Effect of Tango on Motor Symptoms in Patients with Parkinson's Disease: A Systematic Review and Meta-Analysis

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Abstract

Objective: In this study, we systematically reviewed the efficacy of tango in alleviating the motor symptoms of patients with Parkinson's disease (PD).

Methods: We searched internet databases, such as PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science Core collection, and CNKI, for studies examining the effects of tango on the motor symptoms of patients with Parkinson's disease, published from September 2021 to date. All types of tango intervention, including traditional tango, Argentinian tango, and adapted tango, were examined in our review. The Cochrane bias risk assessment tool was used to evaluate the quality of methodologies used in the included studies. RevMan 5.4 software was used for meta-analysis.

Result: Eleven studies that included 390 Parkinson's patients met our inclusion criteria. Meta-analysis indicated that after tango, PD patients showed a considerable decrease in the overall severity of motor symptoms and improvement in balance, functional mobility, fast gait velocity, preferred gait velocity, stride length, and gait cadence. Compared with exercise, tango showed stronger effects on balance and functional mobility; however, no significant differences in the severity of motor symptoms, fast gait velocity, or preferred gait velocity were observed between the group treated using tango and that treated using exercise.

Conclusion: Interventions using tango may help alleviate the severity of motor symptoms, and specifically promote balance and functional mobility, in patients with Parkinson's disease. However, except for improving balance and functional mobility, tango showed no significant advantages over exercise in alleviation of motor symptoms in patients with Parkinson's disease.

Introduction

In the 21st century, neurological disorders have become one of the leading causes of human disability and death[1]. Among these, Parkinson's disease (PD) ranks as the second most important degenerative neurological disease after Alzheimer's disease. Over the past three decades, the incidence of PD has increased dramatically with the increasing age and life expectancy of the world population, imparting a considerable burden on families and societies[2].

PD is a degenerative neurological disease caused by the loss of dopaminergic neurons in the pars compacta of the substantia nigra of the brain, resulting in lesions in the basal ganglia[3]. PD is considered to be a motor-system disorder. Pharmacological treatments, such as dopaminergic medications using carbidopa-levodopa, are the mainstay of treatment for motor symptoms in PD[4]. However, with progression of this disease, levodopa is usually increased in dose strength and frequency, which causes side effects such as hallucinations, delusions, and motor-function complications in patients with PD[5]. Therefore, investigators are increasingly searching for non-pharmacological therapeutic methods such as physical exercise.

Over the past decade, physical exercise has been recognized as an important non-pharmacological modality for treating motor symptoms in patients with PD[6]. Numerous studies have shown that a high level of physical exercise is associated with a decreased risk of PD[7]. The neuroprotective effects of physical exercise in PD have been confirmed in animal models of PD[8]. Additionally, by promoting neuroplasticity, physical exercise may lead to beneficial structural and functional changes in the brains of patients with PD[9]. Alleviation of PD symptoms and improvements in mobility, balance, gait, and quality of life have been verified in PD patients treated using different physical exercise programs[10].

Previous studies also indicate that intervention using dance (i.e., a music-based exercise therapy) exerts positive effects on the motor function of patients with PD[11,12]. Tango is considered particularly advantageous for alleviating specific motor disorders in PD[13]. Several studies have even suggested that tango may be the best option for improving functional mobility in patients with PD[14]. However, the effects of tango on the motor-related symptoms of patients with PD remain controversial. A recent review has also shown that tango does not exert a significant effect on all the aspects of motor symptoms in patients with PD[15]. Therefore, evidence substantiating the effects of tango-based interventions in patients with PD remains insufficient.

In this systematic review and meta-analysis, we evaluated the effectiveness, advantages, and internal mechanisms of tango-based interventions in alleviating the severity of motor symptoms in patients with PD.

Methods

The current review followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRIMSA) guidelines (PRISMA-P 2015) [41].

·Literature research

A systematic search of the literature was undertaken on 20th September 2021, without date or language limitations. This search included searching electronic bibliographic databases, PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science Core collection, and CNKI. We used the following combination of search terms: [(Parkinson OR Parkinson's Disease) AND (tango OR Adapted tango OR Argentine tango)) OR ((Parkinson OR Parkinson's Disease) AND (dancesport OR ballroom dance OR standard dance OR social dance)). We searched the full texts of the selected articles and manually searched the lists of references for studies of interest and relevant publications. Three researchers independently conducted the literature review and evaluated the final included studies; disagreements were resolved by consensus.

·Inclusion and exclusion criteria

Criteria for considering studies

(1) Types of studies

In this review, we selected all peer-reviewed randomized controlled trials (RCTs); RCTs comparing two different types of dance interventions were also included. However, considering the insufficient number of well-designed RTCs, cohort studies that did not include a control group were also included. Master theses, conference papers, and quasi-randomized trials were not eligible for inclusion in this review.

(2) Participants

Persons of any age or sex with confirmed diagnosis of PD, and in all stages and duration of PD, were eligible for inclusion in this study.

(3) Types of interventions

Considering the consistency of rhythm and music in traditional tango and the similarity of dance movements adapted for PD patients, all types of tango-based interventions (i.e., tango in Dancesport, Argentine tango, and Adapted tango) were included in this review. Intervention format (individual/group, partnered/non-partnered), setting (community/ hospital), duration, and frequency were not restricted.

(4) Types of comparisons

Comparison groups included individuals that received non-dance interventions, including, but not limited to, exercise or standard care.

(5) Types of outcomes

In this review, we reported on at least one motor outcome (e.g., gait and balance outcomes). All outcomes were measured using validated scales.

·Data extraction and management

Both authors independently assessed the included literature and abstracts, extracted details of the assessed trials and outcome data, and created a record of the extracted data.

The extracted data were summarized using a trial description form that included trial name (author and year of publication), number and characteristics of group participants (age, sex, and severity of disease), study design, blinding, intervention schedule (type, frequency, intensity, session length, and duration of intervention), and outcome measures.

·Assessment of methodological quality

The Cochrane Collaboration's risk of bias assessment tool was used to determine the methodological quality of each trial included in this review with respect to the following factors: random sequence generation and allocation concealment (selection bias); blinding of participants and personnel (performance bias); blinding of outcome assessment (detection bias); incomplete outcome data (attrition

bias); selective reporting (reporting bias); and other bias. Disagreements between authors were resolved by third-party adjudication.

·Data analysis

Review Manager Software, version 5.4 was used for data analysis. Outcome variables for continuous data were presented as means plus standard deviations (SDs) and/or standard errors (SEs). Mean differences (MDs) with 95% confidence intervals (CIs) were calculated for all variables using the same outcome measure. For trials using different outcome measures that were deemed comparable, standardized mean differences (SMDs) with 95% CIs were calculated. Heterogeneity was assessed based on P value and I^2 statistic. $P < 0.05$ or $I^2 > 50\%$ were regarded as significant heterogeneity, and random effect model was then selected; otherwise, fixed effect model was determined based on $P \geq 0.05$ and $I^2 \leq 50\%$[42].

Results

·Study selection

Details of the screening process are shown in the PRISMA diagram (Fig. 1). A total of 206 studies were retrieved using the database. After duplicates were removed, 176 studies were obtained. Based on the preliminary screening of titles/abstracts, 60 studies satisfied the eligibility criteria for this review. After reviewing the full text of each of those 60 studies, a total of 11 studies were included in our quantitative analysis.

·Study characteristics

The characteristics of the included studies are summarized in Table 1. We included 11 studies (Table 1) published between 2007 and 2019. A total of 390 participants were enrolled in our review, with 10–96 participants per study; all the participants were diagnosed with mild to moderate stage of Parkinson's disease (H&Y stages I–III). All the studies included in our review included both men and women with a minimum mean age of 63.2 years and a maximum mean age of 72.6 years. The intervention methods used in these 11 studies included Argentine tango (n = 5) [16-19], Ballroom dance tango (n = 5)[20-25], and Adapted tango (n = 1)[26]. Among these 11 trials, three studies compared the tango group to the control group that had no intervention, three studies compared the tango group to the control group that performed traditional exercise, and one study compared the tango group to the control group treated using another type of dance-based intervention. Another study evaluated the different effects of partnered and non-partnered tango.

·Risk of bias in studies included in this review

Bias risk assessment of the 11 included studies is shown in Fig. 2. The methodological quality of these studies varies, and trial reports do not always provide sufficient information to determine the risk of bias.

Due to various factors, such as individual athletic ability, venue, and time availability of the patients, complete and rigorous random sequence generation and allocation concealment were not implemented in some of the studies. Also, because of the specificity of the intervention, it was not possible to blind the participants/implementers, leading to some performance bias in our review. In reporting outcome data, two studies[16,17] published their results only in the form of charts and did not report specific data on outcome indicators; we did not receive a response after attempts to contact the authors.

·Meta analysis

Motor severity

(1) Before vs after tango intervention

The severity of motor-related symptoms in PD patients was evaluated using the motor component of the Movement Disorder Society United Parkinson's Disease Rating Scale Part III (MDS-UPDRS-III). Differences in MDS-UPDRS-III scores were compared in 170 PD patients from nine studies before and after tango intervention with a low heterogeneity (I^2 = 46%, P = 0.06) (Fig. 3a). Our results indicate that MDS-UPDRS-III scores were significantly improved in PD patients after interventions using tango (4.06, CI 2.40 to 5.72, P < 0.00001).

(2) Tango vs exercise intervention

Differences in MDS-UPDRS-III scores were compared in 138 PD patients treated using tango and other forms of exercise-based interventions as described in five studies with low heterogeneity (I^2 = 45%, P = 0.14) (Fig. 3b). Our results indicate that there were no significant differences between the groups treated using the two types of intervention (0.26, CI −4.13 to 4.65, P = 0.91).

Balance

(1) Before vs after tango intervention

Differences in balance outcomes were compared in 139 PD patients from eight studies before and after tango intervention with a low heterogeneity (I^2 = 16%, P = 0.30) (Fig. 4a). These eight studies used two measurement tools, Berg Balance Scal and MiniBESTest; therefore, standardized mean difference was selected as the effect value. Our results indicate that balance was significantly improved in PD patients after interventions using tango (0.44, CI 0.20 to 0.68, P = 0.0003).

(2) Tango vs exercise intervention

Balance was compared in 138 patients with PD from four studies that used tango and other types of exercise-based interventions with low heterogeneity (I^2 = 58%, P = 0.07) (Fig. 4b). Our analysis indicates that there was an improvement in balance in patients treated using tango (0.39, CI 0.05 to 0.74, P = 0.03).

Functional mobility

(1) Before vs after tango intervention

Differences in functional mobility outcomes before and after the tango intervention were compared in 124 PD patients described in eight studies (Fig. 5a). All eight studies reported data using the Timed Up and Go (TUG) Dual task having low heterogeneity (I^2 = 0%, P = 0.91). Our results indicate that functional mobility was significantly improved in PD patients after tango-based interventions (0.97, CI 0.37 to 1.58, P = 0.002).

(2) Tango vs exercise intervention

Functional mobility was compared in 68 patients with PD treated using tango and other exercise as described in three studies having significant heterogeneity (I^2 = 74%, P = 0.02) (Fig. 5b). The effect of tango-based intervention on the functional mobility in PD patients was more pronounced than that of interventions using other forms of exercise (1.23, CI −0.19 to 2.65, P = 0.09).

Gait

Gait data from the included studies were analyzed with respect to fast gait speed, preferred gait speed, stride length, and cadence. Among these factors, fast gait speed was measured using a Six-Minute Walk Test (6MWT), while preferred gait speed, stride length, and cadence data were collected using a GAITRite walkway.

(1) Fast gait speed

a. Before vs after tango intervention

Differences in fast walking speed outcomes before and after intervention using tango were compared in 93 PD patients described in five studies (Fig. 6a) having nearly no heterogeneity (I^2 = 0%, P = 0.88). Our analysis indicates that fast gait speed was significantly improved in PD patients after intervention using tango (38.80, CI 10.72 to 66.87, P = 0.007).

b. Tango vs exercise intervention

Differences in fast gait speed were compared in 86 patients with PD treated using tango dance and other forms of exercise as described in two studies (Fig. 6b) with nearly no heterogeneity (I^2 = 0%, P = 0.41). Our analysis indicates that intervention using tango showed no significant advantages compared to that using other forms of exercise in improving fast gait speed in PD patients (−5.56, CI −50.53 to 39.41, P = 0.81).

(2) Preferred gait speed

a. Before vs after tango intervention

Differences in preferred gait speed before and after intervention using tango were compared in 102 PD patients evaluated in six studies (Fig. 7a) with nearly no heterogeneity (I2 = 0%, P = 0.84). Our analysis indicates that preferred gait speed was improved in PD patients after tango-based interventions (0.03, CI −0.02 to 0.09, P = 0.25).

b. Tango vs intervention using exercise

Next,we evaluated three studies comparing differences between the effects of tango and other forms of exercise on the preferred gait speed of 105 patients with PD (Fig. 7b); our analysis indicates nearly no heterogeneity (I2 = 0%, P = 0.66) among these trials. Our results indicate that intervention using tango showed no advantages over those using forms of exercise in improving the preferred gait speed of patients with PD (−0.05, CI −0.11 to 0.02, P = 0.16).

(3) Stride length and cadence

Because of the limited number of studies included in our review, we only analyzed changes in PD patients before and after intervention using tango.

a. Stride length

Differences in stride length outcomes before and after intervention using tango were compared in 38 PD patients evaluated in three studies (Fig. 8a) showing low heterogeneity (I^2 = 8%, P = 0.34). Our results indicate that stride length was improved in PD patients after intervention using tango (0.04, CI −0.02 to 0.10, P = 0.20).

b. Cadence

Next, differences in cadence outcomes before and after intervention using tango were compared in 39 patients with PD evaluated in two studies (Fig. 8b) showing nearly no heterogeneity (I^2 = 0%, P = 0.89). Our results indicate that cadence was significantly improved after intervention using tango (5.42, CI 0.41 to 10.44, P = 0.03).

Discussion

In this review and meta-analysis, we aimed to verify the effects of tango intervention on the motor symptoms of PD patients and whether tango is a more advantageous intervention compared with interventions using other forms of exercise. Our analysis of data obtained from the 11 included studies shows that tango exerted significant positive effects on alleviating the severity of motor symptoms and improving balance, functional mobility, and gait in PD patients. Compared to other exercise, except for balance and functional mobility, we did not find an significantly advantage of tango intervention on motor symptoms in PD patients, especially in gait such as gait speed, where other exercise seemed to be more effective than tango dance.

Our results on the most prominent effects of tango on the severity of motor symptoms and balance are consistent with those described in previous reviews evaluating the effectiveness of tango-based interventions in PD patients[11,15]. Because of a limited number of RCTs comparing tango-based interventions with interventions using other forms of exercise, our present study was unable to provide sufficient evidence for comparative advantages of tango in alleviating the motor symptoms of PD patients. Tango did not appear to relieve gait-related symptoms in PD patients, which may have been due to the degree of gait impairment specific to each patient or to the exercise program selected for the control group. For example, gait speed in PD patients may be more effectively improved by a single periodic exercise program such as that including a treadmill.

·Mechanistic analysis of the effects of tango-based intervention on the motor symptoms of PD patients

Most previous studies only validated the effects of tango-based interventions using outcome data. Few studies discussed the characteristics of tango with respect to its effects on the symptoms of PD. As a distinctive dance involving two partners, there are several pathways that may underlie tango-mediated reduction of damage to basal ganglia in PD patients and resulting alleviation of motor symptoms.

The effect of tango music on motor-related symptoms in PD patients

Tango music, as a necessary external condition in tango-based interventions, is an important factor in alleviating motor symptoms in PD patients. At the molecular level, music, as an abstract stimulus, can cause a pleasurable sensation, which is partly related to dopamine activity in the mesencephalic limbic reward system, that is, strong pleasure stemming from stimulation using music can lead to dopamine release in the striatum[27]. At the systemic level, data obtained in a study using fMRI showed that rhythmic music outperforms non-rhythmic music in significantly increasing the activity of bilateral basal ganglia, supplementary motor areas, and other brain regions; basal ganglia, in particular, show increased activity when stimulated using music having regular accented structures[28]. Significant impairment of rhythmic beat discrimination has been found in PD patients[29], while activation of the basal ganglia induces individual motor prediction and synchronization[30]. The involvement of basal ganglia in auditory stimuli and motor responses has been effectively utilized to alleviate gait impairment in PD patients using musically cued gait training (i.e., synchronizing gait with rhythmic sound cues) [31]. Tango is known as a ‘passionate’ dance because of its impassioned, staccato-based, powerful music[32]. In addition to its prominent melodic style, tango music also has a repetitive rhythmic pattern and strong accent structure. The rhythm speed of 30–31 bars/min provides PD patients with enough adjustment time when completing the basic steps of tango. Therefore, with the accompaniment of tango music, tango-based interventions can effectively activate basal ganglia in PD patients, involving these patients in synchronization and control of movements, which promotes improvement in motor function.

The effect of tango technique on the motor symptoms of PD patients

Resting-state fMRI results obtained in professional modern dancers show that prolonged dance training enhances the functional connectivity of cortico-basal ganglia loops, leading dancers to exhibit excellent motor control[33]. Although no direct evidence for enhanced functional connectivity has been obtained in the brains of professional tango dancers, the unique movement characteristics of tango may potentially enhance functional connectivity in the basal ganglia. Additionally, tango has no obvious rising and falling movements, while the basic steps are close to the walking pattern of the human body, which is simple for PD patients to perform. Also, tango includes numerous rotating and turning movements, which, to a certain extent, can affect the coordination of body movements in PD patients when they turn around[34]. Participants in tango need to follow the music to syncopate the timing of movements, change movement speed, and make frequent stops and starts, rendering tango more conducive than other dance styles to the recovery of functional mobility in PD patients[13].

Effect of partner skills on the motor symptoms of PD patients treated using tango-based interventions

Nearly all the studies examining the effects of tango-based interventions on motor-related symptoms of PD patients have reported significant improvements in balance in these patients. The results of our present review indicate that compared with other forms of physical exercise, tango showed a significant advantage only with respect to balance, which is closely linked to the unique partnered dance style used in tango. In executing the movements involved in tango, PD patients need to shift their body weight while maintaining an upper body hold with their partner. As tango progresses, patients also need to coordinate the separate and integrated movements between upper and lower body. With the help of their partner, PD patients can balance their movements more easily and push the limits of their movements more safely, greatly enhancing confidence in their balance[35] while not becoming dependent on their dance partner[22]. Notably, dance partners in tango-based intervention are mostly family members of PD patients, which greatly enhances the trust level of PD patients in their dance partners and improves their compliance with this intervention[22,36]. This is one of the unique advantages of tango-based interventions compared with other forms of physical exercise.

The effects of tango on the cognitive function of PD patients

Although the effects of tango on motor-related symptoms of PD patients are similar to those of other forms of exercise, tango-based interventions show increased patient compliance, offer the benefit of recreation, and enrich cognitive and social components of the patient's life while ensuring safety[37]. In addition to providing aerobic exercise, tango-based interventions stimulate progressive motor learning and social-emotional engagement with partners, peers, and instructors in an open studio environment[38]. Multi-component physical exercise that incorporates cognitive engagement is more effective in affecting neuroplasticity and improving cognitive function than single-component physical exercise[39]. Current studies have demonstrated that tango potentially alleviates motor-

related symptoms and improves executive function[23], social participation[36], and quality of life[40]in PD patients.

·Limitations

Our present study had several limitations. First, the type of tango and the intensity of exercise in the included studies were not entirely consistent and may have added to the heterogeneity of the study. Second, because the number of included studies was limited, the sample size used to analyze the differences between tango-mediated effects and those of other forms of exercise was small. Additionally, the interventions were not completely consistent in the control group, limiting the representativeness of the results obtained in this analysis. Third, only a small number of the included studies had a post-intervention follow-up; therefore, the findings obtained in our present review represent only short-term effects of tango on the motor symptoms of PD patients and do not represent the effects of tango on retention of motor function recovery. Fourth, most of the included studies evaluated PD patients with akinesia or bradykinesia and postural instability and did not examine tremor at rest and rigidity; therefore, more comprehensive assessments of motor symptoms in PD patients are needed in future studies.

Conclusions

Overall, our present review provides comprehensive evidence for the positive effects of tango-based interventions on alleviating the motor symptoms of PD patients. Compared with other forms of exercise, tango was more advantageous for improving balance and functional mobility in these patients.

Future studies should use more rigorous RCTs with increased follow-up to compare differences in the effects of different programs on the different symptoms of PD patients. Additionally, the mechanisms underlying the effects of tango on the symptoms of PD patients should be analyzed in detail using direct neuroimaging. Such studies will provide basis for designing targeted and effective intervention programs for this patient population.

Declarations

Author contributions statement

Xiao WANG: Conceptualization, Methodology, Software, Investigation, Resources, Writing - Original Draft

Hong SHEN: Validation, Investigation

Yixin WANG: Software, Validation, Investigation

Hongtao MA: Supervision.

Yujie LIANG: Writing - Review & Editing

Additional information

Conflict of interest statement

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled.

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Tables

Table 1. Characteristics of included studies.

		ants (men)	Dance style	Age	H&Y stage	Control	Age	H&Y stage	-ion	measures
Hackney et al. (2007)	RCT	19 (12)	Tango	72.6 ±2.2	2.3 ±0.7	Exercise	69.6 ±2.1	2.2 ±0.6	13 weeks	MDS-UPDRS-III; BBS; TUG; FOGQ; Gait velocity
Hackney et al. (2009a)	Cohort studies	12 (8)	Progressive Argentine tango	67.2 ±9.6	2.4 (2,2.5) *	N/A			2 weeks	MDS-UPDRS-III; BBS; TUG; 6MWT; Gait velocity
Hackney et al. (2009b)	RCT	58 (34)	Tango	68.2 ±1.4	2.1 ±0.1	No intervention	66.5 ±2.8	2.2± 0.2	13 weeks	MDS-UPDRS-III; BBS; TUG; 6MWT; FOGQ; Gait velocity
Hackney et al. (2010)	RCT	39 (18)	Partnered tango	69.6 ±8.5	2.5 (2, 3)*	Non-Partnered tango	69.6 ±9.5	2 (2,2.6)	10 weeks	MDS-UPDRS-III; BBS; TUG; 6MWT; FOGQ; Tandem stance; OLS; Gait velocity
Duncan et al. (2012)	RCT	52 (30)	Argentine tango	69.3 ±1.9	2.6 ±0.1	No intervention	69.0 ±1.5	2.5 ±0.1	12 weeks	MDS-UPDRS-III;9HPT MiniBESTest; 6MWT; FOGQ; Gait velocity
McKee et al. (2013)	Controlled trials	33 (20)	Adapted tango	68.4 ±7.5	2.3 (2.0, 2.6)	Education	74.4 ±6.5	2.0 (2.0, 2.0)	12 weeks	MDS-UPDRS-III; FAB TUG; FOGQ Four-Square Step Test
Duncan et al. (2014)	RCT	10 (8)	Argentine tango	69.6 ±6.6	2.4 ±0.37	No intervention	66±1 1.0	2.3 ±0.24	24 months	MDS-UPDRS-III; TUG; MiniBESTest;6MWT; FOGQ; Gait velocity
Romenets et al. (2015)	RCT	33 (19)	Argentine tango	63.2 ±9.9	1.7 ±0.6	Exercise	64.3 ±8.1	2.0 ±0.5	12 weeks	MDS-UPDRS-III; TUG; MiniBESTest; FOGQ
McNeely et al. (2015)	Controlled trials	16 (8)	Tango	67.6 ±8.6	2.13 ±0.58	D4PD	68.2 ± 10.9	2.25 ±0.27	12 weeks	MDS-UPDRS-III; TUG; MiniBESTest; 6MWT; Five times sit to stand; Four-square step test; Gait velocity
McKay et al. (2016)	Cohort studies	22 (7)	High-volume Adapted tango	65.4 ± 12.8	2.2 ±0.44	N/A			3 weeks	MDS-UPDRSIII; BBS; FAB; DGI; FR; ABC; TUG; FOGB; Two-Footed Jump; Gait velocity;
Rawson et al. (2019)	Controlled trials	96 (56)	Argentine tango	66.7 ± 9.52	2.2 ±0.56	Treadmill Walking	68.5 ± 9.5	2.1 ±0.49	12 weeks	MDS-UPDRS-III; MiniBESTest; 6MWT; Gait velocity
						Stretching Exercise	66.1 ± 7.3	2.1 ±0.48		

Note. Values represent means ± SD. H&Y stage * represent Median (1st, 3rd Quartiles)

Abbr.: H&Y stage: Hoehn and Yahr stage; RCT: Randomized Controlled Trail; D4PD: Dance for Parkinson's; MDS-UPDRS-III: Movement Disorder Society-Unified Parkinson's Disease Rating Scale motor subsection; BBS: Berg Balance Scale; TUG: Timed Up and Go; FOGQ: Freezing of Gait Questionnaire;

6MWT: 6min Walk Test; 9HPT: Nine-Hole Peg Test; OLS: One Leg Stance; FAB Fullerton Advanced Balance Scale; DGI: Dynamic Gait Index; FR: Functional Reach; ABC: The Activities-Specific Balance Confidence Questionnaire.

Figures

Study ID	Methods	Particip	Tango group	Control group	Durat	Outcome

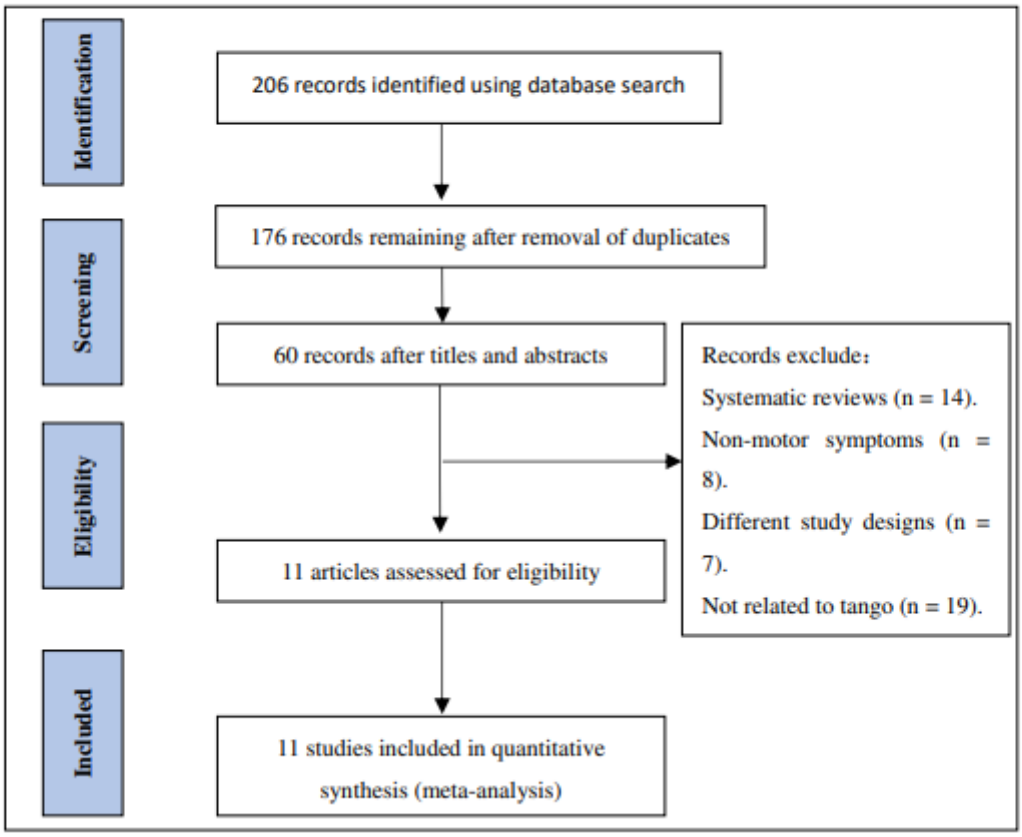


Figure 1

PRISMA diagram of the study.

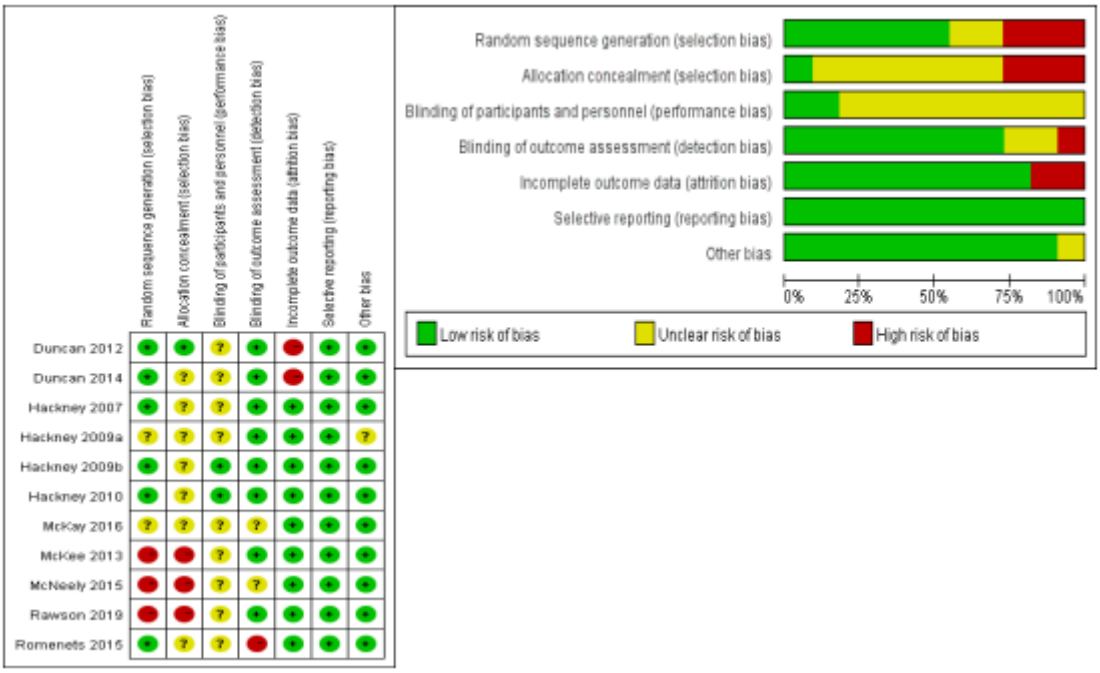


Figure 2

Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

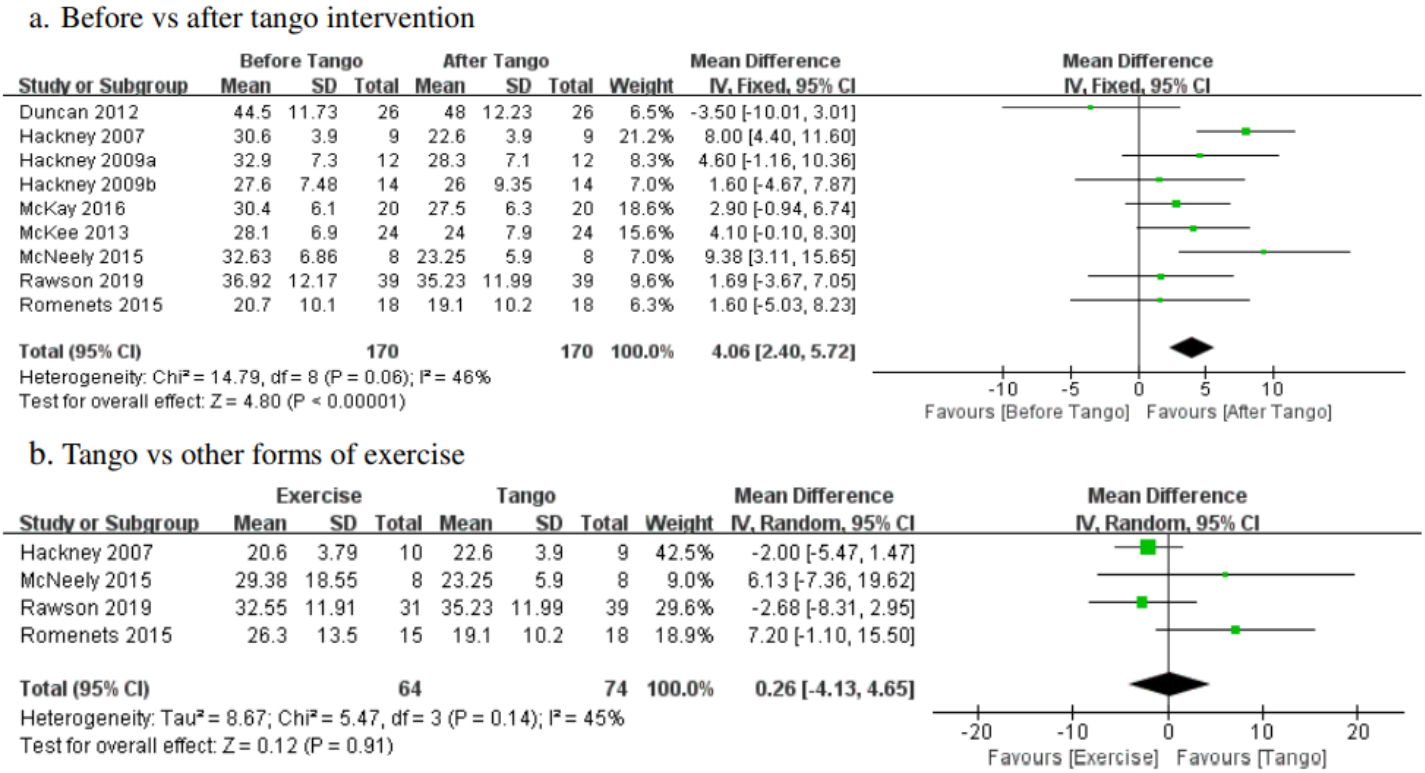


Figure 3

Forest plot: MDS-UPDRS-III

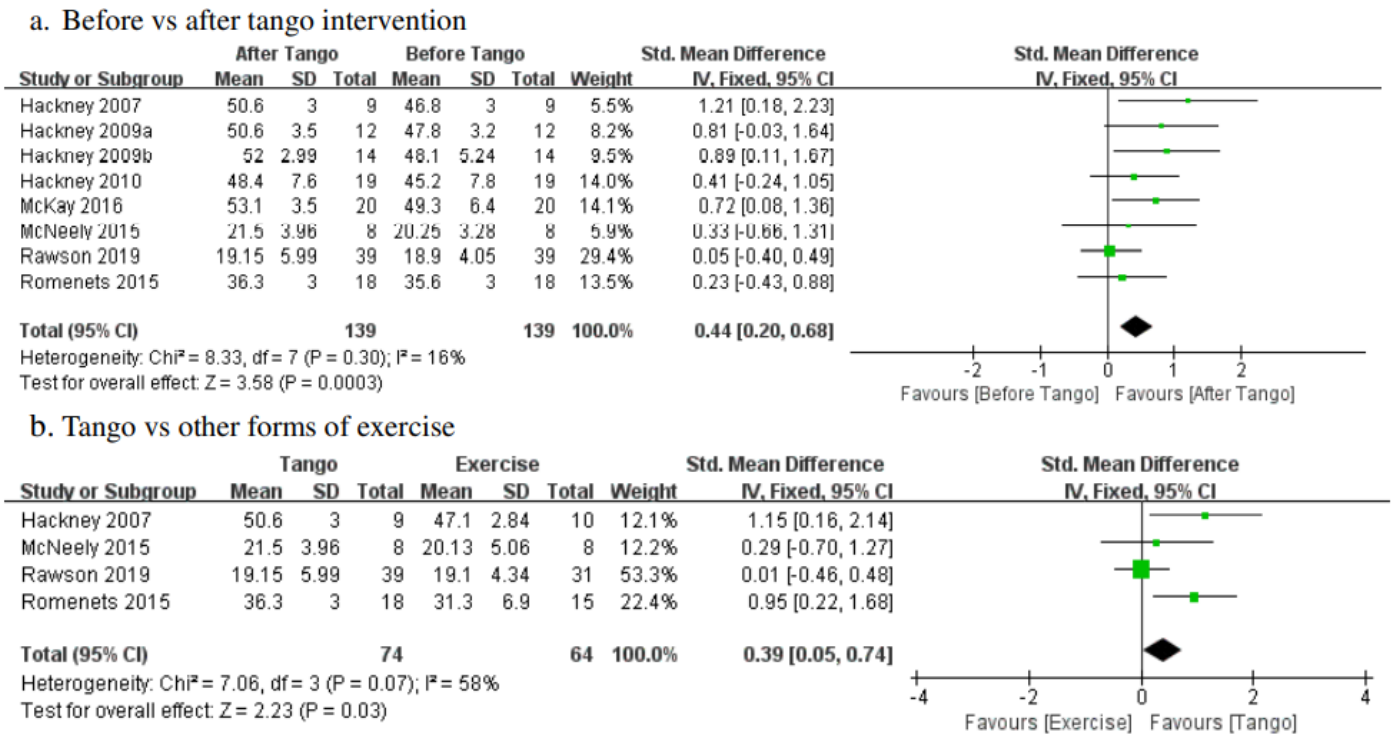


Figure 4

Forest plot: Balance

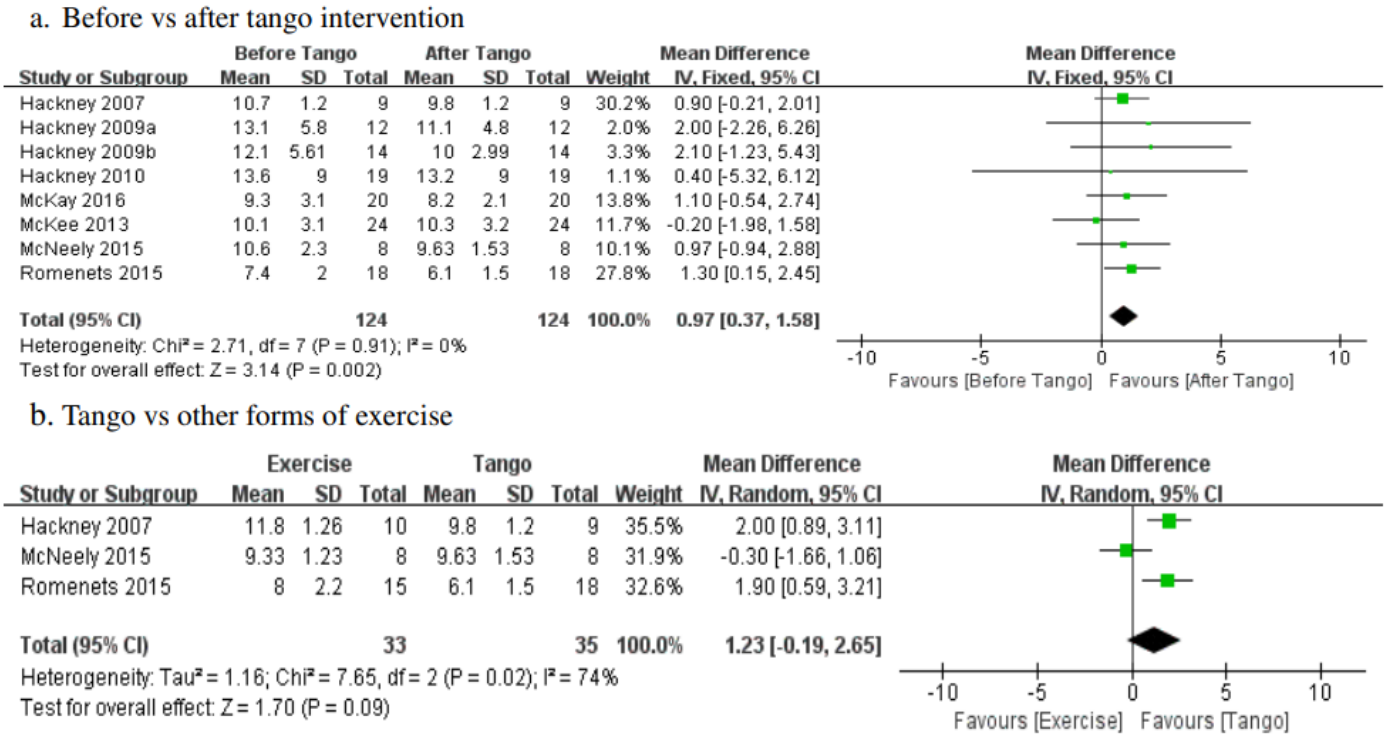


Figure 5

Forest plot: Functional mobility

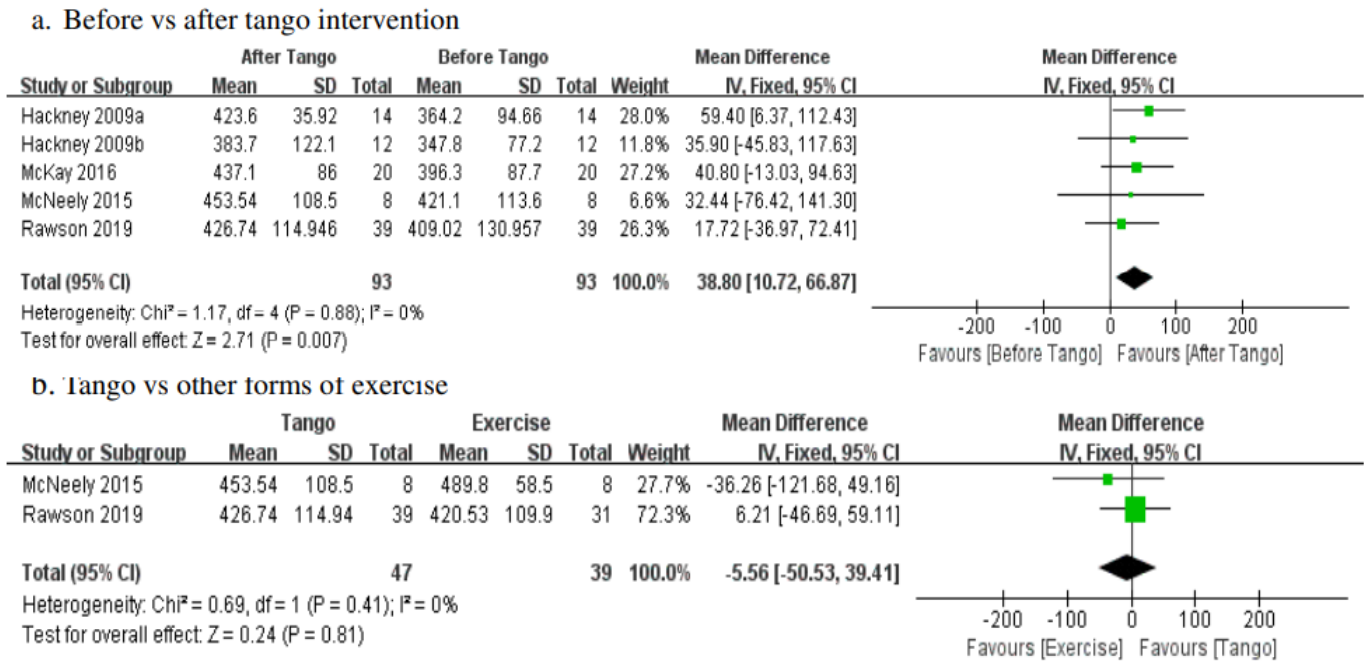


Figure 6

Fast gait speed

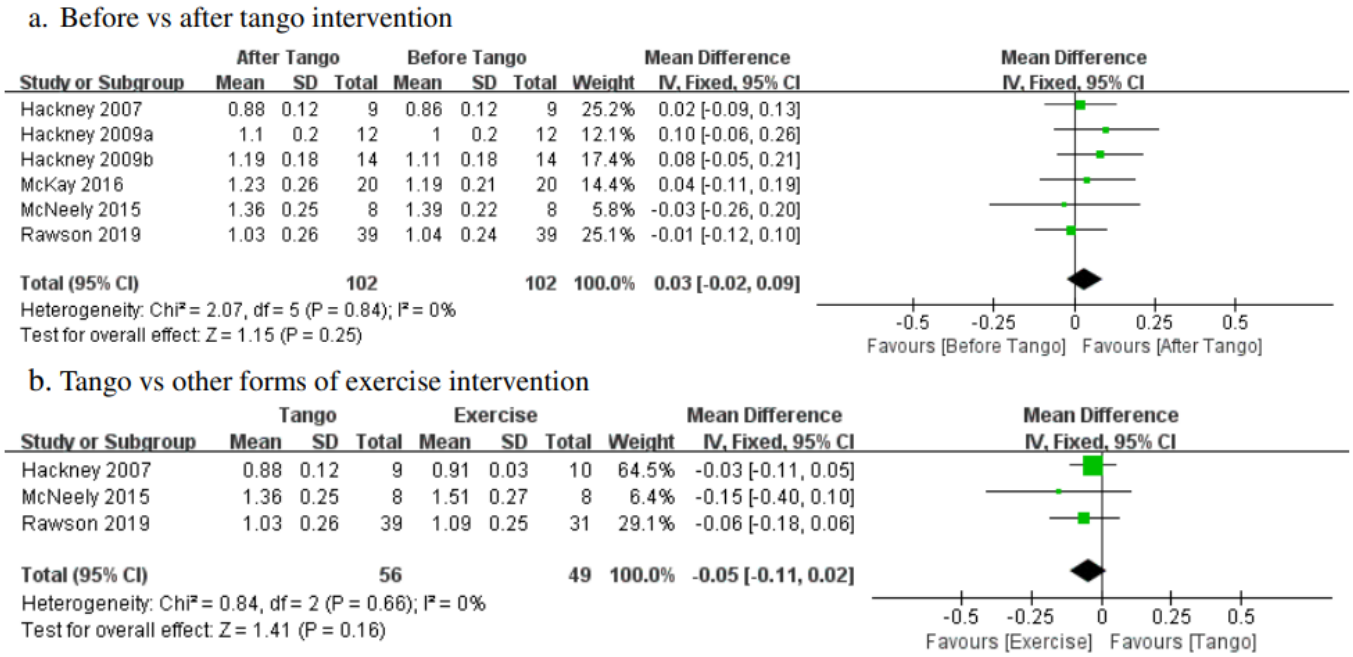


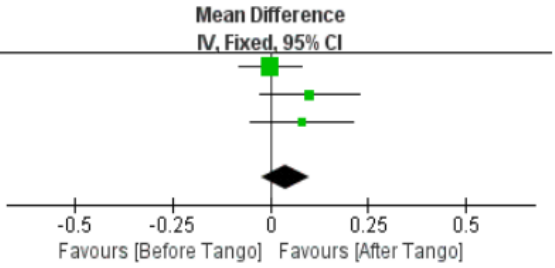
Figure 7

Preferred gait speed

a. Stride length

Study or Subgroup	After Tango Mean	After Tango SD	After Tango Total	Before Tango Mean	Before Tango SD	Before Tango Total	Weight	Mean Difference IV, Fixed, 95% CI
Hackney 2009a	0.6	0.1	12	0.6	0.1	12	56.8%	0.00 [-0.08, 0.08]
Hackney 2009b	0.4	0.2	12	0.3	0.1	12	22.7%	0.10 [-0.03, 0.23]
Hackney 2010	1.33	0.18	14	1.25	0.18	14	20.5%	0.08 [-0.05, 0.21]
Total (95% CI)			**38**			**38**	**100.0%**	**0.04 [-0.02, 0.10]**

Heterogeneity: Chi² = 2.17, df = 2 (P = 0.34); I² = 8%
Test for overall effect: Z = 1.27 (P = 0.20)



Study or Subgroup	After Tango Mean	After Tango SD	After Tango Total	Before Tango Mean	Before Tango SD	Before Tango Total	Weight	Mean Difference IV, Fixed, 95% CI
Hackney 2010	114	13	19	109	12	19	39.7%	5.00 [-2.96, 12.96]
McKay 2016	115.3	9.7	20	109.6	11.1	20	60.3%	5.70 [-0.76, 12.16]
Total (95% CI)			**39**			**39**	**100.0%**	**5.42 [0.41, 10.44]**

Heterogeneity: Chi² = 0.02, df = 1 (P = 0.89); I² = 0%
Test for overall effect: Z = 2.12 (P = 0.03)

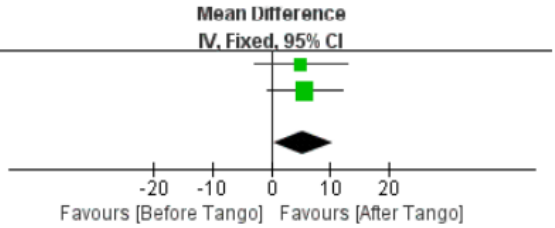


Figure 8

Stride length and cadence