

Texto proveniente de:

ACSM's **Certified News**

Parkinson's Disease

Etiology, Clinical Characteristics and the role of Exercise.

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Parkinson's disease (PD) is a neurodegenerative disease affecting the basal ganglia of the brain, resulting in a deficiency of the neurotransmitter dopamine [8]. It is the second most common neurodegenerative disease after Alzheimer's disease, and affects approximately one million Americans [5]. The overall number of individuals afflicted by this disease is difficult to obtain due to its slow development; however, it is estimated that 0.3% of the entire population and 1% of those over the age of 60 years suffer from PD [5]. Caucasian males have been reported to be at higher risk compared to their female counterparts, as well as African American and Asians [6, 19]. These differences, however, may be related to under-sampling and lower response rates from these ethnic groups in research studies not actual racial differences.

ETIOLOGY & PATHOGENESIS

Although the specific etiology of PD remains unknown, genetic and environmental factors have been thought to influence the disease; hence, two hypotheses have been developed to further understand its development; the genetic hypothesis and the environmental toxin hypothesis.

The genetic hypothesis is based on the discovery of ten genes associated to familial PD. These genes have been identified to be involved in the labeling of proteins for break down [4,8], as well as affecting the response to oxidative stress. Hence, why PD usually presents in the later decades of life [8].

The environmental toxin hypothesis is substantiated by the discovery of the neurotoxin 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) derived from the illicit production of the analgesic drug Demerol, which causes symptoms nearly identical to PD due to the toxic effect of its metabolism on the substantia nigra neurons- neurons affected by PD.4 This discovery allowed for the understanding of how exogenous toxins mimic PD like symptoms and led to the study of herbicides and insecticides as possible causes for PD; as they behave similarly to MPTP and act as poisons in the environment [4]. This may suggest that individuals who live in rural areas, are exposed to pesticides, or drink well water, may be more susceptible to the disease; however, these findings remain equivocal [4].

CLINICAL CHARACTERISTICS, PREVENTION, AND TREATMENT

The syndrome of Parkinsonism, of which Parkinson's disease is the most common (~80% of the cases) [4], is defined as any disease with a dopamine deficiency resulting in tremors at rest, slow movements (bradykinesia), rigidity, loss of postural reflexes, flexed posture, and the inability to initiate movement (akinesia). A clinical diagnosis can be made when either tremors at rest or slow movements are present with other symptoms (see table 1) [4]. Although the disease mainly affects motor functions, with disease progression other non-motor features can be present (see table 2).

Due to the nature of the disease and current lack of identifiable biological markers or conclusive risk factors, primary prevention is not possible [17]. Secondary prevention, should concentrate on slowing down the neurodegenerative effects of the disease as the patient ages.

The three established therapeutic options include; drug therapy, surgical treatment and rehabilitation [17]. These treatment options have been well established in the literature and are beyond the scope of this article.

The following section will concentrate on the effects of exercise as a therapeutic modality in this population. Additional information regarding PD, and the use of exercise as a therapeutic modality for these individuals can be accessed from the National Institute of Neurological Disorders and Stroke (NINDS) and the National Center on Physical Activity and Disability's (NCPAD) websites [4, 15].

THE EFFECTS OF EXERCISE ON PD

The effects of exercise on PD have been less studied than other chronic conditions, such as cardiovascular disease, diabetes, hypertension or cancer. Nonetheless, a body of evidence exists to support the notion that aerobic, resistance and flexibility exercises are beneficial for those suffering from PD. Recently published evidence-based guidelines encourage the use of exercises to improve balance, range of motion and muscular power to improve functional capacity [11]. Enhanced physical function may result in improved activities of daily living and promote independence, hence improving quality of life.

One study found heart rate and rate of perceived exertion³ to be a useful tool when comparing individuals with PD during two maximal-effort exercise tests using an incremental protocol on a semi-recumbent cycle Ergometer [10]. Investigators found no differences between peak work rate, heart rate, or rate of perceived exertion between the two tests. Suggesting these variables may be useful when prescribing exercise to these individuals. Brigewater and Sharpe [3] reported improvements in functional ability, as well as increases in cardiorespiratory fitness among individuals in the early stages of PD. Moreover, an inverse association between cardiorespiratory fitness and severity of symptoms and depression scores were reported, demonstrating the important role aerobic exercise may play in enhancing functional ability and quality of life [3].

In another aerobic training study, the effects of a moderate intensity aerobic exercise (60% - 70% heart rate reserve) on movement initiation, a measurable component of neuromuscular coordination, was found to be significantly improved after 16 weeks of aerobic training [2]. Additionally, those in the exercise group improved their VO₂ PEAK from 19.5 ml/kg/min to 24.5 ml/kg/min (26%), as well as increasing their power output on the cycle ergometer by 32% (123 watts to 163 watts); meanwhile the PD-control group showed a slight decline in VO₂ PEAK (15.9 ml/kg/min vs. 14.1 ml/kg/min; 13%) and in power output (109 watts to 98 watts; 11%). The most significant finding however was that although the mean movement initiation pre-tests were comparable between the PD exercise group and the PD controls, the movement initiation post-tests for the PD exercise group were similar to the healthy controls' pre-test, indicating improvements in neuromuscular motor control following the aerobic training program [2].

In addition to biological changes in muscle with age, the progressive nature of PD promotes the loss of physical conditioning, due to inactivity. Resistance training has demonstrated significant improvements in muscular strength among healthy adults [13] and researchers have considered it as a treatment option for PD patients; particularly those who have experienced decreased effects of drug (Levodopa) therapy or have experienced medical complications, such as muscle atrophy or physical injuries associated with falls. The effects of a rigorous eight-week resistance training program on muscular strength and gait between PD patients and controls were assessed by Scandalis et al. [18]. Although significant increases in abdominal strength were reported for both groups after training, the PD group performed significantly lower abdominal exercises compared to the controls. Additionally, lower limb strength also increased after eight weeks; however, significant differences were not observed between the PD and normal groups before or after training. When comparing gait analysis, PD patients demonstrated a significant increase in stride length without a significant change in cadence, while the controls did not show any changes in stride length or cadence. These findings support the notion that PD patients with mild-to-moderate disease respond similarly to a resistance-training program compared to healthy controls, even though they may have limited function.

In a later study, a 12-week eccentric resistance training program found significant increases in muscle volume, as well as improvements in the six-minute walk test and stair descent and ascent time [7]. This study demonstrated the effects of high-intensity resistance training, thus providing a potentially useful modality for patients with PD. High-intensity resistance training may be an effective mode of exercise allowing PD patients to increase functional ability, and promote muscle hypertrophy, leading to functional gains.

The use of creatine monohydrate supplementation for muscular strength gains has been very popular among healthy individuals. To investigate the effects of a progressive resistance-training program and creatine monohydrate supplementation in muscular fitness among patients with diagnosed PD compared to resistance training alone, investigators developed a resistance training program following the American College

of Sports Medicine resistance training guidelines [1] with a group of PD patients. They administered a creatine monohydrate supplement (loading phase 20 g/d for 7 days, maintenance phase 20 g/d 3-5 days/week) and a placebo mix [9]. After 12 weeks of resistance training both groups significantly increased muscular strength. However, the improvements in strength were more pronounced in the creatine group (20%) versus the placebo group (12%). Muscular endurance, measured as the number of repetitions lifted at 60% of 1RM, also showed improvement between the two groups, with the creatine group showing greater improvements in chest press and leg extension exercises compared to the placebo group (38% and 95% vs. 33% and 59%, respectively). Based on these findings, the authors concluded that resistance training with creatine monohydrate supplementation might be a beneficial option for patients with PD. The limited restrictions placed on the regulation of dietary supplements demands caution be used by the fitness professional when working with PD patients or any other population. Medical supervision or a recommendation from a licensed dietary professional would be prudent, due to the vast amount of side-effects that accompany many supplements.

GENERAL EXERCISE PROGRAMMING FOR PD

A general aerobic exercise prescription should include large muscle group exercises three times per week at 60% - 80% peak heart rate. Depending on the individual's functional ability, walking on a treadmill may be most beneficial. However, a cycle or rowing ergometer may be more appropriate for those with decreased mobility. Exercise time should be maintained to less than 60 minutes per session, with multiple bouts of 20-30 minutes, or as tolerated by the individual (see table 3).

Resistance training exercises for all major muscle groups have been shown to be effective and should be used. Two to three sessions per week is preferred, with at least one day off between sessions. Individuals should begin with one set of 8-12 repetitions, with a comfortable resistance determined by both the individual and fitness professional. Load should be increased when the individual is able to complete 12 repetitions without strain and without compromising safety or posture.

Flexibility exercises should be encouraged one to three times per week. Slow, static stretches and range of motion exercises involving all major muscle groups and joints should be prescribed. The stretch should be maintained for 20 to 30 seconds, or as tolerated by the individual. The shoulders and trunk should be emphasized, as these areas are affected earlier in the disease and may lead to adhesive capsulitis (frozen shoulder) and loss of segmental movement in the spine with disease progression, limiting upper body activities [16]. For a list of specific stretches that may be used with these individuals, the reader is referred to the NCPAD website or the work of Lieberman et al [12]. Moreover, functional training including gait and balance exercises to prevent falls (a common consequence of neural degeneration in PD), and exercises specific to activities of daily living should be included, emphasizing slow, controlled movements through a full range of motion [16]. Although significant studies in this area have not been completed, small studies have demonstrated some benefit [16].

SUMMARY AND CONCLUSION

Parkinson's disease is a neurodegenerative disease characterized by a decrease in dopamine resulting in tremors at rest, slow movement, rigidity, loss of postural reflexes, flexed posture, and the inability to initiate movement. Although a number of medical and surgical therapies are available, the role of the fitness professional should focus on attenuation of the neurodegenerative effects of the disease by promoting an active lifestyle within the capabilities of the individual.

Numerous investigators have established the role of exercise for individuals with PD. Although these studies all share methodological limitations that may limit their application, a regular exercise program that includes aerobic, resistance, and flexibility components, as well as functional exercises, can be considered a safe and effective option to improve symptoms and gain functional ability among those with PD. Therefore, based on the information currently available, and with certain precautions in mind (Box 1-1) practitioners are encouraged to follow ACSM guidelines to develop a safe and effective exercise training program that enhances and promotes functional gains, may limit falling and may lead to favorable changes in the ability to perform activities of daily living while improving quality of life and promoting independence as long as possible.

Box 1-1: Things to Consider by the Exercise Professional:

1. Individuals should be screened for additional conditions that may be affected by an exercise program (i.e., cardiovascular or metabolic diseases, arthritis, and/or musculoskeletal conditions).
2. Exercise prescriptions should be individualized and revised as the disease progresses.
3. Provide simple and clear verbal instructions for individuals to follow during each exercise.
4. Demonstrate and closely observe the individual when performing all exercises.
5. For those with movement difficulties, exercising during medication peak time may be most appropriate to prevent injury.
6. Unassisted walking and/or treadmill exercises may not be appropriate for those with advanced disease, a history of falls and gait or balance problems.
7. Use of other modalities (i.e., stationary or recumbent bicycle, arm ergometer, or swimming/water exercises) should be considered as appropriate.
8. When doing strength training, consider using plate-loaded machines instead of free weights.
9. Groups exercise sessions may be beneficial to ensure safety and promote adherence and socialization.
10. Promote independence by instructing caregivers (i.e., spouse, friends, etc.) appropriate exercises to be done at home.

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