in these populations in addition to the well-documented improvements in motor function [15]. Further well-designed research is required to clarify the benefits of dance in PD and healthy older adults, as well as to determine recommendations for optimal interventions in these populations.

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Abbreviations

PD	Parkinson disease
QoL	Quality of Life
MDS-UPDRS	Movement Disorders Society Unified Parkinson Disease Rating Scale
ADLs	Activities of Daily Living
PDQ-39	Parkinson's Disease Questionnaire-39
SF-12	12-Item Short Form Health Survey
SF-36	36-Item Short Form Health Survey

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Highlights

We review the effects of dance on non-motor functions in older adults and PD.

Participation, quality of life, mood, cognition and non-motor functions are analyzed.

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

Some, but not all, studies indicate dance may improve some non-motor functions.

Table 1

Selection of Studies and Exclusions

	Healthy Older Adults (n studies)	People with PD (n studies)
Initial Search Results	240	68
Exclusions	229	57
Review articles	28	14
Not conducted in human participants	2	0
Not conducted in older adults/PD	28	2
Protocols or focus group descriptions	11	6
Case studies	3	3
Irrelevant article types *	9	8
No multi-session dance intervention	77	11
Cross-sectional studies	27	0
Single-group study designs	9	7
Participants with specific impairments **	15	0
Meta-analysis	0	1
No measures of non-motor function	19	3
Full text article not available	2	3
Included studies	10	10

* Irrelevant article types included corrections, commentaries, summaries, and interviews.

** Five PD, one stroke, one dementia, one multiple sclerosis, one metabolic syndrome, one chronic lower extremity pain, one mixed urinary incontinence, three obesity, and one visual impairment.

Table 2

Summary of Included Studies

Reference	Dance Style	Control/Comparison Group	Dance Intervention Parameters	Relevant Measures Collected
Articles in People with PD				
2009 Hackney, et al. [16]	Tango Ballroom	Tai Chi	13 weeks, 2× per week, 60 min sessions	Parkinson's Disease Questionnaire - 39
2013 Volpe, et al. [22]	Irish set	Physiotherapy exercise program	6 months, 1× per week, 90 min sessions	Parkinson's Disease Questionnaire - 39
2012 Duncan & Earhart [18]	Tango	No intervention	12 months, 2× per week, 60 min sessions	Movement Disorders Society-Unified Parkinson's Disease Rating Scale part I and II
2013 Foster, et al. [20]	Tango	No intervention	12 months, 2× per week, 60 min sessions	Activity Card Sort
2013 McKee & Hackney [17]	Tango	Interactive health education lecture series	10-12 weeks, 2× per week, 90 min sessions	Montreal Cognitive Assessment, Reverse Corsi Blocks, Brooks Spatial Task, Parkinson's Disease Questionnaire - 39, Short Form Health Survey - 12
2014 Duncan & Earhart [19]	Tango	No intervention	24 months, 2× per week, 60 min sessions	MDS-UPDRS part I and II
2014 Lewis, et al. [24]	Mixed styles	Healthy older adults in mixed styles dance	10 weeks, 1× per week, 50 min sessions	Profile of Mood States, Brunel University Mood Scale
2015 Lee, et al. [23]	Virtual reality dance + neurodevelopment treatment (NDT) + functional electrical stimulation (FES)	Neurodevelopment treatment + functional electrical stimulation	6 weeks, 5× per week, 30 min dance, 30 min NDT, 15 min FES sessions	Modified Barthel Index, Beck Depression Inventory
2015 Rios Romenets, et al. [21]	Tango	Self-directed exercise	12 weeks, 2× per week, 60 min sessions	Montreal Cognitive Assessment, Beck Depression Inventory, Apathy Scale, Krupp Fatigue Severity Scale, Parkinson's Disease Questionnaire - 39
2015 Hashimoto, et al. [25]	Mixed styles	Exercise program No intervention	12 weeks, 1× per week, 60 min sessions	Frontal Assessment Battery at bedside, Mental Rotation Task, Apathy Scale, Self-rating Depression Scale
Articles in Healthy Older Adults				
2005 Federici, et al. [27]	Caribbean traditional	Social and recreational activities	3 months, 2× per week 30-60 min sessions	Custom psychosocial questionnaire
2009 Eyigor, et al. [28]	Turkish folkloristic	No intervention	8 weeks, 3× per week, 60 min sessions	Short Form Health Survey - 36, Geriatric Depression Scale
2009 Hui, et al. [29]	Low impact aerobic	No intervention	12 weeks, 2× per week, 50 min sessions	Short Form Health Survey - 36
2011 Coubard, et al. [32]	Contemporary	Fall prevention training Tai Chi Chuan	Over 5.5 months, 1× per week, 60 min sessions	Arithmetic word problems, stroop test, rule shift card test

Reference	Dance Style	Control/Comparison Group	Dance Intervention Parameters	Relevant Measures Collected
2012 Granacher, et al. [26]	Salsa dance	No intervention	8 weeks, 2× per week, 60 min sessions	Freiburg questionnaire for everyday and sports activities, Mini Mental State Exam, Clock Drawing Test
2013 Kattenstroth, et al. [35]	Agilando dance	No intervention	24 weeks, 1× per week, 60 min sessions	Questions of Life Satisfaction (FLZ), Alters-Konzentrations-Test nonverbal geriatric concentration test, Frankfurt Attention Inventory, Repeatable Battery of Neuropsychological Status, Nonverbal learning test, Raven Standard Progressive Matrices
2014 Vankova, et al. [30]	Ballroom Exercise Dance for Seniors	No intervention	3 months, 1× per week, 60 min sessions	Geriatric Depression Scale
2014 Zhang, et al. [31]	Square	Swimming	18 months, daily, 30-60 min sessions	Scale of Elderly Cognitive Function, Hamilton Anxiety and Depression Scales, Cortical event-related potentials
		Running		
		Tai Chi		
2015 Chuang, et al. [34]	Video game	No intervention	12 weeks, 3× per week, 30 min sessions	Flanker attention task, Cortical event-related potentials
		Brisk walking		
2015 Cruz-Ferreira, et al. [33]	Creative	No intervention	24 weeks, 3× per week, 50 min sessions	The Satisfaction with Life scale