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REVIEW

# Strategies to encourage physical activity in patients with Parkinson's disease: improving quality of life



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**Abstract:** The purpose of this article is to discuss strategies to encourage physical activity in patients with Parkinson's disease (PD), to consider the effect that physical activity and exercise has on the quality of life in individuals with PD, identify types of physical activity and exercise most recently and best supported by research, and to explore ways to customize physical exercise to PD patients based on stage and severity. Through research, recommendations are made to encourage physical activity and overcome barriers that may hinder participation in physical activity and exercise across different stages of PD.

**Keywords:** Parkinson's disease, physical activity, barriers, exercise, quality of life

## Introduction

Parkinson's disease (PD) is a chronic and progressive neurodegenerative disorder of the basal ganglia, characterized by neuronal loss predominantly involving the substantia nigra and striatal dopaminergic neurons. Failure of normal dopamine connections result in abnormal downstream basal ganglia synaptic connections, some of which are modulated through glutamatergic pathways.[1–3] This pathological process can lead to the cardinal signs of PD including: bradykinesia, rigidity, resting tremor, and postural instability.[4,5] Over time, changes in ambulation, functional mobility, and ability to perform activities of daily living can occur with a resultant decrease in individual's quality of life.[6] Pharmacological and surgical intervention look to improve this disability process.[7] In recent years, studies have also suggested the benefits of physical activity in patients with PD.[8–14]

Through research, we have begun to understand the mechanisms by which functional activity, training, and physical exercise facilitates improvement in motor behavior in patients with PD. Several mechanisms through animal and human studies have alluded to modulation of neuronal function and structure in promoting neuroplasticity and neurorestoration.[11,15] These mechanisms include both adaptive and protective changes in the circuitry of the basal ganglia, involving both dopaminergic and glutaminergic pathways as well as brain-derived neurotrophic factors (BDNF), leading to long-term benefits and disease modification in PD.[16,17]

Through research, we have begun to establish guidelines for generalized exercise regimens including the addition of balance and strengthening,[18,19] as well as use of flexibility training[20] in patients with PD. However, in the recent decade, a number of clinical studies have also begun to investigate the effectiveness and feasibility of specific types of physical activity intervention. These intervention types include: amplitude-specific training (ie, LSVT BIG),[21–24] rhythmic dance training (ie, tango),[25,26] functional

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balance training (ie, yoga),[27] and treadmill training (including body weight support training).[28]

This paper will aim to highlight strategies to encourage physical activity in PD patients, the effects of physical activity and exercise on the quality of life of individuals with PD, identify types of physical activity most recently and thoroughly supported by research and literature, and identify common barriers to participating in physical activity and ways to overcome barriers that may hinder participation in physical activity through the different stages of PD.

## Methods and materials

A complete literature review was performed on PubMed that included the terms such as exercise and Parkinson's disease, Parkinson's and physical activity, Parkinson's, exercise and neuroplasticity, Parkinson's disease, exercise and quality of life, exercise and disease progression, dance and Parkinson's disease, Yoga and Parkinson's disease, Tai chi and Parkinson's disease, Parkinson's disease, animal models and exercise between 1970 and 2015; all peer-reviewed articles and abstracts were included.

## Animal studies and exercise

In review of the literature, much of our understanding of the neurobiological changes in exercise was being derived from animal studies. These neurotoxin-based animal models have demonstrated potential effects of exercise in Parkinson's disease; those benefits included motor skill training, neuroplasticity, and neurorestoration.[29–32] Increased dopamine levels and improved response to dopamine-replacement therapies as well as improvements noted in the dopamine handling and neurotransmission[33–36] were documented in these animal models.

Studies have demonstrated neuroprotective effects of exercise in PD, though not completely understood this is implied through dopaminergic and/or downstream compensatory mechanisms, increased expression of BDNF,[17,37–39] alterations in glutamatergic receptor expression are well known basis for neuronal death in many neurodegenerative diseases.[40] Changes in glutamatergic neurotransmission induced via exercise, including changes in glutamate and glutamatergic receptor families such as NMDA or AMPA, are well-established, critical components of neuroplastic changes by altering glutamate release, glutamate receptor expression, which leads to attenuation of glutamatergic hyperexcitability.[41–43] These alterations help restore normal synaptic plasticity of the neurodegenerative basal ganglia, resulting in restoration of motor behavior.[44,45]

Collectively, these studies demonstrate that alterations in dopaminergic and glutamatergic neurotransmission modulate corticostriatal hyperexcitability, which in turn leads to improvement of exercise-induced behavior.

## Human studies of exercise in PD

In the recent decade, clinical studies of exercise in individuals with PD have generated a great deal of interest in the ability of exercise to perhaps restore brain function and/or modify disease[46,47] as well as the effect of exercise on response of dopamine-replacement therapies.[48,49]

Numerous studies support use of exercise in modulating brain function in individuals with PD.[50–53] Petzinger et al[35,54,55] and several other researchers[56,57] were able to demonstrate that intensive treadmill training over 24 sessions showed an improvement in gait velocity, stride length, step length, and hip and ankle joint excursion. Improvement of weight distribution during sit-to-stand through the use of transmagnetic stimulation during these treadmill training sessions showed exercise-induced lengthening of cortical changes. Also, effects of intensive treadmill training was similarly shown via positron emission tomography 18F-fallypride imaging, which was able to demonstrate increased dopamine $D_2$ receptor expression via an increase in binding potential of $D_2$ receptor expression[58] in participants with PD.[55]

Other studies have shown that these changes might not necessarily be cortical but related to changes in behavior and generalized motor benefit perhaps owing to improvement in muscle memory.[59,60]

Accelerometer gait analysis[61] is a valuable tool for obtaining quantitative information on motor deficits in PD with current applications of accelerometers in gait and balance evaluation, fall risk assessment, and mobility monitoring. Hence it provides an added objective and quantitative dimension to gait analysis when combined with clinical assessment[62] for defining benefits of physical activity and rehab in patients with PD.

The greatest impairment from PD is seen in the areas related to physical and social functioning.[63] Effect of physical activity and exercise on health-related quality of life (HRQoL) of individuals with PD has been well established in the literature.[12,64–66] Subsequently, there have been a number of recent studies exploring the effect of exercises for individuals with PD, particularly in relation to motor behaviors and quality-of-life determinants. These studies have found links between exercise programs and improvement in several factors related to HRQoL[67,68] as well as to individuals'

perceived improvement in quality of life after engaging in an exercise program.[13]

In addition to the benefits of physical activity and exercise on motor symptoms of PD, benefits on nonmotor symptoms of PD including cognitive and affective benefits have been described.[69–72] Although the link between exercise and improvement in quality of life for individuals with PD is becoming more accepted, the specific mechanism continues to be investigated.

## Types of physical activity and exercise most recently and best supported by research

As research points to a positive effect of exercise on quality of life for individuals with PD, often patients want to know what type of exercises should be incorporated into their daily lives. Certain overall aspects of exercise have been demonstrated to consistently improve quality of life, including strengthening, balance,[18,19] and flexibility training.[20] Many recent studies have investigated different exercise types and their impact on PD symptomatology and HRQoL. These exercise types can be loosely categorized into several categories including amplitude-specific training (ie, LSVT BIG),[22–24] rhythmic dance training (ie, tango), functional balance training (ie, yoga), gait/treadmill training (including body weight support training), and other exercise programs such as boxing.

Amplitude-specific training emphasizes high-intensity, repetitive, progressively challenging activities in an attempt to counteract the commonly early seen symptoms of bradykinesia.[24,60,73–75] Amplitude-specific training for individuals with PD has demonstrated an improvement in Unified Parkinson's Disease Rating Scale (UPDRS) scores, several aspects of ambulation including starting/stopping, and quality and degree of functional reach.[18,66,76,77]

Rhythmic dance training includes several styles of dance (tango, ballroom, etc). The rhythmic nature of the dancing is thought to have a positive effect on several aspects of movement in individuals with PD by emphasizing repetitive multidirectional stepping and balance;[64] some have shown the power of cueing in freezing of gait and gait disturbances in PD.[78,79] Both tango[80,81] and ballroom dancing have been shown to have a positive effect on standing balance, UPDRS scores, and ambulation starting/stopping.[82–84]

Functional balance training includes exercise programs like yoga, tai chi, and boxing. Several studies demonstrate the positive effect of yoga[85] and tai chi[86,87] on gait and balance in PD patients. Some of these studies have also shown a trend toward reduction of depression score or increased awareness of emotional well-being.[88]

Studies involving the use of boxing as an intervention type demonstrated improvements in balance, gait, disability score, and quality-of-life scores for the majority of participants. Also, individuals with PD were able to demonstrate the ability to perform group therapy sessions and prolonged duration exercise sessions (more than 60 minutes) without difficulty, demonstrating endurance to perform these types of exercises. Therefore, perhaps a regular exercise regimen in itself improves endurance in PD.[89]

Sensorimotor agility exercise programs strive to incorporate several different types of functional balance training exercises (including tai chi, boxing, etc) to emphasize improved coordination, improved motor program selection, and improved sensory integration.[21]

Gait/treadmill training has also been investigated for its effect on quality of life, improvement in gait stride, and balance. Treadmill training through an external cue[79] enhances rhythmicity and reduces variability in gait, and decreases stride/swing time variability, leading to a more stable gait.[90] Intensive treadmill training has also demonstrated improvements in several aspects of motor deficit including UPDRS scores, gait speed, cadence, and perceived physical performance.[28,50,91,92]

In summary, all the different types of exercise programs have been shown to demonstrate improvement in movement impairments including balance, some areas of ambulation, as well as improvement for various aspects of quality of life. Each of the exercise programs incorporate varying amounts of focus on strengthening, balance, and flexibility. However, studies comparing the effect of one type of intervention over another are limited.

## Common barriers to participating in physical activity and exercise

Literature has shown that both dose and intensity of exercise matter.[68] The Centers for Disease Control and Prevention recommends that all older adults need at least 150 minutes a week of at least moderate intensity aerobic activity, such as brisk walking and muscle-strengthening activities on two or more days a week for important health benefits.[93] Currently, a vast majority of patients do not have a regular exercise program.

Furthermore, patients with PD often report other barriers to participating in exercise programs, including fear of falling, lack of exercise knowledge, lack of motivation, low expectation, lack of time, lack of transportation, lack of monetary support, or difficulty with medical coverage.

## Developing physical activity and exercise strategies for patients with PD

### Education

The role of physical activity and exercise in PD should be clearly communicated to our patients. Often, early into the diagnosis of PD, most physician communication centers on symptomology and medication management in the initial stages of PD. Care should be taken to also discuss physical activity as a modifying agent with a referral to an exercise specialist or physical therapist if the patient is unfamiliar with what or how to exercise. Support groups and structured educational seminars may also be helpful for newly diagnosed PD patients or family members. Community-based programs may be effective in alleviating some of the psychosocial limitations, as they not only offer a place for social support but also offer a way to have group exercise therapy.

### Prevention

Traditionally, most referrals to rehabilitative services are initiated after PD patients report having significant changes in mobility (falls, fracture, or dependence on caregivers). However, the literature demonstrates the effect of different types of exercise programs and a dose-dependent effect on PD with more persistent and positive effects in patients with mild-to-moderate PD as compared to individuals with severe PD.[24,57,66,94] This suggests that giving patients the tools to success starts with early implementation of exercise programs. Early referral to physical or occupational therapy may play a role in improving exercise knowledge, decreasing fear of falling with exercise, and setting up patients with home programs[95] that may limit monetary or transportation barriers. The literature in itself has not documented the translation of physical therapy to home exercise, but guidance in exercise therapy and self-exercise will attempt to solve these problems.

### Customization

Although the key diagnostic factors for individuals with PD are the same, each individual with PD may report varying degrees of functional loss or psychological impairment. The key to a successful development of an exercise regimen is to customize these programs taking into account an individual's barriers to exercise as well as their stage of severity. Patients with low disease severity may show improvements more quickly and may progress to nonsupervised therapies more efficiently. Patients with lower disease severity states can perform more challenging balance and gait exercises. However, patients with more progressed disease or higher disease severity states may require more supervision for longer duration in order to minimize environmental risks such as risk of falls. This is where regular health utilization of physical therapists in the form of either outpatient or home health rehabilitation remains a mode for more supervised exercise programs.

## Conclusion

Early introduction to exercise therapy should be key and adjunctive to PD management. Through animal and human studies, disease-modifying benefits of exercise have been established. Behavioral strategies targeting barriers may help to improve compliance to exercise. Hence early implementation, early intervention, and early referral are important strategies to establishing and encouraging physical activity and exercise programs in PD.

## Disclosure

The authors report no conflicts of interest in this work.

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