MUZYK, Magdalena, DUDA, Weronika, MROWCZYK, Patrycja, NOWOŚWIAT, Patrycja, BADO, Michał, GONCERZ, Michał, BILECKI, Krzysztof, BEDNARCZYK, Paulina, PILAWSKA, Sandra Agnieszka, MAŚLANKIEWICZ, Maria and MALAKA, Ewa Katarzyna. Impact of tango on Parkinson's disease - a narrative review. Quality in Sport. 2024;19:53905. eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.19.53905
https://apcz.umk.pl/QS/article/view/53905

The journal has had 20 points in Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 29.07.2024. Revised: 19.08.2024. Accepted: 23.08.2024. Published: 29.08.2024.

IMPACT OF TANGO ON PARKINSON'S DISEASE - a narrative review

1. Magdalena Muzyk [MM]

5th Military Clinical Hospital with Policlinic (SPZOZ) in Krakow, ul. Wrocławska 1-3, 30-901 Kraków, Poland

https://orcid.org/0009-0008-4822-5651

magdalenamuzyk7@gmail.com

2. Weronika Duda [WD]

H. Klimontowicz Specialist Hospital in Gorlice, Węgierska 21, 38-300 Gorlice, Poland

https://orcid.org/0009-0007-1332-7036

weronika.duda23@gmail.com

3. Patrycja Mrowczyk [PM]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

https://orcid.org/0000-0002-4569-2173

patrycja.mrowczyk@outlook.com

4. Patrycja Nowoświat [PN]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

https://orcid.org/0009-0008-7939-6621

patkano1998@gmail.com

5. Michał Bado [MB]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

https://orcid.org/0009-0008-6595-6560

michalbado@yahoo.com

6. Michał Goncerz [MG]

Department of Anatomy - Jagiellonian University, Kopernika 12 Street, 31-034 Krakow, Poland

https://orcid.org/0009-0003-8444-6922

michal.goncerz@uj.edu.pl

7. Krzysztof Bilecki [KB]

SP ZOZ MSWiA, Kronikarza Galla 25, 30-053 Cracow, Poland

https://orcid.org/0009-0001-8778-1422

kbilecki5@gmail.com

8. Paulina Bednarczyk [PB]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

https://orcid.org/0009-0009-3598-2490

bednarczyk.paulina1998@gmail.com

9. Sandra Agnieszka Pilawska [SAP]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

sandra.pilawska@gmail.com

https://orcid.org/0009-0005-3565-9723

10. Maria Maślankiewicz [MM]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

https://orcid.org/0000-0001-7522-5018

m_maslankiewicz@wp.pl

11. Ewa Katarzyna Malaka [EKM]

The University Hospital in Krakow, Jakubowskiego 2 Street, 30-688 Krakow, Poland

https://orcid.org/0009-0007-6746-698X

ewa.malaka@interia.pl

Abstract

Introduction: Parkinson's disease (PD) is a fast-growing neurodegenerative condition caused by the deficiency of dopamine (Bloem et al., 2021). Main symptoms include tremor, bradykinesia, muscular rigidity and postural instability (Ye et al., 2023). Although PD treatment primarily involves pharmacotherapy, physical activity-based treatments such as tango dance can improve the quality of life of patients.

Aim of the study: This narrative review aims to assess the impact of the therapeutic benefits of tango dance therapy for people with PD.

Materials and methods: A comprehensive literature search was conducted in the PubMed database up to 2024. The review included randomised controlled trials, case reports, and pilot studies focused on the impact of tango on PD.

Results: Several studies have evaluated the impact of tango on patients with PD. Some of them found that tango improves dynamic balance and walking, reduces the risk of falling, improves body awareness, stability, and emotional well-being among patients with PD.

Conclusions: The impact of tango on PD is not yet conclusively documented, and further research is needed.

Keywords: Parkinson's disease, neurodegenerative condition, Tango, dance

Introduction

Parkinson's disease is a rapidly growing neurodegenerative condition, second most common after Alzheimer's disease (Ye et al., 2023). The most important disturbance in the pathophysiology of the disease is the deficiency of the neurotransmitter dopamine in the striatum caused by the loss of nigrostriatal dopamine cells (Bloem et al., 2021). PD is characterised by the accumulation of α-synuclein in Lewy bodies and Lewy neurites. The main symptoms that allow the recognition of PD include tremor, bradykinesia (hypokinesia or akinesia), plastic-type muscular rigidity, and postural instability (Ye et al., 2023), while the early phases of PD may be easy to miss (the average delay in diagnosis is 10 years). The most common early symptom is constipation. Others include acting out dreams during the rapid eye movement (REM) phase of sleep, hyposmia, and depression. Delays in diagnosis are especially frequent when tremors are not present, in individuals with early-onset disease and

when legs are primarily impacted. The diagnosis of PD is based on a comprehensive medical history and neurological examination that reveal symptoms such as bradykinesia along with rigidity and/or resting tremor. To improve diagnostic certainty and exclude other possibilities, additional emphasis is placed on supportive characteristics, such as a positive response to dopaminergic therapy and negative characteristics, such as indications of cerebellar dysfunction. A conclusive diagnosis can only be made by identifying characteristic neuropathological changes in the brain during a postmortem examination. Brain magnetic resonance imaging may occasionally help rule out rarer and atypical causes of parkinsonism. Likewise, dopamine transporter single-photon emission computed tomography might detect dopaminergic deficits in people with mild parkinsonism.

PD presents with motor and non-motor symptoms. Classical motor features occurring at early stages are bradykinesia, rigidity, tremor, and gait alterations. Bradykinesia is general slowness and lack of spontaneous movement. A patient with bradykinesia may additionally present with symptoms such as reduced facial expression, decreased gesturing or small handwriting. There is a progressive decrease in the speed and amplitude of voluntary repetitive movements, such as tapping of the fingers. Rigidity is an increased muscle tone demonstrated by resistance to passive movements, equally affecting opposing muscle groups ("lead-pipe" rigidity). When this resistance is interrupted by tremors, it results in a phenomenon of the revolving wheel. Rest tremor occurs mainly in the limbs (“pill-rolling” in hands), lips, chin, or jaw, rarer in the head. Motor features that are presented at later stages include posture alterations, gait freezing, and balance alterations. Posture alterations usually occur when the trunk and head lean forward while standing with the arms abducted and bent at the elbows. Freezing of gait refers to sudden and temporary episodes where an individual cannot initiate effective forward movement. This may occur when starting to walk ("start hesitation") or during walking (motor block). Balance alterations can be tested with the “pull test” (Tolosa et al., 2021). Non-motor manifestations can also lead to disability and impaired quality of life (Muslimovic et al., 2008) . They present as hyposmia, sleep disorders, neuropsychiatric characteristics, autonomic dysfunction, mild cognitive impairment, pain, somatosensory disturbances, and dementia. Hyposmia is a loss of smell, which occurs in 70% of patients and nearly 90% of patients show this impairment when subjected to formal testing. Sleep disorders include parasomnia, insomnia, periodic movements of the limbs, restless leg syndrome, akathisia, and excessive daytime sleepiness. Neuropsychiatric features may include apathy, generalised anxiety, panic attacks, and typically mild depression. The appearance of

autonomic dysfunction can cause constipation, delayed gastric emptying, urinary urgency or incontinence, erectile dysfunction, and orthostatic hypotension. Patients may also suffer from pain, paresthesias and burning sensations. Additionally, approximately 30% of patients with PD develop dementia. The probability of dementia increases with the duration of the disease and is often accompanied by hallucinations and psychosis (Tolosa et al., 2021).

Medications for managing motor symptoms in Parkinson's disease mainly focus on dopamine. Initial treatments often include levodopa formulations, dopamine agonists, catechol-o-methyl transferase (COMT) inhibitors, and monoamine oxidase-B (MAO-B) inhibitors. Dopamine replacement therapy may cause some side effects such as impulse control disorders or psychosis (Weintraub et al., 2022). In younger patients with significant tremor, anticholinergic medications may be beneficial. However, it is necessary to proceed with caution considering the risk of undesirable side effects impacting cognitive function (Fox et al., 2018). As PD advances, patients often need to take levodopa more frequently (such as every 2-3 hours) and in larger amounts. This increase is due to the progression of the disease, which leads to a diminished long-duration response to dopaminergic treatments and a reduced short-duration response caused by disease-related changes in the brain (Chou et al., 2018).

Supportive therapy may include physical activity and physiotherapy. Effective exercise strategies for PD encompass various approaches such as gait and balance training (Mak et al., 2017), progressive resistance training (Chung et al., 2016), strength training , aerobic activities (Mak et al., 2017), music and dance therapies (Lötzke et al., 2015; Zhang et al., 2017), and tai chi (Yang et al., 2014). Research on the impact of physical exercise on various nonmotor symptoms of PD is still insufficient. Furthermore, standard exercise regimens often fail to attract patients with PD (Ellis et al., 2013). Key obstacles to exercise among individuals with PD include low expectations of its benefits, lack of time, and fear of falling (Rios Romenets et al., 2015).

There is a noticeable connection between music and dopamine release in the mesolimbic dopaminergic reward system. Emotional states triggered by music enhance reward signals through the release of dopamine from the ventral tegmental area. This phenomenon may be useful in explaining why musical experiences can be intensely pleasurable stimuli (Menon & Levitin, 2005). When it comes to dancing, Argentine tango can be especially beneficial for functional mobility and improving balance in people with PD (Hackney & Earhart, 2009). The social interactions and support systems connected to dancing classes may positively influence mood and encourage to the activities (Foster et al., 2013). In

addition, the technique of tango involves specific steps that synchronise forward and backward walking with the rhythm, making it potentially effective for addressing freezing of gait and preventing falls (Brichetto et al., 2006).

Clinical evidence

The impact of tango on PD has been evaluated in several clinical studies. In 2015 a randomised control trial study was performed (Rios Romenets et al., 2015). Participants were randomized into tango or control groups. The tango intervention included 24 partnered classes for 12 weeks, with sessions twice a week. The partners were mainly spouses, friends, or volunteers from the dance studio. Participants learned a 90-second dance routine after five classes. The control group followed their regular pharmacological treatment and received a pamphlet on PD exercises to practice at home. There were no significant differences in PD duration, age, or Movement Disorder Society-Unified Parkinson Disease Rating Scale (MDS-UPRDS3) scores between those who adhered to the study and those who dropped out. At baseline, controls had a higher prevalence of falls (47% vs. 6%) and were more likely to exercise regularly (93% vs. 50%) and for more hours per week (4.5 vs. 2.1), particularly in muscle strength/endurance exercises (47% vs. 11%). The primary analysis showed no significant reduction in MDS-UPRDS-3 scores for the tango group compared to controls. For motor functions, the tango group showed significant improvement in dynamic balance compared to controls, even after adjustments ($p = 0.013$). An improvement in the pivotal walk was observed in the tango group. Non-motor outcomes indicated a trend towards improved cognitive function and improvement in fatigue for the tango group.

In another study from 2019 (Albani et al., 2019), 10 PD patients (6 males, 4 females; average age 63.1 years) participated in tango therapy. The study involved four weekly home exercise sessions, each lasting one hour, and a weekly two-hour group session. The results showed a significant improvement in the UPDRS3 (Unified Parkinson's Disease Rating Scale) scores after the first tango s ssion (mean score decreased from 28.67 to 24.44, $p < 0.01$), but reaction times did not change significantly. After five weeks of home practice, the UPDRS scores improved from 28.67 to 25.1 ($p < 0.01$), and the Parkinson's disease questionnaire (PDQ-39) scores improved from 24.44 to 21.11 ($p < 0.05$). Kinematic analysis revealed an increase in stride cadence and some patients showed improved pelvic position during gait.

The 2020 study (Peter et al., 2020) aimed to find out if Argentino tango reduces the risk of falling in patients with PD. Twenty individuals who had degenerative movement

disorders such as PD participated in the study. Eleven (six PD, five non-PD) were in tango lessons and nine PD patients were in the control group. Results indicated that the PD participants in the tango group experienced a significant reduction in fall risk compared to the control group, with a significant interaction between the groups ($P < .01$). During the intervention period, the control group showed the expected increase in fall risk due to the degenerative nature of PD, while the tango group with PD showed a decrease in fall risk, aligning with the hypothesis of the study and other studies measuring subjective motor skills. The non-PD tango group showed no significant improvement during the intervention.

The prospective controlled trial performed in 2019 (Rawson et al., 2019), examined the impact of three exercise interventions—tango, treadmill walking, and stretching—on gait and mobility in individuals with PD. A total of 96 participants (average age: 67.2±8.9 years, 42% being female) diagnosed with mild to moderate idiopathic PD were sequentially assigned to one of three groups: tango dancing, treadmill walking, or stretching. Regarding forward velocity, there were no significant effects for time, group, or their interaction. For the six-minute walk test (SMWT), the tango group showed the greatest improvement from baseline to post-test, but also decreased more than the other groups from post-test to follow-up. In conclusion, the tango group did not show any notable changes in the study.

To explore the personal experiences and perceptions of people with PD in tango classes, a qualitative study design (Beerenbrock et al., 2020) was performed. This study aimed to uncover a wide range of participant experiences without preconceived biases. Eligibility required participants to be diagnosed with PD, as self-reported rather than medically verified. All participants had to complete at least ten dance lessons in a PD-specific tango course. Ten women and eleven men aged 38-82 years were interviewed. Through qualitative content analysis, five primary categories were inductively identified: body awareness, motor symptoms and movement, body sensations, general feelings, disease-related feelings, and attitudes. The study found that patients observed improvements in body awareness, stability, walking safety, mobility, and the quality of gestures and facial expressions. In general, participants reported a reduction in fatigue, anxiety, shame, and frustration, alongside an increase in joy, pride, curiosity, and improved partnership dynamics. Tango classes made them feel healthier and led to better acceptance of their disease and greater self-confidence.

Furthermore, a two-arm randomised controlled trial (Poier et al., 2019) was carried out to investigate the impact of Argentino tango versus tai chi on quality of life in patients with PD. Participants with PD, aged 50 to 90, were enrolled. Each participant was paired with a

non-PD partner, usually a spouse but sometimes a relative, for the interventions: Argentino tango or Tai Chi. Participants were randomly assigned to the Argentino tango or Tai Chi group using a computer-generated list. Both groups participated in a 10-week intervention, with one-hour weekly sessions. In general, 14 patients and their partners received tango and 15 received Tai Chi. The study found that there were no significant improvements in both groups. Both interventions showed a trend toward a difference only on the "Emotional well-being" subscale of PDQ-39 at the end of the study. However, patients in the tango group reported better emotional well-being ($p = 0.039$) after 10 weeks of intervention compared to the Tai Chi group.

The 2020 case report (Koh & Noh, 2020) showed the impact of tango therapy on two patients with PD, both without prior dance experience. They underwent 10 hours of structured Argentine tango therapy over two weeks. Both patients showed significant improvements after this short-term intervention. The first patient was a 67-year-old woman with PD and a history of motor disturbances and gait problems. Post-therapy evaluations showed significant improvements. The UPDRS score dropped from 32 (indicating moderate severity) to 15 (indicating mild severity). The gait analysis indicated better balance and reduced freezing. The patient's posture improved, and she experienced fewer falls and better sleep. Overall, tango therapy effectively improved her PD symptoms in a short duration of two weeks. Next patient was a 79-year-old male patient with PD. His condition included severe motor disturbances, such as tremors, bradykinesia, and a stooped posture. After 10 hours of tango therapy, his UPDRS score improved from 105 (stage 4) to 82 (stage 3), and the Berg Balance Scale score increased from 2 to 12. His posture became more upright, and while his stepping pattern showed some improvement, he still experienced some gait issues. Therapy led to a notable reduction in festination and a partial improvement in stride width and stability, although freezing symptoms persisted.

Another case series study (Abraham et al., 2024) from 2024 aimed to explore the impact of internally guided (IG) versus externally guided (EG) adapted tango (AT) dance training. Six participants were randomly assigned to the roles of IG ("Leader") or EG ("Follower"). Participants, aged 61–78, were all retired, lived independently, and varied in their exercise routines from daily activity to occasional walking. Participants attended 20 90-minute AT classes for 12 weeks, aiming for two classes per week. People with PD always danced with people without PD, such as caregivers or student volunteers. EG participants showed greater improvement and maintenance across more outcomes in all domains

compared to IG participants. Five participants showed improvements in PD motor symptoms, global cognitive function, and the Freezing of Gait (FOG) Questionnaire either immediately or one month post-intervention. All participants noticed improvements in walking, balance, and endurance. In conclusion patients in both roles showed ameliorations in outcome measures.

A pilot study from 2024 (Rabini et al., 2024) aimed to assess the efficacy of tango and physical therapy on motor and cognitive skills in PD. It involved 24 individuals diagnosed with idiopathic PD. Participants, aged 51 to 82, were divided into two groups—Tango and Physiotherapy—with 12 patients each. Interventions consisted of 60 minute sessions twice a week for four months. The Tango group involved 12 patients with PD paired with healthy volunteers for each session, facilitated by experienced tango instructors. Both the leading and the following roles were practised. Thanks to this study, a general stabilisation of motor and cognitive abilities was observed in several motor skills, mainly related to static and dynamic balance, in both groups. Improvement in facial emotion recognition was only shown in PD patients assigned to the tango group. These findings highlight the positive effects of group-based physical interventions, particularly tango which may lead to improvements in emotion recognition.

Conclusions

In conclusion there are numerous studies testing impact of tango dance on patients with PD. Results are still inconclusive, but we can observe that interventions including tango dance tend to improve various PD symptoms. Through an extensive review of current clinical evidence, including randomized controlled trials, case reports and pilot studies, we can observe that interventions based on tango dancing may lead to significant improvement in dynamic balance, stability, mobility, and reduction in fall risk. Some studies suggest improvement in cognitive functions and in the quality of gestures and facial expressions. Patients who have participated in tango dance exercises also reported a reduction in fatigue, anxiety, and frustration related to the disease. Future studies are needed to assess whether tango dance indeed shows superior outcomes compared to different physical activities in patients with PD. As of right now, it seems that tango dance is one of the promising complementary treatment methods in this group of patients.

Authors' Contributions: Conceptialisation was done by Magdalena Muzyk; methodology by Magdalena Muzyk and Weronika Duda; software by Michał Bado; checking by Patrycja Nowoświat; formal analysis by Michał Goncerz; investigation by Patrycja Mrowczyk;

resources by Krzysztof Bilecki; data curation by Paulina Bednarczyk; writing-rough preparation by Patrycja Mrowczyk; writing - review and editing by Ewa Katarzyna Makala; visualisation by Patrycja Mrowczyk; supervision by Maria Maślankiewicz; project administration by Sandra Agnieszka Pilawska;

All authors have read and agreed with the published version of the manuscript.

Funding statement

The study did not receive special funding.

Informed Consent Statement

Not applicable.

Acknowledgements

Not applicable.

Conflict of Interest Statement

The authors report that there are no conflict of interest.

References:

Abraham, A., Hart, A., Bozzorg, A., Pothineni, S., Wolf, S. L., Schuh, K., Caughlan, M., Parker, J., Blackwell, A., Tharp Cianflona, M., Asker, C., Prusin, T., & Hackney, M. E. (2024). Comparison of externally and internally guided dance movement to address mobility, cognition, and psychosocial function in people with Parkinson's disease and freezing of gait: a case series. *Frontiers in Aging Neuroscience*, *16*. https://doi.org/10.3389/fnagi.2024.1372894

Albani, G., Veneziano, G., Lunardon, C., Vinci, C., Daniele, A., Cossa, F., & Mauro, A. (2019). Feasibility of home exercises to enhance the benefits of tango dancing in people with Parkinson's disease. *Complementary Therapies in Medicine*, *42*, 233–239. https://doi.org/10.1016/j.ctim.2018.10.028

Beerenbrock, Y., Meyer, L., Böhme, J., Herrlich, S., Mews, S., Berger, B., Martin, D., & Büssing, A. (2020). Perceived effects of Tango Argentino on body experience in persons with Parkinson's disease (PD)—A qualitative study with affected persons and their partners. *Complementary Therapies in Medicine*, *48*. https://doi.org/10.1016/j.ctim.2019.102221

Bloem, B. R., Okun, M. S., & Klein, C. (2021). Parkinson's disease. In *The Lancet* (Vol. 397, Issue 10291, pp. 2284–2303). Elsevier B.V. https://doi.org/10.1016/S0140-6736(21)00218-X

Brichetto, G., Pelosin, E., Marchese, R., & Abbruzzese, G. (2006). Evaluation of physical therapy in parkinsonian patients with freezing of gait: a pilot study. In *Clinical Rehabilitation* (Vol. 20).

Chou, K. L., Stacy, M., Simuni, T., Miyasaki, J., Oertel, W. H., Sethi, K., Fernandez, H. H., & Stocchi, F. (2018). The spectrum of "off" in Parkinson's disease: What have we learned over 40 years? In *Parkinsonism and Related Disorders* (Vol. 51, pp. 9–16). Elsevier Ltd. https://doi.org/10.1016/j.parkreldis.2018.02.001

Chung, C. L. H., Thilarajah, S., & Tan, D. (2016). Effectiveness of resistance training on muscle strength and physical function in people with Parkinson's disease: A systematic review and meta-analysis. In *Clinical Rehabilitation* (Vol. 30, Issue 1, pp. 11–23). SAGE Publications Ltd. https://doi.org/10.1177/0269215515570381

Ellis, T., Boudreau, J. K., DeAngelis, T. R., Brown, L. E., Cavanaugh, J. T., Earhart, G. M., Ford, M. P., Foreman, K. B., & Dibble, L. E. (2013). Barriers to exercise in people with parkinson disease. *Physical Therapy*, *93*(5), 628–636. https://doi.org/10.2522/ptj.20120279

Foster, E. R., Golden, L., Duncan, R. P., & Earhart, G. M. (2013). Community-based argentine tango dance program is associated with increased activity participation among individuals with parkinson's disease. *Archives of Physical Medicine and Rehabilitation*, *94*(2), 240–249. https://doi.org/10.1016/j.apmr.2012.07.028

Fox, S. H., Katzenschlager, R., Lim, S. Y., Barton, B., de Bie, R. M. A., Seppi, K., Coelho, M., & Sampaio, C. (2018). International Parkinson and movement disorder society evidence-based medicine review: Update on treatments for the motor symptoms of Parkinson's disease. In *Movement Disorders* (Vol. 33, Issue 8, pp. 1248–1266). John Wiley and Sons Inc. https://doi.org/10.1002/mds.27372

Hackney, M. E., & Earhart, G. M. (2009). Effects of dance on movement control in Parkinson's disease: A comparison of Argentine tango and American ballroom. *Journal of Rehabilitation Medicine*, *41*(6), 475–481. https://doi.org/10.2340/16501977-0362

Koh, Y., & Noh, G. (2020). Tango therapy for Parkinson's disease: Effects of rush elemental tango therapy. *Clinical Case Reports*, *8*(6), 970–977. https://doi.org/10.1002/ccr3.2771

Lötzke, D., Ostermann, T., & Büssing, A. (2015). Argentine tango in Parkinson disease - a systematic review and meta-analysis. *BMC Neurology*, *15*(1). https://doi.org/10.1186/s12883-015-0484-0

Mak, M. K., Wong-Yu, I. S., Shen, X., & Chung, C. L. (2017). Long-term effects of exercise and physical therapy in people with Parkinson disease. In *Nature Reviews Neurology* (Vol. 13, Issue 11, pp. 689–703). Nature Publishing Group. https://doi.org/10.1038/nrneurol.2017.128

Menon, V., & Levitin, D. J. (2005). The rewards of music listening: Response and physiological connectivity of the mesolimbic system. *NeuroImage*, *28*(1), 175–184. https://doi.org/10.1016/j.neuroimage.2005.05.053

Muslimovic, D., Post, B., Speelman, J., Schmand, B., de Haan, R., & Epidemiology, C. (2008). Determinants of disability and quality of life in mild to moderate Parkinson disease From the Departments of Neurology (D. In *Neurology* ® (Vol. 70). www.neurology.org

Peter, S., Crock, N. D., Billings, B. J., Wu, R., Sterling, S., Koul, S., Taber, W. F., Pique, K., Golan, R., & Maitland, G. (2020). Argentine Tango Reduces Fall Risk in Parkinson's Patients. In *Journal of the American Medical Directors Association* (Vol. 21, Issue 2, pp. 291–292). Elsevier Inc. https://doi.org/10.1016/j.jamda.2019.10.009

Poier, D., Rodrigues Recchia, D., Ostermann, T., & Büssing, A. (2019). A Randomized Controlled Trial to Investigate the Impact of Tango Argentino versus Tai Chi on Quality of Life in Patients with Parkinson Disease: A Short Report. *Complementary Medicine Research*, *26*(6), 398–403. https://doi.org/10.1159/000500070

Rabini, G., Meli, C., Prodomi, G., Speranza, C., Anzini, F., Funghi, G., Pierotti, E., Saviola, F., Fumagalli, G. G., Di Giacopo, R., Malaguti, M. C., Jovicich, J., Dodich, A., Papagno, C., & Turella, L. (2024). Tango and physiotherapy interventions in Parkinson's disease: a pilot study on efficacy outcomes on motor and cognitive skills. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-62786-6

Rawson, K. S., McNeely, M. E., Duncan, R. P., Pickett, K. A., Perlmutter, J. S., & Earhart, G. M. (2019). Exercise and Parkinson Disease: Comparing Tango, Treadmill, and

Stretching. *Journal of Neurologic Physical Therapy*, *43*(1), 26–32. https://doi.org/10.1097/NPT.0000000000000245

Rios Romenets, S., Anang, J., Fereshtehnejad, S. M., Pelletier, A., & Postuma, R. (2015). Tango for treatment of motor and non-motor manifestations in Parkinson's disease: A randomized control study. *Complementary Therapies in Medicine*, *23*(2), 175–184. https://doi.org/10.1016/j.ctim.2015.01.015

Tolosa, S., Scholz, W., Tolosa, E., Garrido, A., Scholz, S. W., & Poewe, W. (2021). Challenges in the diagnosis of Parkinson's disease. In *Lancet Neurol* (Vol. 20). www.thelancet.com/neurology

Weintraub, D., Aarsland, D., Chaudhuri, K. R., Dobkin, R. D., Leentjens, A. F., Rodriguez-Violante, M., & Schrag, A. (2022). The neuropsychiatry of Parkinson's disease: advances and challenges. In *The Lancet Neurology* (Vol. 21, Issue 1, pp. 89–102). Elsevier Ltd. https://doi.org/10.1016/S1474-4422(21)00330-6

Yang, Y., Li, X. Y., Gong, L., Zhu, Y. L., & Hao, Y. L. (2014). Tai chi for improvement of motor function, balance and gait in Parkinson's disease: A systematic review and meta-analysis. In *PLoS ONE* (Vol. 9, Issue 7). Public Library of Science. https://doi.org/10.1371/journal.pone.0102942

Ye, H., Robak, L. A., Yu, M., Cykowski, M., & Shulman, J. M. (2023). Genetics and Pathogenesis of Parkinson's Syndrome. In *Annual Review of Pathology: Mechanisms of Disease* (Vol. 18, pp. 95–121). Annual Reviews Inc. https://doi.org/10.1146/annurev-pathmechdis-031521-034145

Zhang, S., Liu, D., Ye, D., Li, H., & Chen, F. (2017). Can music-based movement therapy improve motor dysfunction in patients with Parkinson's disease? Systematic review and meta-analysis. *Neurological Sciences*, *38*(9), 1629–1636. https://doi.org/10.1007/s10072-017-3020-8