



Effect of exercise on perceived quality of life of individuals with Parkinson's disease

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Abstract—The purpose of this study was to determine if individuals with Parkinson's disease (PD) who completed an 8-week, supervised *PoleStriding* exercise program would undergo significant improvements in cognitive skills, activities of daily living, motor function, and quality of life. The Unified Parkinson's Disease Rating Scale (UPDRS) and the Parkinson's Disease Questionnaire (PDQ-39) were used to measure functional independence. Six male volunteers (72.7 ± 3.7 years of age) performed *PoleStriding* exercise three times per week for 37 ± 3 minutes. Differences in the participants' pre- and post-training scores on the UPDRS and PDQ-39 were analyzed using the Wilcoxin Signed Ranks Test. A statistically significant improvement occurred in the UPDRS ($P < 0.026$) and PDQ-39 ($P < 0.028$) scores following the moderate-intensity exercise intervention. The results of this nonrandomized clinical trial indicate that an 8-week individualized *PoleStriding* exercise program increases perceived functional independence and quality of life in individuals with PD.

Key words: exercise tolerance, exercise training, Parkinson's disease, quality of life, rehabilitation.

INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease that occurs in more than a million people in the United States. This disease is mainly characterized by the following symptoms: impaired gait, bradykinesia, rigidity, tremors, diminished expression, kyphotic posture, seborrhea, and sialorrhea. Onset of this disease can range from 40 to 70 years of age. There has also been a form of the disease that strikes people in their teens. Relatives of individuals with PD have an increased risk of the disease. Presently, PD is attributed to the lack of a neurotransmitter called dopamine. The exception is PD secondary to head trauma. Although a susceptibility gene for PD has been identified on chromosome four, the pathological origin of this disease is still unknown (1). Dopamine is a neurotransmitter that regulates the substantia nigra and the striatum. The pigmented cells in the substantia nigra synapse with other cells located in the striatum, which are responsible for movement, balance, and walking. Messages are transmitted between the substantia nigra and the striatum by dopamine. A chemical imbalance due to the lack of dopamine aggravates the symptoms of the disease, leaving patients eventually incapable of accomplishing simple tasks of daily living. Consequently, physicians

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usually prescribe carbidopa-levodopa to offset the imbalance. The molecule dopamine cannot be used as treatment because it is too large to cross the blood brain barrier; therefore its precursor levodopa is used.

Research suggests that an exercise regimen can increase dopamine levels and metabolism, which subsequently increases functional independence in PD subjects (2,3). One study investigated the history of physical activity in adulthood prior to the occurrence of PD in order to determine if regular physical activity was associated with a lower incidence of PD (2). These investigators found that an increase in the level of dopamine depends on the frequency, intensity, and duration of exercise. During training the rate at which dopamine increases is reduced and during intense exercise dopamine levels can be produced at a reduced rate or remain stable (2). Higher levels of dopamine have been found during moderate exercise, which suggest that a regular program of moderate intensity exercise may serve to reduce the progression of PD (2).

Goetz et al. investigated the relationship between blood levodopa levels and the Unified Parkinson's Disease Rating Scale (UPDRS) in exercising and non-exercising subjects; they found that the UPDRS is a good indicator for levodopa response in PD subjects (4). Levodopa absorption was altered by exercise. The investigators recommended that for maximal benefit, PD subjects should take their medication, rest for an hour, and then begin their exercise program (4).

No studies have examined the effects of exercise on the quality of life of individuals with PD. The purpose of this study was to observe whether individuals with PD who participated in a moderate intensity physical activity program called *PoleStriding* experienced significant improvements in mental functioning, activities of daily living, motor function, and overall quality of life. *PoleStriding* is a form of walking using poles in a motion similar to cross-country skiing. Poles were purchased in different lengths (44–54 inches) and issued to the participants based on their height, i.e., a person >5 ft 6 in but <5 ft 9 in received a 48 in pole. This mode of exercise increases the base of support in addition to promoting an upper and lower body workout. Because PD impairs balance, *PoleStriding* appeared to be an appropriate exercise for this cohort. Subjects completed 8 weeks of interval training using *PoleStriding*. Training consisted of repeated bouts of exercise at varied intensity and duration followed by rest intervals of varied length. The intermittent bouts of exercise allow for a higher total volume of more intense work.

METHODS

This study was a pretest/posttest quasi-experimental design in which the participants served as their own controls. Subjects were identified by the neurologist co-investigator (MBJ) who directs a movements disorder clinic at the hospital. All participants gave their written informed consent after the study physician approved their enrollment. Prior to participation, each subject received an explanation of the study procedure, an informational video on *PoleStriding* technique, and a demonstration of the *PoleStriding* technique. All subjects completed a pre- and posttraining test battery designed to measure mental functioning, activities of daily living, and motor function. In addition, all volunteers underwent a resting electrocardiogram.

Inclusion criteria for this study were veteran subjects with PD currently in stage one, two or three of the Hoehn and Yahr classification scheme. These stages are inclusive of symptoms that are inconvenient but not disabling, characterized by significant slowing of the body, early impairment of equilibrium on walking or standing, and generalized dysfunction that is moderately severe (5). Those with secondary PD, chronic heart disease, and osteoporosis were excluded based on review of medical records as well as the study physician's judgment. Subjects completed an 8-week interval training program at a frequency of three times per week, for 60 minutes per session.

Subjects

Initially the study sample size was eight, but two individuals withdrew late in the program (one person did not have reliable transportation and the other sustained a stroke). Subjects were six men with a mean age of 72.7 ± 3.7 years. Four were married; three reported that their spouse was their caregiver. Following the guidelines of the Hoehn and Yahr Scale for severity of disability secondary to PD the study physician classified three of the subjects as stage two, one as stage two and a half, and two as stage three. All subjects reported a previous cardiac history. Five had not been hospitalized in the past 12 months. The majority of the subjects (83 percent) reported they used a cane regularly. Half of the subjects were not satisfied with their current level of activity. Five of the subjects were on Parkinson's medication (Sinemet) and five of the subjects were taking beta-blockers. Mean onset of PD was 3.7 ± 3.9 years with a range of 10 years. All of the subjects rated their health as fair.

Exercise Intervention

Subjects were trained at the Physical Performance Research Laboratory at Edward Hines, Jr. VA Hospital's campus. The exercise regimen consisted of a stretching warmup that included the use of the *PoleStriding* poles, *PoleStriding* training, and a cool-down phase (same exercises as were used during the warmup). Moderate intensity exercise prescriptions were individualized. EXERSTRIDER® poles (EXERSTRIDER Products Inc., Madison, WI) were purchased in different lengths and were issued to the participants in accordance with the sizing guidelines published in the "EXERSTRIDER® Manual & Instruction Guide" (6). Subjects were taught the *PoleStriding* techniques (double and single pole). They chose the most stable *PoleStriding* technique for them and utilized it for 8 weeks. Heart rate was monitored by Polar Heart Rate Monitors (Polar CIC, Inc., Port Washington, NY). Subjects were instructed to take their medicine (Sinemet) 1 hour prior to each training session. Training sessions were up to 1 hour in duration 3 times per week. During each training session heart rate, rate of perceived effort (RPE, 15-point category scale), time rested, and time exercised were recorded. These data are summarized in **Table 1**. Also, topics pertaining to PD were informally discussed throughout the 8 weeks, including: benefits of exercise, side effects of the disease, medication, vitamins, diet, different types of treatments that are available, Parkinson's support organizations, depression, and information sources.

Tests

Before beginning the study, all participants completed a medical history. The UPDRS and the Parkinson's Disease Questionnaire (PDQ-39) were administered at pre- and posttraining. The PDQ-39 was utilized to evalu-

ate the impact of PD on the quality of life of the participants (7–9). This self-administered survey is composed of 39 questions that encompass 8 discrete dimensions: mobility, activities of daily living, emotional well-being, stigma, social support, cognition, communication, and bodily discomfort. The scale ranges from 0 (no difficulty) to 100 (maximum level of difficulty) (8,9). In the event that a response to any question was missing, the dimensional score and total score were not calculated for that individual. However, it was possible to calculate a single index score utilizing the PDQ-8, which is composed of eight of the original items from the PDQ-39 (8,9).

The UPDRS was used to characterize the severity of PD at the time of testing. It is composed of the following parts (a) mentation, behavior, and mood, (b) activities of daily living, and (c) motor sections (2,3). The UPDRS is administered by interview. A maximum score of 199 points is possible and is indicative of the most severe disability, whereas 0 represented no disability.

A pedometer was utilized to measure the distance traveled during the training sessions. These data were not a primary outcome measure. During training the trainer, not the subject, wore the pedometer, and this was done to obtain consistency in stride length measurement. However, the stride length of the subjects varied greatly and in turn effected the stride length of the trainer, making the reliability and validity of the actual measure questionable. After 4 weeks of training some subjects continued to have interest in the pedometer measure. Others developed their own method of noting how far they had walked during a training period and had little interest in the actual numbers. As a result recording of the pedometer measurements during training was inconsistent. Little confidence can be placed on the pedometer measures as true indicators of the subjects' performance.

Table 1.

Subject profile and training record (mean±1 SD) for the six subjects with Parkinson's disease who completed the 8-week *PoleStriding* exercise program.

No	BMI	Class	Ave	Min	Max	RPE	Att
1	23	2.0	36±8	19	42	13	96
2	29	2.0	39±3	33	44	13	96
3	24	2.0	39±3	31	42	15	96
4	26	2.5	37±7	21	42	15	96
5	28	3.0	40±6	28	45	8	92
6	36	3.0	32±6	23	42	13	96
*	28±5		37±5	26±6	43±1	13±4	95±2

No=subject number; BMI=body mass index; Class=Hoehn & Yahr classification; Ave=average exercise time, in minutes; Min=minimum exercise time, in minutes; Max=maximum exercise time, in minutes; RPE=rate of perceived exertion, on a 15-point category scale; range=6 to 20.

Therefore, the pedometer readings were not analyzed.

During the intermittent training the 15-category RPE was employed as an index of each subject's training intensity (10). This scale was used to measure the perceived exertion or the overall effort or distress of the subject during exercise. The target training intensity for this cohort was 13, or "somewhat hard" on the 6–20 scale and was considered equivalent to a moderate intensity level of exercise. The RPE allows the individual to subjectively assess his feelings of exertion during exercise taking into consideration current fitness level, environmental conditions, and general fatigue level. During exercise there is a linear relationship between RPE and oxygen uptake and heart rate (10–13). Exercisers of all fitness levels benefit from use of this scale because it provides them with an easily understood guideline for exercise intensity. This scale has been found to be a valuable and reliable indicator in monitoring an individual's exercise intensity (10).

Statistical Procedures

Comparisons between baseline and post-intervention scores on the UPDRS and the PDQ-39 were made using the Wilcoxin Signed-Ranks Test. Statistical significance was accepted at $P < 0.05$. No power analyses were conducted because the exercise program was a feasibility trial.

RESULTS

Subjects attended 95 ± 2 percent of the scheduled training sessions. Disease-related quality of life, as measured by the PDQ-39 index score, differed significantly between baseline and follow-up ($P < 0.028$). The percent improvement for the overall score and eight subscales is illustrated in **Figure 1**. Three subjects' scores decreased on some of the subscales, one on emotional well-being, communication, and bodily discomfort, a second on emotional well-being, cognition, and communication, and a third on stigma and cognition. Individuals with PD have a higher incidence of depression than other subject groups (9). Usually, it is difficult to ascertain whether emotional problems are a direct result of the disease itself or the disability caused by disease. In this study, all of the subjects improved on the subscales for mobility and activities of daily living; therefore one feasible explanation for the decline in these subjects' scores for emotional well being, stigma, and communication was the pathology of the disease. Subject five failed to complete

the mobility item on the PDQ-39; therefore a PDQ-8 single index score was calculated for this individual and utilized in the data analysis. All subjects improved their overall score and activities of daily living score. Most subjects improved their mobility, cognition, and bodily discomfort scores.

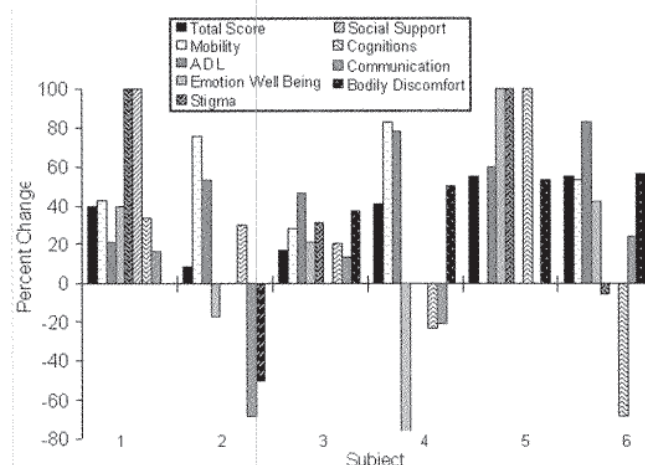


Figure 1.

Percent change between baseline and post-intervention for the eight dimension Parkinson's Disease Questionnaire (PDQ-39 disease specific quality of life survey) for each subject. The difference in the PDQ-39 single index score between baseline and post *PoleStriding* exercise intervention was significant ($P < 0.028$).

Correspondingly, a significant difference was noted for the total UPDRS score following the *PoleStriding* intervention ($P < 0.026$). The percent improvement for the overall UPDRS score and subsequent subscales for each subject are illustrated in **Figure 2**. Clearly there was marked individual variation in the magnitude of subjects' perceived improvements in mentation, activities of daily living, and motor skill as measured by the UPDRS.

Anecdotal reports from the study participants provided additional insight into the impact of the exercise intervention. One person reported that since he has been in the program he was falling less often. Two others reported that they experienced leg cramps less frequently since they started training. All of the subjects reported feeling stronger. Five subjects reported that they were capable of doing housework and leisurely activities with greater ease. Because five out of the six subjects were taking beta-blocker medication, the subjects' RPE's were used to regulate exercise intensity. Subject number 5 (see **Table 1**) consistently gave low subjective ratings of exer-

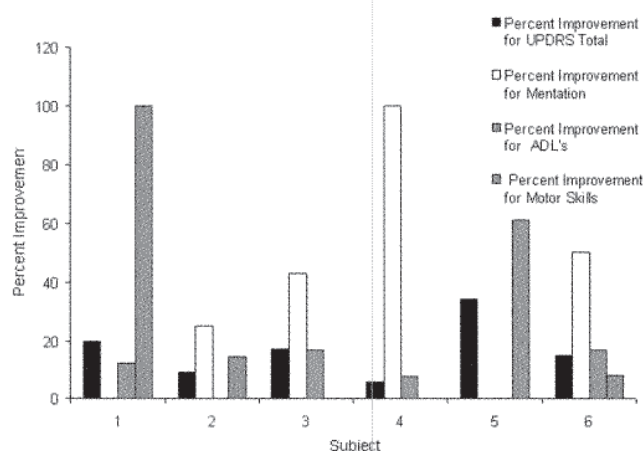


Figure 2.

Percent improvement for the Unified Parkinson's Disease Rating Scale after 8 weeks of moderate intensity *PoleStriding* training. A significant difference was found for the overall total score for the UPDRS measure of mentation, activities of daily living, and motor skills ($P < 0.026$).

tion. He rated all exercise as very light (<9) and consistently refused to use the upper range of the scale during exercise bouts that were clearly more difficult for him to perform. With this one exception, the objective of planning and conducting the interval training sessions so that the average perceived exercise intensity was rated by the subjects to be 13 (somewhat hard) was accomplished without subjects reporting post-training muscle or joint pain/discomfort or excessive fatigue. Moreover, after the first 2 weeks of training the subjects were *PoleStriding* for nearly 40 minutes per session (Figure 3).

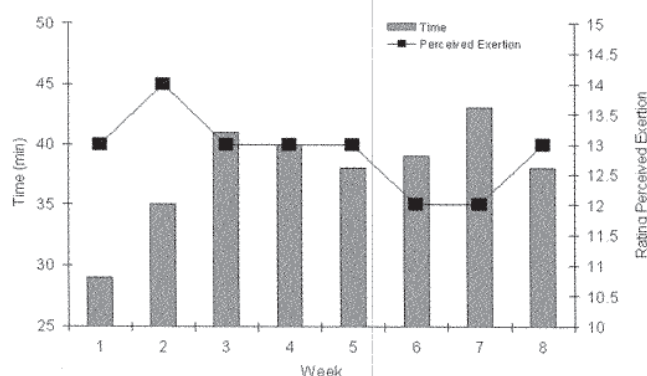


Figure 3.

Average duration of *PoleStriding* exercised for subjects with Parkinson's disease for each of the 8 weeks of training (bars). Mean training intensity as measured by the Rate of Perceived Exertion Scale for each week of *PoleStriding* exercise (squares).

DISCUSSION

In the majority of studies where PD subjects completed an exercise intervention there was an improvement in ability to initiate motion, range of motion, relaxation, and strength (11,12). Kuroda et al. reported that physical exercise influences mortality of PD through prevention of physical deterioration from lack of activity (13). Factors that affect the progression of the disease are age at onset, duration of the disease, onset of tremor, dementia, and gait disturbance. Psychological, as well as physical, effects of an exercise program promote self-efficacy, increase confidence, increase muscular strength, improve memory, and increase acceleration of movement (11–13). The purpose of this research was to assess whether subjects with PD who exercised at a moderate intensity would significantly improve their perceived quality of life and physical functioning.

PoleStriding training had a significant effect on the exercise tolerance of individuals with PD as indicated by a steady improvement in the duration of walking during training sessions over the 8 weeks of the exercise program. Subjects' adherence to the individualized *PoleStriding* exercise was excellent (Table 1). Subjects completed 95 ± 2 percent of the scheduled training sessions. Improvements were found on both the UPDRS and PDQ-39. Both the PDQ-39 and the UPDRS include items that measure perceived abilities in cognition, motor function, and activities of daily living. Further support for the consistency of the subjects' perception is the fact that the subjects' ratings on the PDQ-39 and UPDRS for these three variables were parallel. Moreover, the results from the PDQ-39 overall total and dimensions scores indicate that after only 8 weeks of *PoleStriding* training, the health-related quality of life of the subjects improved.

Recently, Reuter et al. conducted an intense 14-week exercise training program with 16 subjects who had slight to moderate PD. Changes in motor ability, UPDRS, and the Columbia University Rating Scale (CURS) were measured. These investigators found a significant ($P < 0.0001$) improvement in the UPDRS and CURS total test scores as well as physical measures of motor ability (muscle strength, range of motion, and coordination). Furthermore, many of the benefits acquired during the study period persisted 6 weeks after the training ended. These published findings provide confirmation of the veracity of the observations reported in the present study (15).

The ability to generalize from this study is limited because the sample was small, subjects served as their own control, and the study did not employ a more rigorous randomized design with a control treatment condition. However, the fact that statistically significant changes were found in the primary outcome variables is indicative of a strong effect of the treatment that was employed in this study. Therefore, it is concluded that moderate-intensity *PoleStriding* exercise promotes perceived independence in activities of daily living and quality of life in persons with stage one, two, or three PD. Additionally, the finding from this study provides sufficient evidence to merit a larger randomized clinical trial.

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