

PARKINSON'S DISEASE

A Comprehensive Approach to Exercise Prescription for the Health Fitness Professional

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LEARNING OBJECTIVE

- To provide the health fitness professional with the current evidence, considerations, and guidelines for providing exercise counseling for people with mild-to-moderate Parkinson's disease.

Key words:

Neuromuscular Disease, Exercise Training, Physical Function, Functional Fitness, Physical Fitness, Quality of Life, Motor, Nonmotor

INTRODUCTION

The health fitness professional may encounter individuals with mild-to-moderate Parkinson's disease (PD) in fitness and wellness settings because few specialized exercise programs are available for persons with PD. Professional fitness specialists, for the most part, do not lead many of the community and clinically based programs that are offered for persons with PD, and these programs often do not meet current recommendations for exercise training for adults. Although some persons with PD will be referred to physical therapy, this typically is a time-limited intervention, and many of the benefits may be lost after the therapy ends.

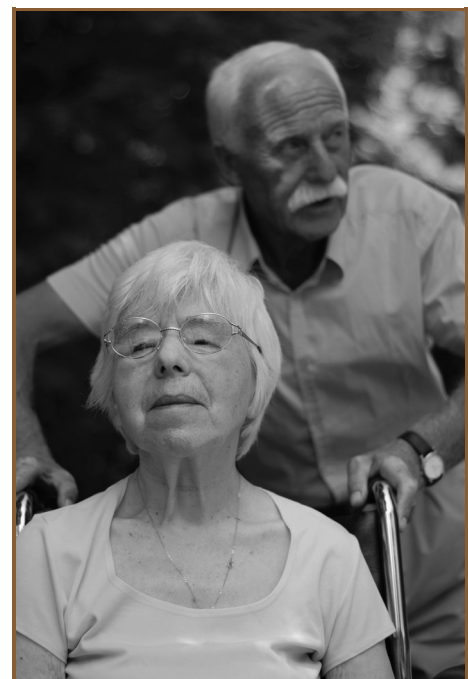
WHAT IS PD?

PD affects initiating, stopping, and coordinating movements, which results in difficulties in carrying out simple and complex motor tasks, including exercise. A neurodegenerative disorder affecting motor control, PD involves a deficiency of the neurotransmitter dopamine in the brain. PD results from the degeneration of dopamine-producing cells (dopaminergic), mostly affecting the basal ganglia and substantia nigra areas of the corpus striatum area of the cerebral hemispheres. In a normal brain, there is a bal-

ance between the neurotransmitters involved in motor control: dopamine, acetylcholine, and γ -aminobutyric acid. An imbalance between these neurotransmitters occurs because of the loss of dopamine in PD and, consequently, results in the abnormal movements observed (29).

Affecting approximately 1 million Americans, PD most commonly is seen in individuals who are ages 50 years and older and in white men. It is less prevalent in women, African Americans, and Asian Americans. Signs and symptoms of the disease usually appear gradually, and PD may not be clinically apparent until degradation of dopamine-producing cells is as high as 80%. The causes of PD are unknown, although some popular hypotheses include exposure to environmental toxins, oxidative stress, and genetic influences (29).

PD is associated with many motor and non-motor signs and symptoms including balance decrements, gait perturbations, depression, fatigue,



and cognitive deficits. A common motor phenomenon affecting persons with more severe PD (especially those with gait disorders and rigidity) is “freezing.” This is an inability to initiate movement, typically occurring during walking. Freezing presents clinically as a shuffle step or as if the individual cannot lift their feet off of the floor. More severe PD also may present with a fenestrating gait where individuals will take short fast steps as though hurrying and may have difficulty in stopping (42,69).

Pulmonary and nervous system abnormalities also are associated with PD. Restrictive or obstructive pulmonary dysfunction can occur in part because of muscle rigidity and difficulty in coordinating the respiratory muscles. Respiratory issues can manifest as dyspnea (shortness of breath), problems with voice (hypophonia), swallowing (dysphagia), and coughing (42,69). Autonomic dysfunction affecting cardiovascular and other autonomic nervous system functions can develop. The most common indicants are orthostatic hypotension, decreased heart rate variability, sweating disorders (hypohidrosis and hyperhidrosis), urinary and bowel dysfunction, and symptoms, such as light-headedness, weakness, and syncope (70).

HOW IS PD DIAGNOSED?

The diagnosis of PD involves the assessment of clinical signs and symptoms by a trained physician. There are no definitive diagnostic tests for PD, so definite diagnosis can be obtained only on autopsy (23). The cardinal signs for the clinical diagnosis of PD are bradykinesia (slowness of movement) and at least one of the following criteria: rigidity, postural instability, and tremor at rest (45). Clinical tools for the diagnosis and evaluation of PD are the older, very simple Hoehn and Yahr (H-Y) scale (34) shown in Table 1 and the Movement Disorder Society Unified Parkinson’s Disease Rating Scale (MDS-UPDRS) (23). The MDS-UPDRS is a newer, more comprehensive tool than the H-Y scale. Commonly used in research and clinical settings, the MDS-UPDRS consists of four subscales: nonmotor experiences of daily living, motor experiences of daily living, motor examination, and motor complications (23). Higher scores on the H-Y and the MDS-UPDRS indicate more severe PD.

HOW IS PD TREATED?

Treatment of PD primarily involves medications to improve symptoms and functional status, protect against neuronal degeneration (neuroprotection), and prevent or minimize drug toxicity. Four main classes of drugs may be prescribed: dopaminergics, dopamine antagonists, anticholinergics, and monoamine oxidase type B inhibitors (Table 2). These drugs work via several mechanisms: to increase dopamine levels through dopamine replacement, enhancing dopamine synthesis, or delaying the breakdown of dopamine; to enhance dopamine action by increasing the sensitivity of dopamine receptors to dopamine; and/or to improve the balance between dopamine, acetylcholine, and γ -aminobutyric acid by blocking the muscarinic (acetylcholine) receptors.

TABLE 1: Hoehn and Yahr Scale for Staging of PD

Stage	Description
Stage 1	Unilateral involvement only usually with minimal or no functional disability
Stage 2	Bilateral or midline involvement without impairment of balance
Stage 3	Bilateral disease: mild-to-moderate disability with impaired postural reflexes; physically independent
Stage 4	Severely disabling disease; still able to walk or stand unassisted
Stage 5	Confinement to bed or wheelchair unless aided

[Adapted from Hoehn M, Yahr M. Parkinsonism: onset, progression, and mortality. Neurology 1967;17(5):S11–26. Copyright © 1967 Lippincott Williams & Wilkins. Used with permission.]

Many adverse effects are associated with these drugs. These include nausea, vomiting, dizziness, postural hypotension, motor fluctuations, dyskinesias (abnormal, involuntary movements), headache, drowsiness, insomnia, constipation, diarrhea, Reynaud phenomena, and confusion. More serious, but rarer, side effects are hallucination, paranoia, pleural effusion, and pleural thickening. The side effects of these drugs can present a considerable burden to the individual and may affect the individual’s willingness to engage in activities of daily living and to exercise, particularly when they are severe. A common side effect of dopamine replacement drugs, such as L-dopa, is the “on-off” phenomenon. The on-off effect refers to the wide variation in motor function depending on the effective levels of the drug (12,45,50). On-off fluctuations are more common with more advanced disease and the lessening effectiveness of the medications over time (4).

Surgical treatments for PD are available, but surgery is used less commonly than pharmacological treatments. Surgical treatments include deep brain stimulation and stereotactic ablation of areas of the brain, such as the subthalamic nucleus, to improve tremor. Experimental therapies include transplant of dopaminergic cells and gene therapies (7,17). Complementary treatments, such as physical and occupational therapy and exercise training, can be beneficial for persons with PD (69).

HOW IS PD AFFECTED BY PHYSICAL ACTIVITY AND EXERCISE?

Individuals with PD have reduced range of movement. They also experience difficulties with gait, balance, agility, coordination, and the ability to adjust their center of gravity under varying environmental conditions, partly because of a stooped posture (6,39,43,45). Decrements in executive functions, such as attention, planning, and cognition, also occur. Executive function deficits affect the performance of motor tasks and exercise, especially those that are more complex and involving dual motor

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tasks (such as walking while carrying an object and walking while talking) (57,62).

Physical inactivity is common, and it contributes to the attenuated exercise capacity, reduced muscular strength and endurance, and physical function impairments associated with PD (9,11,21,35,52). Abnormal cardiovascular and pulmonary re-

sponses resulting from autonomic dysfunction may be present at rest and probably during exercise, although the responses to exercise have not been well studied (14,67,70).

There is wide variability in motor function among individuals with PD, and this is increased by the many nonmotor signs and symptoms, multifaceted treatments, and treatment side effects (20,24). This variability creates difficulty in precisely describing the effects of PD on the acute and chronic responses to exercise. The comorbid diseases and conditions associated with older age additionally affect motor function and exercise performance (20,21,24) and further confound the understanding of how PD affects the responses to exercise. When interpreting the results of exercise studies, it is difficult to distinguish between the direct effects of the disease itself and the indirect effects due to aging, medications, and comorbid conditions (24).

WHAT ARE SOME GENERAL CONSIDERATIONS FOR EXERCISE TRAINING IN PERSONS WITH PD?

Exercise training has beneficial effects on aerobic capacity, muscular strength, balance, gait, physical function, executive function, falling, and quality of life in individuals with PD (13,24,27,31,46,49,51,62). However, there are many gaps in the scientific literature specific to exercise in people with PD. When evidence is unavailable, it is reasonable for the health fitness professional to apply accepted exercise recommendations for

TABLE 2: Common Drugs Used to Treat PD

Drug Category	Actions	Drug (Brand Name)	Side Effects
Carbidopa/L-dopa	Increases dopamine levels in the brain	Carbidopa/L-dopa (Sinemet®)	Low blood pressure, nausea, confusion, dyskinesias, dry mouth, dizziness, on-off effect resulting in motor fluctuations
Dopamine agonists	Binds to and stimulates dopamine receptors in the brain	Pramipexole (Mirapex®) Ropinirole (Requip®) Apomorphine hydrochloride (APOKYN™) Bromocriptine (Parlodel®)	Arthritis, chest pain, nausea/vomiting, low blood pressure, sleep disturbances, sedation, abdominal pain, dyskinesias, hallucinations, edema, confusion, dry mouth, depression, headaches
Anticholinergics	Blocks action of the neurotransmitter acetylcholine to restore dopamine/acetylcholine balance in the brain	Benzotropine mesylate (Cogentin®) Trihexyphenidyl HCL (Artane®)	Confusion, hallucinations, nausea, blurred vision, dry mouth, urinary retention, nervousness
Monoamine oxidase B inhibitors	Used to block an enzyme (monoamine oxidase B) in the brain that breaks down dopamine	Selegiline (Eldepryl®, Carbex®) Selegiline HCl (Zelapar®) Rasagiline (Azilect®)	Agitation, insomnia, hallucinations, dizziness, nausea, pain, headache, sleep disturbances, runny nose, back pain, increased dyskinesias, postural hypotension, headaches, joint pain, indigestion
Catechol-O-methyltransferase inhibitors	Blocks the action of an enzyme (catechol-O-methyltransferase) which breaks down dopamine and L-dopa (taken along with L-dopa)	Entacapone (Comtan®) Tolcapone (Tasmara®)	Abdominal pain, back pain, constipation, nausea, diarrhea, blood in the urine, constipation, liver failure
Amantadine	Antiviral drug that stimulates release of dopamine and/or inhibits dopamine reuptake	Amantadine (Symmetrel®)	Dizziness, weakness, dry mouth, constipation, skin blotches

adults to persons with PD (e.g., 1,2,30,47), with modification according to disease status and physical function limitations.

The irregularities of motor function and exercise responses in persons with PD must be considered by the exercise professional when testing and prescribing exercise. The motor and nonmotor signs and symptoms of PD can affect an individual to varying degrees at different points in time or not at all. Nevertheless, the possibility for occurrence exists, and close observation of the client for these abnormalities is important, particularly with changes in medication or disease status. In addition, physical and mental effects of PD, such as fatigue, depression, cognitive impairment, and social factors, may affect the adoption and maintenance of a regular exercise program (24).

Whenever possible, exercising near the peak drug effect (on effect) is suggested because the individual's motor function will be at its best (4). Because of individual variability in pharmacokinetics, it is difficult to identify the peak effect of the drug solely based on the time since the drug was ingested. A practical method to determine peak effect is for the client with PD to exercise at a time of day when the individual feels best (4,24). Progress resulting from exercise training can be masked by the great variability in day-to-day motor performance. Furthermore, the progressive nature of the disease means that the individual with PD will experience inevitable declines in exercise performance over time (20). Thus, the health fitness professional will need to frame the benefits of exercise in different ways to assist the individual in maintaining motivation despite apparent lack of progress or even regression.

Impaired attention and cognition should be taken into consideration in the design of the exercise program. To address these issues, it is important to consider the nature of the exercise training session, instructional methods, and the level of supervision. Clients with greater impairments of attention or cognition may benefit from simple exercise programs without complex or multiple steps, reduced background distractions (e.g., music and television), and increased supervision during the exercise session. Other helpful techniques are repeated demonstration of exercises; attentional cues, such as stepping to a verbal instruction; and repeated practice in performing complex tasks (55,62,68).



The health fitness professional needs to be alert to potential autonomic abnormalities in persons with PD, and modification — or even termination — of exercise may be indicated, according to *ACSM's Guidelines for Exercise Testing and Prescription* (2). Autonomic dysfunction can lead to abnormal heart rate, blood pressure, respiratory, and thermoregulatory responses at rest and during exercise and also may alter the chronic responses to training (14). Autonomic dysfunction can nullify the use of heart rate methods for prescribing exercise. Furthermore, alterations in the perception of effort and dyspnea can occur, which changes the relationship between ratings of perceived exertion and physiological responses to exercise (14). Persons with PD can have problems with regulating body temperature, so avoiding exercise during extreme temperature may be wise.

Attention to safety during the exercise session is paramount, particularly because of balance and mobility limitations in persons with PD. Removal of obstacles, providing railings and handholds for support, using harness support and/or assistive devices, and adapting exercise to be performed in a sitting position are all strategies to be considered to enhance client safety (64). Close supervision during exercise is indicated when poor balance or cognitive difficulties exist (55).

Symptoms of depression, fatigue, and sleep disorders are common in persons with PD, and these may affect exercise endurance and the motivation to exercise. Although these symptoms often coexist in the same person, they are distinct problems associated with PD (19,41). Persons with PD identify fatigue as one of the three worst problems of the disease, and it also is one of the most common (19). Fatigue is associated with greater levels of physical inactivity and reduced physical fitness and physical function (21,24). PD significantly reduces quality of life of individuals affected, and it can result in social isolation (42). Exercise programs, especially group exercise, may be helpful in providing social interaction and social support for PD patients and their caregivers.

WHAT ARE SOME SPECIFIC EXERCISE RECOMMENDATIONS FOR PERSONS WITH PD?

Cardiorespiratory Exercise Training

Exercise training studies using treadmill and lower body (cycle) ergometers have consistently resulted in improvements in cardiorespiratory fitness and maximal oxygen uptake ($\dot{V}O_{2max}$) in persons with PD (10,32,53,64). The programs in most of these studies have involved exercise durations of 30 to 60 minutes per session at intensities of 60% to 80% of the heart rate reserve (HRR). Effective exercise interventions were performed at home or in a fitness center at a frequency of 2 to 5 days per week for 4 to 8 weeks. These data, although limited, suggest that contemporary recommendations (1,2,30,47) for improving cardiorespiratory fitness in adults also result in improvements in cardiorespiratory

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fitness in persons with PD. Further research is needed to determine the most efficacious training programs for these individuals.

Weight-bearing cardiorespiratory exercise, such as walking, also improves physical function (18,65), MDS-UPDRS scores, balance, coordination, dexterity, and gait (18,32,53,64) in persons with PD, particularly when performed at forced exercise intensities of 30% or higher greater than self-selected walking pace. Cadence walking, in which visual or auditory cues are used to maintain a particular cadence or pace (32), and sensory

attention-focused exercise incorporating proprioceptive feedback (56) result in improved physical function, balance, gait, and diminished clinical signs such as tremor (32,56). Exercise using visual or auditory cues also can be helpful in reducing freezing (65). Non-weight-bearing exercise, such as lower body ergometry (LBE), is as effective as weight-bearing activity in improving aerobic capacity (53). Thus, when an individual has impaired balance, LBE is a safe and effective alternative exercise modality. For weight-bearing exercise, assistive devices, such as suspension or harness equipment, can be used to reduce the chances of falling during treadmill walking (32).

Current physical activity guidelines for older adults and deconditioned persons (1,28,47) recommend starting at moderate or light intensity to enhance program adoption and adherence. Similar considerations should be taken with individuals with mild-to-moderate PD, with the understanding that fitness gains may not be as profound as with higher intensity exercise. Table 3 summarizes recommendations for cardiorespiratory exercise for persons with PD.

Resistance Training

Resistance training (RT) has not been studied as widely as cardiorespiratory exercise. However, existing studies demonstrate that RT results in improvement of muscular fitness in persons with PD (16,58). Resistance training programs also improve MDS-UPDRS scores (58), enhance lower extremity physical function and gait speed (33,58), and decrease falling (16). Effective training programs have used training regimens consisting of 1 to 3 sets of 8 to 15 repetitions performed on 2 to 3 days per week. Exercise intensity ranged from 60% to 80% of the 1 repetition

TABLE 3: Summary of Recommendations for Cardiorespiratory Exercise Prescription for Persons with PD

Frequency	Intensity	Time	Type	Special Considerations
≥3 days per week of moderate exercise	Vigorous intensity (≥60% HRR or $\dot{V}O_2R$)	20–60 minutes of purposeful moderate exercise per day	Weight-bearing exercise such as walking	Implement precautions to prevent falling, particularly with persons with more advanced PD
≥5 days per week of vigorous exercise	Moderate intensity (40% to 60% of the HRR or $\dot{V}O_2R$)	30–60 minutes of vigorous exercise per day	Lower body ergometer	Consider using visual or auditory cues to prompt exercise movement
A combination of moderate and vigorous exercise on ≥3 to 5 days per week	Light intensity (<40% of the HRR or $\dot{V}O_2R$) may be beneficial for those unable or unwilling to engage in more intense exercise	A combination of moderate and vigorous exercise per day <20 minutes of exercise per day		Adapt exercise as needed because of functional limitations and comorbidities
	Forced exercise intensity (≥30% of usual walking speed)	Multiple sessions of ≥10 minutes can be used to accumulate the desired duration and volume of exercise per day		Symptoms, such as depression, fatigue, anxiety, cognitive impairment, and dementia, may lead to attention interference with tasks and should be taken into consideration in designing the exercise session and the level of supervision needed Exercise near peak effect of L-dopa (“on effect”) is suggested

maximum (1-RM) or by inducing muscular fatigue (MMF) during every set (16,31,33,58). The length of training ranged from 8 to 12 weeks, and the majority have involved primarily lower body resistance exercises that were weight bearing and closed chain, such as the seated leg press or body weight squat (16).

Low-to-moderate intensity (<60% 1-RM) resistance exercise may provide only mild benefit in clients with PD (16). However, further study is needed because apparently healthy adults show beneficial effects at these lower intensities (1,3). Current exercise guidelines recommend lower intensity and higher repetitions of exercises for sedentary and older individuals initiating RT. Age, fitness levels, and previous exercise experiences should be taken into consideration for persons with PD. The RT prescription for individuals with PD should include all major muscle groups and encourage multijoint movements, as recommended for apparently healthy adults (1–3).

Preliminary reports show that creatine monohydrate supplementation results in improved strength gains in persons with PD when coupled with RT (16,31). Until further research is available on the effective dosage ranges, potential drug interactions and adverse effects, creatine supplementation is not recommended unless under the guidance of a physician (31). In summary, the available evidence (16,31,58,65) supports that resistance exercise consistent with current recommendations for apparently healthy adults (1–3) is effective in improving muscular fitness and physical function in persons with PD. Table 4 summarizes recommendations for RT exercise for individuals with PD.

Flexibility Training

Persons with mild PD who engage in flexibility exercise training improve their joint range of movement to a similar degree as their

counterparts without PD (59,60). Individuals with more advanced PD may not show as much improvement, but they still can benefit from stretching exercise (59,60). Recent research has focused on the impact of stretching exercise on spinal flexibility because this area of the body is affected notably by PD (59,60). Spinal inflexibility affects physical function because the PD-associated truncal stiffness and neck rigidity results in a stooped posture. Abnormal posture impairs the individual's ability to control the center of gravity and results in difficulties with balance and agility and increases the risk of falling (59,60). By focusing on improving flexibility of the spine, trunk, hips, and shoulders, physical function can be improved as well (59,60).

Although the data are limited, there is reason to believe that persons with PD can benefit from engaging in static stretching at least twice per week, holding each stretch at a level of mild discomfort for an average of 30 seconds (59,60), consistent with current exercise recommendations for adults (1,2). Dynamic and proprioceptive neuromuscular facilitation (PNF) stretching also has been shown to be effective for healthy adults (2,3,26) and may have benefit for clients with PD as well. It is clear that flexibility should be a component of a comprehensive exercise program for individuals with PD, just as it also is recommended for persons without PD (1,2,28). Table 5 provides a summary of recommendations for flexibility exercise training.

Neuromotor Exercise Training

Neuromotor exercise training, sometimes termed *functional fitness training*, incorporates motor skills, such as balance, coordination, gait, and agility. In older persons without PD, neuromotor exercise training is recommended because it improves balance and reduces falls in older persons at risk of

TABLE 4: Summary of Recommendations for Resistance Exercise Prescription for Persons with PD

Frequency	Intensity	Time	Type	Special Considerations
2 to 3 days per week	60% to 80% of the 1-RM (moderate-to-hard intensity) for novice to intermediate exercisers to improve strength	8 to 15 repetitions to improve strength in middle-aged and older persons starting exercise	Resistance exercises involving each major muscle group	Implement precautions to prevent falling in persons, particularly in more advanced PD
	Higher intensity sets should elicit muscular fatigue	Two to four sets are recommended for most adults to improve strength and power	Exercises that involve multiple joints, or compound exercises that involve more than one muscle group are recommended	Adapt exercise as indicated because of functional limitations and comorbidities
	40% to 50% of the 1-RM (very light to light intensity) for older persons beginning exercise to improve strength	A single set of resistance exercise can be effective especially among older and novice exercisers		Symptoms, such as depression, fatigue, anxiety, cognitive impairment, and dementia, may lead to attention interference with tasks and should be taken into consideration in designing the exercise session and the level of supervision needed
				Exercise near peak effect of L-dopa ("on effect") is suggested

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TABLE 5: Summary of Recommendations for Flexibility Exercise Prescription for Persons with PD

Frequency	Intensity	Time	Type	Special Considerations
≥2 to 3 days per week	Holding a static stretch at the point of discomfort for 10 to 30 seconds is recommended for most adults	A reasonable target is to perform 60 seconds of total stretching time for each flexibility exercise	A series of flexibility exercises for each of the major muscle-tendon units is recommended	May be most effective if begun early in disease progression
Daily exercise yielding greater gains in joint range of motion	In older persons, holding a stretch for 30 to 60 seconds may confer greater benefit For PNF stretching, a 3- to 6-second contraction at 20% to 75% maximum voluntary contraction followed by a 10- to 30-second assisted stretch is desirable		Particularly emphasize the upper trunk and spine Static flexibility (active or passive), dynamic flexibility, and proprioceptive neuromuscular facilitation are each effective	Implement precautions to prevent falling in persons, particularly in more advanced PD Adapt exercise as indicated because of functional limitations and comorbidities
				Symptoms, such as depression, fatigue, anxiety, cognitive impairment, and dementia, may lead to attention interference with tasks and should be taken into consideration in designing the exercise session and the level of supervision needed Exercise near peak effect of L-dopa ("on effect") is suggested

falling (44,47). Gait and balance can be enhanced through aerobic exercise, resistance exercise, balance exercise, Tai Chi, and gait training (22,26,40,48,55). Gait training is a typical part of physical therapy for persons with PD and involves the use of

cues and forced treadmill speeds and the use of visual and auditory cues. Physical therapy also incorporates a combination of fall prevention education and exercises dealing with lower body strengthening, balance, postural stability, and walking

TABLE 6: Summary of Recommendations for Neuromotor Exercise Prescription for Persons with PD

Frequency	Intensity	Time	Type	Special Considerations
≥2 to 3 days per week is recommended.	The effective intensity is not established.	≥10 to 15 minutes per day is recommended.	Exercises involving motor skills (<i>e.g.</i> , balance, agility, coordination, and gait), proprioceptive exercise training, and multifaceted activities (<i>e.g.</i> , Tai Chi and Qigong) are recommended to improve and maintain physical function and reduce falls in those at risk for falling.	Implement precautions to prevent falling, particularly in persons with more advanced PD.
	As tolerated by the individual.	30 to 60 minutes per day may be needed in persons at risk for falling.		Adapt exercise as indicated because of functional limitations and comorbidities. Symptoms, such as depression, fatigue, anxiety, cognitive impairment, and dementia, may lead to attention interference with tasks and should be taken into consideration in designing the exercise session and the level of supervision needed. Exercise near peak effect of L-dopa ("on effect") is suggested.

mechanics, including assistive device instruction when necessary (25).

Tai ji, Qigong, and Yoga are multifaceted physical activities consisting of varying combinations of neuromotor, resistance, and flexibility exercises. In older persons without PD, Tai Ji improves balance, agility, coordination, and proprioception, and it reduces the risk of falls in persons at risk of falling (47). Research on activities, such as Qigong and Tai Ji, in persons with PD is limited. Existing studies demonstrate improved balance and gait, with a magnitude of improvement similar to cardiorespiratory and resistance exercise training programs (10,26,40,66). Although there is need for further study, it is reasonable to apply current exercise recommendations (2,47) to adults with PD. Table 6 summarizes the exercise recommendations for neuromotor exercise.

HOW CAN THE OUTCOMES OF EXERCISE TRAINING BE ASSESSED?

An important aspect of exercise prescription is the evaluation of outcomes by use of assessments completed before and at various time intervals during exercise training. Evaluation of fitness and physical function provides feedback about the effectiveness of the exercise training program and allows for the development of an individualized exercise program and rate of progression. As recommended by the American College of Sports Medicine, re-testing should take place approximately every 8 weeks (2).

Cardiorespiratory fitness can be measured using tests that measure or estimate cardiorespiratory fitness (2,38). Useful indirect tests of cardiorespiratory fitness are the Six Minute Walk Test (54), 2-minute Step Test (54), and Incremental Shuttle Walk Test (61). One or multiple repetition maximum tests can demonstrate the effectiveness of most RT programs (3,38). Functional fitness tests also can be used to assess muscular fitness and may include the biceps curl test (54) and repeated sit to stand tests (8,36). Goniometry (38), the Chair Sit and Reach (37), and the Back Scratch Test (54), and other assessments can measure flexibility. The Functional Reach Test (15), the Tinetti Gait and Balance Test (63), and the Berg Balance Scale (5) are examples of physical function tests and test batteries that the health fitness professional might use to evaluate balance and gait.

CONCLUSIONS

Although exercise is beneficial, people with PD commonly are physically inactive. Individuals with mild-to-moderate PD seem to respond similarly to exercise as adults without PD. A regular program of exercise is important for maintaining physical fitness and function, enhancing quality of life, and attaining multiple health benefits in clients with PD. It is unclear whether exercise can delay the progression of PD, but the short-term benefits of exercise training programs suggest this possibility. The benefits of exercise are less clear in persons with more advanced PD, but as long as an individual is able to perform exercise, it is recommended.

Exercise training in persons with PD should follow established exercise guidelines that are individualized and progressive in nature. The ideal program will include cardiorespiratory, resistance, flexibility, and neuromotor exercises. Disease status, comorbidities, physical function, cognitive limitations, atypical physiological responses, and safety are particular areas of consideration when prescribing exercise to persons with PD. Modifications to exercise may be necessary depending on disease status.

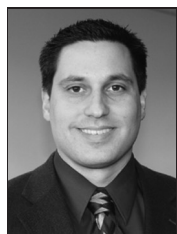
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CONDENSED VERSION AND BOTTOM LINE

Parkinson's disease (PD) is a neurodegenerative disorder caused by a deficiency in the neurotransmitter, dopamine, resulting in slowness of movement, resting tremors, rigidity, and postural instability. These physiological and functional changes can result in balance decrement, increased risk of falling, and gait disruption. Cardiorespiratory, resistance, flexibility, and neuromotor exercise training has been shown to improve physical fitness and physical function and to decrease falls in persons with mild-to-moderate PD. Exercise training consistent with current exercise recommendations for adults generally can be applied to persons with mild-to-moderate PD, with modifications according to disease status and physical function limitations.