

# **Exercise as a Therapeutic Strategy in Parkinson's Disease Management: A Comprehensive Review**

## **Abstract**

This paper provides a comprehensive review of the role of exercise in managing Parkinson's Disease (PD), a neurodegenerative disorder characterized by motor and non-motor symptoms. While current pharmacological treatments offer some relief, they often come with adverse reactions. This review highlights the benefits of exercise as a complementary approach to PD management. Exercise has been found to have neuroprotective effects, reduce motor symptoms, improve functional mobility, balance, and gait performance, and enhance quality of life. Exercise also mitigates common adverse drug reactions associated with PD treatment. Various forms of exercise, including Tai Chi, dancing, resistance training, walking programs, biking, aquatic therapy, non-contact boxing, yoga, virtual reality exercise, treadmill training, and sensory training have shown promising results, in addition to PD-specific exercise protocols based on these activities. This paper underscores the need for further research to establish standardized exercise protocols for PD patients and to integrate exercise into routine PD care.

## **Keywords**

## **Introduction**

Parkinson's Disease (PD) is a prevalent neurodegenerative disorder that significantly impacts the lives of millions of individuals worldwide. Current statistics indicate that the incidence, mortality, and morbidity of PD are on the rise, underscoring the urgent need for effective management strategies.<sup>1</sup>

The pathophysiology of PD is characterized by a progressive loss of neurons within the substantia nigra, a region of the brain that plays a crucial role in reward and movement.<sup>2</sup> This

neuronal loss leads to a decrease in the production of dopamine, a neurotransmitter that is essential for normal motor function. As a result, PD patients often experience a range of motor symptoms, including bradykinesia (slowness of movement), rigidity, and tremors.<sup>3</sup>

In addition to these motor symptoms, PD patients may also experience non-motor symptoms such as depression, cognitive impairment, and sleep disturbances, which can further reduce their quality of life.<sup>4</sup>

Current pharmacological treatments for PD primarily aim to restore dopamine levels in the brain.

However, these treatments are not without their drawbacks. They can cause adverse drug reactions, including orthostatic hypotension, which can increase the risk of falls in PD patients.<sup>5</sup>

Given these challenges, there is a growing interest in exploring alternative or complementary strategies for managing PD. However, it is also important to consider potential barriers to participation in these programs and to work towards solutions that will enable more PD patients to reap the benefits of exercise.<sup>6</sup> The subsequent sections of this paper will delve into the potential benefits of exercise programs for PD patients, including their impact on symptoms commonly experienced by these patients, and the potential for these programs to mitigate the adverse effects of pharmacological treatments.

## **Benefits that Exercise May Provide for PD Patients**

### **Neuroprotective effects**

Exercise has been shown to have neuroprotective effects in Parkinson's Disease (PD) patients, contributing to the management of the disease's symptoms and potentially slowing its progression. These effects are multifaceted and include enhanced neuroplasticity, increased levels of brain-derived neurotrophic factor (BDNF), increased cerebral gray matter volumes,

improved corticomotor excitability, mitigation of effects of dopaminergic neurotoxins, and increased dopamine release.<sup>2,7</sup>

Neuroplasticity, the brain's ability to reorganize itself by forming new neural connections, is enhanced by exercise. This increased neuroplasticity can help the brain compensate for the loss of dopaminergic neurons in PD, potentially slowing the progression of the disease and improving motor function. In a study by Langer et al.,<sup>2</sup> PD patients who participated in a program of aerobic exercise showed significant improvements in neuroplasticity.

Exercise also increases levels of BDNF, a protein that supports the survival of existing neurons and encourages the growth and differentiation of new neurons and synapses. Increased BDNF levels can help protect the remaining dopaminergic neurons in PD patients, further contributing to the management of motor symptoms. Lima et al.<sup>7</sup> found that resistance training led to increased BDNF levels in PD patients.

Furthermore, exercise has been shown to increase cerebral gray matter volumes and improve corticomotor excitability, both of which can contribute to improved motor function in PD patients. In the study by Langer et al.,<sup>2</sup> aerobic exercise was associated with increased cerebral gray matter volumes and improved corticomotor excitability.

Exercise can also mitigate the effects of dopaminergic neurotoxins, which can exacerbate the neuronal loss in PD. By increasing the release of dopamine, exercise can help manage the motor symptoms of PD. For instance, Lima et al.<sup>7</sup> found that resistance training led to increased dopamine release in PD patients.

Finally, exercise can alter the responsivity of the ventral striatum, another part of the brain that is involved in motor function. Aerobic exercise, in particular, has been shown to lead to increased ventral striatal activation, which can contribute to improved motor function in PD patients.<sup>7</sup>

Sacheli et al.<sup>8</sup> found that high-intensity treadmill exercise increases caudate dopamine release and ventral striatal activation in PD patients, which can help manage the motor symptoms of PD.

### **Decreased severity of motor symptoms**

Exercise has been found to significantly reduce the severity of motor symptoms in Parkinson's Disease (PD) patients, thereby enhancing their functional mobility and balance.<sup>2,3</sup> This reduction in motor symptoms is reflected in the decrease of the Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS-III) scores, a standard measure for PD symptoms.<sup>2,5</sup>

In a study by Langer et al.,<sup>2</sup> PD patients who engaged in a structured cycling (SC) program over a period of 6 weeks showed a significant improvement in motor symptoms, as indicated by a decrease of the MDS-UPDRS-III by 9.2 points. This improvement was primarily attributed to the reduction of bradykinesia, a common motor symptom in PD characterized by slowness of movement.<sup>3</sup>

Moreover, exercise has been associated with improved connectivity of the upper centers, particularly the basal ganglia region, which plays a crucial role in motor control.<sup>3</sup> This improved connectivity could explain the significant reduction in motor symptoms and the increase in functional capacity observed in PD patients following exercise interventions.

In addition to these findings, other studies have reported improvements in specific motor impairments such as tremor, falls, freezing of gait, and medication wearing-off among PD patients who participated in exercise programs.<sup>9</sup> These improvements further underscore the potential of exercise in managing the motor symptoms of PD.

Increased functional mobility and balance

Exercise has been shown to significantly enhance functional mobility and balance in patients with Parkinson's Disease (PD), thereby reducing the risk of falls and improving the ability to perform daily living activities.<sup>3</sup>

PD patients who participated in a 6-week SC program demonstrated improved functional mobility and balance, as reflected in the significant reduction in the Movement Disorder Society- Unified Parkinson's Disease Rating Scale (MDS-UPDRS-III) scores.<sup>2</sup> Continuing along the line of their previous study, in Langer et al.<sup>10</sup> PD patients who participated in a multidimensional climbing therapy showed significant improvements in their functional mobility and balance. This form of exercise, which involves a combination of physical and cognitive challenges, was found to be particularly beneficial for PD patients.

Yoga, a form of exercise that involves stretching and prolonged physical postures, has been found to improve balance, body alignment, flexibility, and functional gait in PD patients.<sup>5</sup> An 8-week yoga intervention led to significant improvements in motor function, balance control, and postural stability in PD patients, and also decreased fall rates.<sup>5</sup>

Tai Chi, a Chinese martial art that emphasizes balance, flexibility, and coordination, has been associated with improved balance and functional mobility in PD patients.<sup>4</sup> A systematic review by Yang et al.<sup>4</sup> found that Tai Chi was effective in improving balance and functional mobility, but not in improving gait velocity, step length, or gait endurance.

Furthermore, a study by Gulcan et al.<sup>11</sup> found that a 6-week training program involving exercises in supine, sitting, and standing positions, followed by walking exercises, stretching, and relaxation exercises, led to improved body alignment, mobility, and balance in PD patients. The training program was applied three days a week, with each session lasting approximately one hour, and was accompanied by a physiotherapist.

## **Gait performance**

Gait disturbances, a common occurrence in PD, often lead to falls and loss of independence.

These disturbances manifest as increased cadence and double support phase duration, and decreased step length, swing phase duration, and walking speed.<sup>11</sup>

Exercise interventions, particularly those focusing on large amplitude movements, rhythmical activities, and balance training, have been shown to improve these gait parameters. For instance, treadmill training can enhance walking speed and stride length, while resistance training can bolster muscle strength and power, both of which are crucial for gait performance.<sup>7</sup>

Rhythmical activities such as dancing and cycling can also enhance the cadence and fluidity of gait.<sup>3</sup> A study by Gulcan et al.<sup>11</sup> found that augmented and virtual reality gait training increased step length and improved the swing phase and walking adaptability to environmental changes.

Yoga has been identified as a significant contributor to the improvement of freezing of gait, a common and debilitating symptom in PD patients.<sup>5</sup>

Furthermore, a study by Sangarapillai et al.<sup>12</sup> reported a slight increase in stride length in PD patients following a boxing training program, suggesting that boxing may contribute to improved gait velocity in PD patients.

## **Increased quality of life and emotional wellbeing**

PD significantly impacts not only physical health but also emotional wellbeing and quality of life due to the disease's progressive nature and its effect on daily activities.<sup>7,13</sup>

Exercise has been demonstrated to positively influence the emotional wellbeing of PD patients.

Regular physical activity can mitigate symptoms of depression and anxiety, which are prevalent in PD patients.<sup>2</sup> For example, a six-week program comprising aerobic, strength training, and core

stability exercises significantly reduced depression scores in PD patients, as reported by Langer et al.<sup>2</sup>

Furthermore, exercise can bolster self-efficacy and confidence in PD patients, thereby enhancing their emotional wellbeing. A study by Kwok et al.<sup>14</sup> found that a 90-minute group training program, supplemented with home exercises, led to significant improvements in self-efficacy scores in PD patients.

Exercise can also enhance the quality of life of PD patients by improving their ability to perform daily activities. A 9-week resistance training program was reported to increase the functional capacity of PD patients, enabling them to perform daily activities with greater ease.<sup>3</sup> This improvement in functional capacity can significantly enhance the quality of life of PD patients. Moreover, the Rock Steady Boxing (RSB) program, a group fitness program designed for individuals living with all levels of PD, was found to improve balance, reduce the risk of falls, and enhance overall mobility in PD patients.<sup>9</sup> This improvement in mobility can enhance the quality of life of PD patients by increasing their independence and ability to participate in social activities.

### **Improvement in manual dexterity**

Manual dexterity, defined as the ability to make coordinated hand and finger movements to grasp and manipulate objects, is often compromised in PD patients due to bradykinesia and rigidity.<sup>7</sup> Exercise interventions focusing on fine motor skills can enhance manual dexterity in PD patients. For example, a study by Gulcan et al.<sup>11</sup> found that a 12-week program of hand exercises significantly improved manual dexterity in PD patients.

Tai Chi, characterized by slow, controlled movements, can also enhance fine motor control and coordination, thereby improving manual dexterity. A 12-week Tai Chi program was found to significantly improve manual dexterity in PD patients.<sup>9</sup>

Moreover, a study by Vieira de Moraes Filho et al.<sup>3</sup> reported that a 9-week resistance training program improved grip strength in PD patients. Grip strength, a crucial component of manual dexterity, enables individuals to effectively grasp and manipulate objects.

Boxing training, involving repetitive and rhythmical movements, can also enhance hand-eye coordination and reaction time, thereby improving manual dexterity. A study by Sangarapillai et al.<sup>12</sup> found that a 12-week boxing training program significantly improved manual dexterity in PD patients.

### **Resistance to adverse drug reactions**

The management of PD typically involves medications such as levodopa, which unfortunately can result in side effects like dyskinesia, nausea, and orthostatic hypotension<sup>7</sup>. Exercise has been proposed as a potential tool to alleviate some of these adverse drug reactions. For instance, Langer et al.<sup>2</sup> demonstrated that a six-week regimen of aerobic, strength training, and core stability exercises could diminish levodopa-induced dyskinesia in PD patients.

Exercise's role in improving cardiovascular fitness can also be beneficial in managing orthostatic hypotension, a frequent side effect of PD medications. Vieira de Moraes Filho et al.<sup>3</sup> reported that a 9-week resistance training program bolstered cardiovascular fitness in PD patients, potentially mitigating the risk of orthostatic hypotension.

Additionally, exercise can bolster gastrointestinal function, which can be instrumental in managing nausea, another common side effect of PD medications. Larson et al.<sup>9</sup> discovered that



a 12-week Tai Chi program improved gastrointestinal function in PD patients, potentially decreasing the risk of medication-induced nausea.

Exercise also has the potential to enhance mood and alleviate anxiety, which can help manage the psychological side effects of PD medications. A study by Kwok et al.<sup>14</sup> found that a 90-minute group training program significantly reduced anxiety scores in PD patients.

## **Conclusion**

The benefits of exercise for Parkinson's Disease (PD) patients are multifaceted and significant. Exercise has been shown to have neuroprotective effects, decrease the severity of motor symptoms, enhance functional mobility and balance, improve gait performance, increase quality of life and emotional wellbeing, improve manual dexterity, and enhance resistance to adverse drug reactions. These benefits are derived from a variety of exercise programs, including structured cycling, yoga, Tai Chi, resistance training, boxing, and the Rock Steady Boxing program.

Given these benefits, it is crucial for medical providers to incorporate exercise programs into their management plans for PD patients. However, it is equally important to consider potential barriers that may prevent PD patients from participating in these programs. Factors such as living environment, driving status, educational background, employment status, and income levels can influence a patient's ability to participate in and adhere to an exercise program. Therefore, medical providers should be prepared to discuss these barriers with their patients and work around them to ensure that the patients can reap the benefits of exercise.

Furthermore, the choice of exercise program should be patient-specific, taking into account the patient's physical abilities, preferences, and compliance. A one-size-fits-all approach may not be

effective, as different patients may respond differently to different types of exercise. Therefore, a personalized approach to exercise prescription is essential.

In conclusion, exercise is a valuable tool in the management of PD, offering a range of benefits that can enhance the quality of life of PD patients. Medical providers should therefore consider exercise as a key component of their management plans for PD patients, while also considering the potential barriers to exercise participation and the need for personalized exercise prescription.

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