Physical Functioning After 1, 3, and 5 Years of Exercise Among People With Parkinson's Disease: A Longitudinal Observational Study

Rebecca A. States, PhD[1]; Theresa L. Sweeny, DrPH, RN[1]; Amerigo Rossi, EdD, CSCS[1]; David K. Spierer, EdD, CES[1]; Yasser Salem, PT, PhD, NCS, PCS[2]

ABSTRACT

Background and Purpose: Regular physical activity is thought to be crucial to maintaining optimal physical function in people with Parkinson's disease (PWP), and it may have neuroprotective effects. As with many medical treatments, exercise is most effective when performed consistently over a period of years. The primary aim of this study was to examine multiyear adherence to a community-based group exercise program for PWP. A secondary aim was to document how physical functioning progressed after 1, 3, and 5 years for participants who consistently attended a community-based, group, exercise program.

Methods: Forty-six individuals with idiopathic Parkinson's disease, who were at modified Hoehn and Yahr stage I, II, or III and were community ambulators, were recruited on a rolling basis between 2008 and 2013. Each provided yearly medical clearance to exercise. Participants engaged in a free, community-based, group exercise program offered 2 days per week, 1 hour per day, for three 10-week sessions per year. The program included supervised floor exercises for balance, coordination, strength, and flexibility along with resistance training on dual-action exercise machines. Participants who attended more than half the classes for 1, 3, or 5 years (n = 27, n = 14, n = 7, respectively) were considered to have completed the fitness program (consistent exercisers) and were included in the longitudinal data analysis; participants who either dropped out or attended less than half the classes (n = 19) were not included. Physical functioning was evaluated at baseline for all participants and yearly thereafter for consistent exercisers. Wilcoxon signed rank tests were used to compare baseline data with data collected after 1, 3, and 5 years of consistent exercise.

Results and Discussion: Over half of the participants initially evaluated completed at least 1 year of the fitness program (27 of the 46 = 59%) and a proportion completed 3 years (14 of the 39 = 39%), and 5 years (7 of the 24 = 29%). At baseline, consistent exercisers were younger than those who dropped out (63.9 vs 69.9 years, $P < .05$), but had similar modified Hoehn and Yahr medians (2.0 vs 2.3), and similar time since diagnosis (8.0 vs 5.6 years). Consistent exercisers showed small statistically significant improvements in grip strength (8.9% change), Berg Balance scores (5.1% change), and 6-minute walk test (11% change) from baseline to year 1. No significant differences were found in these variables after 3 or 5 years, or for gait speed and timed up and go after 1, 3, or 5 years.

Conclusion: Despite the progressive nature of Parkinson's disease, many PWP can sustain a regular program of varied modes of community-based, group exercise over a period of years. Participants who did so maintained initial performance levels on key measures of physical functioning. By working with an interprofessional team in a supportive community-based exercise program, physical therapists can help many PWP engage in consistent and sustained exercise activity over multiyear periods.

Key Words: exercise, Parkinson's disease, physical function

(*J Geriatr Phys Ther* 2017;40:127-134.)

[1]*Long Island University–Brooklyn, Brooklyn, New York.*

[2]*University of North Texas Health Science Center, Fort Worth, Texas.*

Portions of this work were funded by Long Island University Health and Wellness Grants, the Brooklyn Parkinson Group, and the Leonore Gordon PD Arts and Wellness on the Go Fund at the Stonewall Community Foundation.

Portions of this work have been submitted for presentation at the Combined Sections Meeting of the American Physical Therapy Association, February 2016 in Anaheim, California.

None of the authors or their family members had financial relationships with entities that might benefit from this research within the past 36 months.

Address correspondence to: Rebecca A. States, PhD, Long Island University–Brooklyn, Brooklyn, NY 11201 (Rebecca.States@liu.edu).

Robert Wellmon was the Decision Editor

DOI: 10.1519/JPT.0000000000000084

INTRODUCTION

Parkinson's disease (PD), a progressive neurological disorder, causes a wide array of debilitating symptoms, including tremors, stiffness, impaired balance, and other movement difficulties, which lead to a decrease in physical function.[1] The prevalence of people with Parkinson's disease (PWP) in the United States has been estimated at 630 000 people, and is likely to double by 2040.[2] Although treatments with medications[3] and surgical procedures[4]

ameliorate symptoms in the earlier stages, the debilitating effects of PD progressively increase over time and eventually leave PWP severely physically and mentally disabled and unable to perform activities of daily living.[5]

Regular physical activity has been shown to be crucial for maintaining optimal physical functioning and quality of life among PWP after short interventions[6-8] as well as for 1- to 2-year interventions.[9-14] A recent review of the effects of physical activity on PD symptoms found that PWP who participated in interventions such as Tai Chi, dancing, resistance training, and walking programs, experience fewer symptoms, improved physical function and quality of life.[15] The current physical activity recommendations for PWP from the American College of Sports Medicine include aerobic, resistance, and flexibility training, as well as neuromotor exercise training.[16]

As with many medical treatments, physical activity is most effective when performed consistently, and the benefits may be reversed when the intervention ends. Therefore, it is imperative to assess the long-term impact of sustainable physical activity interventions for PWP to determine how physical activity affects the progression of PD symptoms over several years. A randomized controlled trial by Steffen and colleagues showed maintenance or improvement in measures of physical function and quality of life after 10 months of exercise.[9] A previous study conducted by our research team found that a community-based participatory approach to developing a comprehensive physical activity intervention was safe, feasible, and effective for PWP after 14 months.[11] A randomized controlled trial comparing 2 years of progressive resistance exercise (PRE) versus a nonprogressive general exercise program showed that participants in both programs maintained or improved their levels of function although the PRE group demonstrated fewer PD signs than the general exercise group by the end of the program.[12] These studies also note the need for additional longitudinal studies about long-term ongoing exercise to establish a clear evidence base for exercise prescription for PWP.[9] The primary aim of this longitudinal observational study was to examine adherence to a community-based group exercise program that has been available to PWP since 2008. The secondary aim was to document the effects of sustained, consistent participation in group fitness classes on physical function among people with mild to moderate PD after periods of 1, 3, and 5 years.

METHODS

Participants

Forty-six individuals with idiopathic PD were recruited for this study with the assistance of a community support group. The support group provided a general description of the fitness program on their website and hosted 15-minute demonstrations of the fitness program at 2 support group events. Participants of the fitness program who were members of the support group also discussed the program anecdotally with their peers. Details of the program and the research study were explained to potential participants once they contacted a study investigator.

The participants comprised a sequential sample of PWP who met the following inclusion criteria: (1) medical diagnosis of idiopathic PD; (2) modified Hoehn and Yahr stage I, II, or III; (3) independent community ambulator with or without an assistive device; and (4) written medical clearance provided by the participant's personal physician to participate in exercise. Exclusion criteria were as follows: (1) other major neurological disease (eg, multiple sclerosis and Alzheimer disease); (2) heart condition requiring supervised exercise, or uncontrolled high blood pressure; (3) more than 6 falls in the previous 6 months; and (4) other health conditions precluding participation in an exercise program. All participants completed an informed consent process approved by the Institutional Review Board.

Participants joined the fitness program on a rolling basis, starting sometime between May 2008 and May 2013. All participants were eligible to attend the program in perpetuity with the result that some participants have completed 7 years of the fitness classes, whereas others only joined the program and the study as late as 2013.

In May 2015, participants were categorized as consistent exercisers if they completed at least half of the classes for at least 1 year (n = 27). Those who attended irregularly or who dropped out of the program within their first year were designated as not completing the program. Consistent exercisers were categorized further into (a) 5-year group—attended at least half of the classes for 5 years (n = 7); (b) 3-year group—attended at least half of the classes for 3 years (n = 14); and (c) 1-year group—attended at least half of the classes for 1 year (n = 27). All individuals in the 5-year group were also members of the 1- and 3-year groups, and all individuals in the 3-year group were also members of the 1-year group (Figure 1). If a participant began as a consistent exerciser and later reduced his/her participation to an inconsistent level, that individual's data was only included for the years he/she exercised consistently.

Fitness Program

Three 10-week sessions of group exercise were conducted each year from 2008 through 2015. All sessions were offered for free to individuals with PD with support of the investigators' university and the community support group. Classes were conducted for 1 hour, 2 times per week at a university wellness center, with a maximum of 20 participants per class. Class activities were based on a general exercise program for PWP,[16] and exercises were chosen to address components of fitness (aerobic, flexibility, resistance, and neuromotor) deemed essential to healthy aging in individuals with clinically significant chronic conditions or functional limitations.[17]

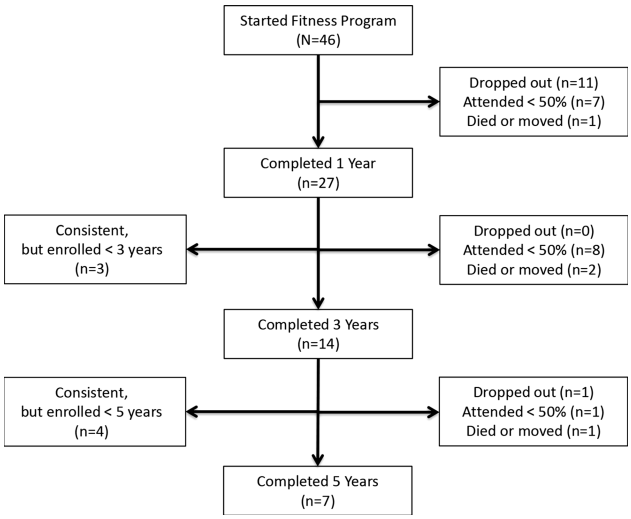

Figure 1. Flow diagram of participant adherence.

The class was formatted so that half of the participants began with a group class focusing on general exercise, and half began each class with strength training on 7 dual-action exercise machines; after 30 minutes, the groups switched phases. The group exercise portion of each class included a warm-up, stretching exercises, floor exercises for core muscles, balance exercises emphasizing weight shifts, and stepping exercises for aerobics and for neuromotor processing. The content of the group exercise portion varied from day to day and across sessions and was progressed within a 10-week session by the exercise instructor in consultation with the investigators. Progression was aimed at helping participants understand and perform new exercises with good form and mechanics, and then challenging participants to improve their aerobic capacity, balance, coordination, and mobility skills. The group exercise portion was not progressed across 10-week sessions as the participants who attended varied from one session to the next.

The resistance training portion of each class focused on the major agonist and antagonist muscle groups of the upper and lower extremities. The amount of weight lifted and number of repetitions performed were recorded each day on a separate card for each individual; data were carried over from one session to the next. Weight progression on a particular machine was suggested to participants if they easily performed 15 repetitions at a given weight for 4 weeks and the individual was amenable to increasing the load. Recommendations were made by the supervising faculty member or a graduate assistant. Additional details of the exercise content are described in a previous publication.[11]

A certified personal trainer with more than 5 years of experience with older adults with physical limitations led the group exercise, and a graduate student from exercise physiology was employed to run the strength training component. One to four health professions students also assisted with class and a faculty member from physical therapy, exercise physiology, or nursing, supervised them; students initially received 2 hours of training on the program. In total, the ratio of staff to participants ranged from 1:3 up to 1:7 at various times.

Heart rate and blood pressure were taken before each exercise class. Participants whose systolic pressure remained over 139 mm Hg, when taken over three 5-minute intervals were considered prehypertensive and were asked not to exercise that day in accordance with national blood pressure guidelines.[18] Individuals with sustained diastolic pressure below 60 mm Hg were considered hypotensive and also asked to refrain from exercise that day.

Data Collection

Adherence was investigated in 2 ways: (a) by documenting the proportion of participants who consistently attended the program for 1, 3, or 5 years; and (b) by documenting the proportion of classes attended by consistent exercisers.

Physical function evaluations were conducted at initial enrollment (the baseline) and within the 2 weeks before each 10-week fitness session. Evaluations were conducted by the investigators, each of whom has done physical function testing with this population for at least 5 years. Evaluations lasted 45 to 60 minutes each, and they took place in the physical therapy research laboratory. Evaluations were not conducted for individuals who dropped out of the program or stopped exercising consistently.

Participants were asked to take their PD medication 1.5 hours before the evaluation session to help control for pharmaceutical effects. At the baseline evaluation, information about participants' demographics, medical risk factors, and comorbidities was collected. For all evaluations, participants performed 2 trials each of gait speed using a 3-m version of the GAITRite system,[19,20] 2 trials of the "timed up and go" test,[21] and 3 trials of grip strength using a hand-grip dynamometer on the right and on the left sides.[22] Values were averaged across trials and sides for analysis. Investigators also administered the Berg balance test (BBT)[23] and, at the end of each evaluation session, the 6-minute walk test (6MWT).[24] Participants were provided rest periods as needed. The measures selected sample a range of dimensions important for daily physical functioning, are likely to be affected by exercise, and have been shown to be reliable for people with PD[25,26] or older adults.[27] Additional details of the administration are described in a previous publication.[11]

Data Analysis

Attendance was recorded for all participants who exercised during each class, and these data were summed at the end of each 10-week session. For participants who dropped out, the timing of withdrawal from the program was noted, but reasons for withdrawal could not be documented

consistently enough for analysis. The flow diagram depicts the longitudinal pathway of the 46 participants as they progressed or withdrew from the exercise program (Figure 1).

Baseline demographic variables and medical information for the consistent exercisers were compared with data from participants who did not complete at least 1 year of the program. Independent sample *t* tests were used for the continuous demographic variables (age, body mass index, years since diagnosis) and a Mann-Whitney *U* test was used to analyze the ordinal variable of the modified Hoehn and Yahr score. Chi-square tests were used to compare the proportions in each category across the 2 groups (consistent exercisers vs those who did not complete at least 1 year of the fitness program).

Physical function was evaluated by comparing baseline data with data from evaluations done 1, 3, and 5 years after enrollment for all participants who continued to exercise consistently throughout each period (ie, consistent exercisers only). A nonparametric method, the Wilcoxon signed rank test,[28] was used for these comparisons because of the small sample sizes for the 3- and 5-year groups (n = 14 and n = 7, respectively) and to maintain consistency across analyses. No comparisons between the 1-, 3-, and 5-year groups were done because of the overlap in participants among the groups (the 5-year group was a subset of the 3-year group, and the 3-year group was a subset of the 1-year group).

The alpha level was set to 0.05 and no adjustments for multiple statistical tests were made as the observational nature of this report creates *de facto* limits on its explanatory conclusions. All statistics were calculated in Excel 2010 using procedures provided by Portney and Watkins.[28]

Given the duration of the study and the difficulties that PWP experience in maintaining functional behavior on a routine schedule, several anomalies are present in the data. First, baseline values for the BBT for 4 of the 7 participants in the 5-year group came from an evaluation session done 3 months after starting the exercise program because the BBT was not administered during the initial evaluation session in 2008. Second, 1 participant was assigned to the 1-year group after having participated irregularly for a time and then completing 1 full year of exercise. As a result, baseline values for this analysis were based on the evaluation immediately before her full year of exercise rather than from her initial evaluation.

RESULTS

Descriptive statistics are summarized in Table 1. The consistent exercisers were significantly younger and significantly less likely to have reported dizziness or loss of balance, though they were similar on all other demographic and health variables including baseline modified Hoehn and Yahr levels, and number of years since diagnosis.

Table 1. Participant Demographics[a]

Demographics	Attended <1 y (n = 19)	Attended ≥1 y (n = 27)
Female (male)	10 (9)	14 (13)
Age, y	69.9 (8.3)	63.9 (6.6)[b]
Body mass index, kg·m^{-2}	24.9 (4.3)	25.9 (7.0)
Race/ethnicity		
Non-Hispanic white	11 (69%)	20 (77%)
Non-Hispanic black	3 (19%)	4 (15%)
Non-Hispanic Asian	1 (6%)	1 (4%)
Hispanic	0	0
Mixed	1 (6%)	1 (4%)
No answer	3 (19%)	1 (4%)
Employment status		
Employed	3 (21%)	6 (23%)
Retired	11 (79%)	19 (73%)
Disability	0	1 (4%)
No answer	5	1
Modified Hoehn and Yahr	2.0 (1-3)	2.3 (1.5-3.5)
Time since Parkinson's disease diagnosis, y	5.5 (3.9)	8.0 (7.2)
Deep brain stimulator	2 (11%)	4 (15%)
Dizziness/loss of balance	14 (78%)	10 (37%)[b]
More than 1 fall in past year	6 (33%)	3 (27%)
Joint replacement	2 (11%)	4 (17%)
Arthritis	5 (26%)	8 (30%)
Chronic back/neck pain	9 (47%)	13 (48%)
History of smoking	2 (11%)	2 (9%)
Major comorbidities		
Stroke	0	2 (7%)
Diabetes	2 (11%)	1 (4%)
Heart disease	1 (5%)	0
Hypertension	3 (16%)	7 (26%)
High cholesterol	5 (26%)	8 (30%)
History of cancer	4 (21%)	4 (15%)
Chronic infectious disease	1 (5%)	1 (4%)
Asthma	0	3 (11%)
Emphysema	1 (5%)	0

[a]For the continuous variables (age, body mass index, time since diagnosis), independent samples *t* tests were conducted and the mean values are listed with standard deviations in parentheses. For the ordinal variable of the Hoehn and Yahr score, a Newman-Keuls test was used and the median value is given with the range in parentheses. For all other variables, chi-square tests were calculated and the number of participants in each category is given followed by the proportion of the sample in parentheses.
[b]A significant difference between groups with $P = .01$.

Of the 46 participants who started the study, 27 completed at least half the classes in year 1 (59%), 15 completed fewer than half of the classes in year 1 (33%), and 4 participants (9%) did not attend any classes (as shown in

Figure 1). On average, the consistent exercisers attended 45 of the 60 classes offered in year 1 (76%), whereas the other participants completed an average of only 10.5 out 60 classes offered (18%). Of the 27 consistent exercisers, 14 of them continued to exercise consistently for years 2 and 3. Those 3-year consistent exercisers attended an average of 131 of the 180 classes offered throughout years 1 through 3 (73%). From that group, 7 continued to exercise consistently throughout years 4 and 5. The 5-year consistent exercisers attended an average of 225 of the 300 classes offered throughout years 1 through 5 (76%). Note that enrollment in the program occurred on a rolling basis; 46 participants were enrolled for at least 1 year, 39 were enrolled for at least 3 years, and 24 for at least 5 years. Hence, 59% (27 of the 46) exercised consistently for 1 year, 39% (14 of the 39) for 3 years, and 29% (7 of the 24) for 5 years.

Table 2 provides results of the physical function tests for the consistent exercise groups after 1, 3, and 5 years. It shows that no significant decrements in baseline levels of performance were evident after 1, 3, and 5 years for gait speed, 6MWT, and timed up and go (TUG) test among the consistent exercisers. Significant improvements from baseline to year 1 were found for the 6MWT ($P = .049$), the BBT ($P = .02$), and grip strength ($P = .04$). Although the median value for grip strength declined by 0.1 kg, the Wilcoxon test for grip strength showed that year 1 values were significantly greater than the pretest values (W = 104; sum of positive difference ranks = 274; sum of negative difference ranks = 104). From baseline to year 3 and from baseline to year 5, no significant changes were seen for any measure of physical function. The small improvements in BBT scores (3 points), grip strength (0.1 kg), and 6MWT (43 m) at the end of year 1 were all less than their associated MDC_{95} or smallest detectable difference scores of 5 units, 4.2 kg, and 82 m, respectively.[25,29] It is possible that failure to find significant changes over these periods, including possible long-term declines, may reflect a lack of statistical power because of the small number of participants observed.

Adverse Events

Over the 7 years the program has run, 1 serious injury was experienced by an 82-year-old male participant who had a history of heart disease, diabetes, and transient ischemic attacks (TIA), and had been encouraged to exercise in this program by his physician. He had a TIA within an hour of leaving the exercise class in his third year of participation and was hospitalized for 1 week. Some participants also reported transient muscle soreness, fatigue, or exacerbation of pre-existing orthopedic conditions as a result of their participation. Two participants reduced their participation for a period of months because of reported recurrence of sciatica though neither attributed the recurrence to participation in class, and both later returned to regular participation without difficulty. Some falls did occur within the context of movements that include periods of instability such as transitions from standing to sitting or to quadruped position or vice versa. No more than 3 such falls per 10-week session (300 person hours of exercise) were observed, and no falls led to injury, although falling is a well-known problem for PWP.[30] Participants sometimes elected to forgo particular exercises because of muscle soreness, limitations from a preexisting medical condition, or fatigue. Some participants also occasionally sat out a class if his/her vital signs were outside the established limits after repeated measurements across a 15-minute period. In those instances, they were considered to have not attended for that class. Given the importance of exercise, the careful supervision provided, and the strong desire of participants and the community support group to allow everyone to exercise despite their limitations, these risks were deemed acceptable.

Table 2. Physical Function Measures for Consistent Exercisers[a]

Physical Function Measure	Baseline Median IQR	Year 1 Median IQR	BsLn-Yr1 *P* Value n	Baseline Median IQR	Year 3 Median IQR	BsLn-Yr3 *P* Value n	Baseline Median IQR	Year 5 Median IQR	BsLn-Yr5 *P* Value n
Gait speed, cm/s	117.9 (110-127)	120.7 (107-131)	>.20 (27)	123.3 (117-137)	121.40 (111-128)	>.20 (14)	124.2 (123-133)	117.8 (94-130)	>.20 (7)
6MWT, m	402.6 (330-358)	445.0 (358-498)	.049[b] (26)	468.9 (363-494)	439.2 (335-553)	>.20 (14)	460.9 (408-487)	409.3 (314-432)	.09 (7)
TUG, s	10.3 (8.5-11.6)	9.6 (8.4-11.4)	>.20 (27)	9.7 (8.4-10.8)	8.5 (7.9-10.1)	>.20 (14)	9.8 (9.1-10.8)	9.2 (7.5-10.6)	.18 (7)
Berg Balance (out of the 56)	50 (43-54)	53 (48-55)	.02[b] (25)	52 (50-54)	54 (52-56)	>.20 (14)	50 (49-53)	51 (46-54)	>.20 (7)
Grip strength, kg	23.3 (20-32)	23.2 (22-36)	.04[b] (27)	23.0 (20-35)	24.8 (20-36)	>.20 (4)	22.7 (18-35)	24.4 (22-35)	>.20 (7)

Abbreviations: BsLn, baseline evaluation; IQR, interquartile range; 6MWT, 6-minute walk test; TUG, Timed Up and Go; Yr1, year 1; Yr3, year 3; Yr5, year 5.
[a] *P* values are calculated from Wilcoxon signed rank test with significant differences. Note: Although the median value for grip strength declined marginally from baseline to year 1 (bottom row, first 2 columns), calculations showed a significant *improvement* in grip strength across that period as described in text.
[b] Significant differences.

DISCUSSION

Results from this study show that 59% of participants evaluated for this study attended the fitness program consistently for at least 1 year. Those participants attended nearly three fourths of the exercise classes available to them, achieving an average of 1.5 hours of supervised exercise per week for 30 weeks of a calendar year. In addition, proportions of the enrolled participants continued to exercise for 3 and 5 years. These results extend the findings from previous studies of community-based group exercise programs[9,11,13] by showing that multiyear participation is feasible and, apparently, welcomed by participants with PD.

In the current study, participants who exercised consistently were younger (63.9 vs 69.9 years old) and less likely to self-report balance problems or dizziness than participants who did not complete the program, raising the possibility that this fitness program was too challenging for some PWP. Despite this, both groups reported similar time since diagnosis, modified Hoehn and Yahr scores, and major comorbidities. Participants who exercised consistently also had characteristics similar to a recent profile of people with mild to moderate PD.[31] At baseline, consistent exercisers had mean age (63.9 years), 6MWT distance (403 m), and TUG times (10.3 seconds) comparable to the scores exhibited in the Schenkman study by participants whose modified Hoehn and Yahr scores were between 2.0 and 3.0 (mild to moderate PD).[31] Hence, the consistent exercisers appear to be of similar age and physical capabilities as the general population of PWP who have participated in exercise and adjuvant therapy studies.

For the consistent exercisers, baseline abilities for balance, mobility, and grip strength were maintained after 1, 3, and 5 years despite the progressive nature of PD. It is unknown whether participants who did not complete at least 1 year of classes would have maintained their physical function if tested again. These results replicate and extend the findings from a study about PWP contrasting a 10-month program of one-to-one general exercise versus supervised treadmill training versus an individualized home exercise program. Those results showed that all 3 exercise groups maintained balance and physical function after 10 months. Similar results were achieved in this study using a community-based group class that varied exercise content over time, avoided extended time on treadmills or stationary bicycles, and that some participants continued attending for 5 years. The current findings also add to the many other studies showing maintenance of physical function for PWP who consistently adhere to any of a wide range of specific physical activity programs, such as programs for Tai Chi, Nordic walking, aquatic exercise, resistance exercise, or treadmill training.[7,8,10,12,14,15,32] In the current study, maintenance of gait speed and 6MWT over 3 and 5 years were noteworthy given recent findings of significant deterioration in ambulatory activity and gait speed for PWP over a 2-year period.[33] It is possible, however, that there was insufficient power to detect a decline in function at 3 or 5 years because the samples were small (n = 14 and n = 7, respectively).

The results of this study add to the overall message recently promoted by the Movement Disorders Society that all PWP should exercise regularly doing whatever type of exercise best suits them even though some adverse events may occur.[34] At the 19th International Congress of Parkinson's Disease and Movement Disorders, evidence was presented from a prospective longitudinal study of 2940 PWP in 20 sites affiliated with the National Parkinson Foundation Quality Improvement Initiative. It showed that regular exercise slows the decline in PD, at least in terms of quality of life.[34] That study also showed that increasing physical activity to at least 2.5 hours of exercise per week through any of a wide array of programs was associated with slower decline in the 39-item Parkinson Disease Questionnaire scores. Results of the current study suggest a similar benefit of consistent exercise insofar as individuals who consistently exercised in this community-based general fitness program for a period of 1, 3, or 5 years maintained their initial levels of physical function.

National health care organizations that provide recommendations defining the standard of care for PWP have promoted exercise as a crucial component in any treatment plan for PWP. The American College of Sports Medicine (ACSM) provides a detailed evidence-based "exercise prescription" in its guidelines for PWP,[17] and suggests that the exercise prescription recommendations for healthy adults should be tailored to the individual's needs. The current study followed ACSM guidelines in that all participants underwent a functional assessment annually to identify changes in health status that might require adjustments in supervision—such as increased frequency of falls. The participants received the recommended 2 to 3 days per week of resistance exercise needed to maintain mobility and did 10 to 12 repetitions on all major muscle groups of the upper and lower extremities. As recommended, the aerobic and flexibility exercises were led by a trainer with expertise in working with PWP, and weight training exercises were adjusted to fit the individual's capabilities and performance each day.

One key element in the success of the current fitness program has been the close coordination and collaboration with an active and growing community support group for PWP using an approach similar to Hirsch's community-based participatory research model.[35] The fitness program was initiated by a key member of that community support group. The group publicized the fitness program and referred most of the participants for this study. The nature of this particular community group is also well suited to support the fitness class described here as the group uses a grassroots approach to develop programs, identify talented leaders, and reach out to potential constituents. They have a firm commitment to inclusiveness, charging no fees for the vast majority of their activities, and finding ways to

incorporate PWP, their caregivers, and important friends regardless of the physical or cognitive limitations, or their abilities to attend consistently. The group's founder and current leader is a firm advocate of the ACSM campaign, Exercise is Medicine,[17] and maintains frequent and constructive involvement in this research. By combining their philosophy of inclusiveness with a wide range of programs that promote physical activity and social engagement, the community group provides an ideal partner to support this community-based group fitness program.

The major strength of the current longitudinal study of adherence to exercise and retention of physical function is its focus on the "real life" of the participants. Compared with the typical older adult, many PWP have an even greater daily struggle to maintain an active life style that includes consistent exercise. For over 7 years, this fitness program has succeeded in providing an ongoing evidence-based exercise class, guided by faculty from varying disciplines with expertise in PD and an expert trainer to lead a fun and effective group class. Studies have found that many PWP are disinclined to walk in public or exercise in public gyms because of embarrassment associated with freezing or dyskinesia.[36,37] To avoid these issues, the fitness program was conducted in an exclusive exercise space separate from a public gym. Other factors that may have contributed to the long-term participation include close collaboration with a vibrant community-based support group for PWP, the supportive and sociable atmosphere among participants and with staff, no fees for participants, a varied program of exercise, and an organizational approach similar to Hirsch's community-based participatory research model.

The findings from this study must be taken with caution because of several important limitations. There was no control group in this study and participants were self-selected from members of a very active community-based support group. Hence, the participants may not be representative of all PWP, as they may be especially knowledgeable about PD and especially proactive about seeking beneficial treatments and activities to assist in coping with PD. In addition, the power of the study to detect changes in the outcome variables is limited given the small number of participants, especially for the 5-year consistent exercise group. This raises the possibility that the declines in median values for gait speed and 6MWT distance at year 5 might have been judged to be statistically significant if more participants had been included. Another limitation is that medication dosage and compliance, as well as use of other adjuvant treatments, were not controlled in this study allowing for the possibility that their effects may have contributed to the benefits seen here. Despite these caveats, results from this study show that multiyear adherence to a community-based fitness program and maintenance of physical function is possible when PWP participate in exercise over a period of years.

CONCLUSION

The results of this study suggest that multiyear participation in a community-based group exercise program is feasible and may be beneficial for PWP. On average, participants who exercised consistently saw some benefits in physical function at the end of year 1, and maintained baseline performance for mobility, balance, and grip strength for 3 to 5 years despite the progressive nature of PD. These results extend the findings from previous studies by showing benefits of a general community-based fitness program and by showing that adherence to multiyear participation is feasible for PWP. By working with an interprofessional team in a supportive community-based exercise program, physical therapists can help many PWP engage in consistent and sustained exercise activity over multiyear periods.

ACKNOWLEDGMENTS

The authors wish to make several acknowledgements that have been critical to our success. We thank our incredible exercise instructor, Janice Mason, whose dedication, knowledge, and enthusiasm carry us all forward from day to day, and the unique Brooklyn Parkinson group and its leaders Olie Westheimer and Carroll Neesemann, who inspire an entire community to enjoy life with and without PD. We also thank Said Hamdan, Director of the Health & Wellness Institute at Long Island University–Brooklyn, who provided critical administrative support for our activities, Dr William Bannon who assisted with the analysis, and the many LIU students who generously and graciously assisted with exercise classes, scheduling, and data input.

REFERENCES

1. Boelen MP. *Health Professional's Guide to Physical Management of Parkinson's Disease*. Champaine, IL: Human Kinetics; 2009.
2. Kowal SL, Dall TM, Chakrabarti R, Storm MV, Jain A. The current and projected economic burden of Parkinson's disease in the United States. *Mov Disord*. 2013;28(3):311-318.
3. Foreman KB, Singer ML, Addison O, Marcus RL, Lastayo PC, Dibble LE. Effects of dopamine replacement therapy on lower extremity kinetics and kinematics during a rapid force production task in persons with Parkinson disease. *Gait Posture*. 2014;39(1):638-640.
4. Stegemoller EL, Vallabhajosula S, Haq I, Hwynn N, Hass CJ, Okun MS. Selective use of low frequency stimulation in Parkinson's disease based on absence of tremor. *Neurorehabil Neural Repair*. 2013;33(2):305-312.
5. Maetzler W, Liepelt I, Berg D. Progression of Parkinson's disease in the clinical phase: potential markers. *Lancet Neurol*. 2009;8(12):1158-1171.
6. Shulman LM, Katzel LI, Ivey FM, et al. Randomized clinical trial of 3 types of physical exercise for patients with Parkinson disease. *JAMA Neurol*. 2013;70(2):183-190.
7. Hackney ME, Earhart GM. Tai Chi improves balance and mobility in people with Parkinson disease. *Gait Posture*. 2008;28(3):456-460.
8. Kurtais Y, Kutlay S, Tur BS, Gok H, Akbostanci C. Does treadmill training improve lower-extremity tasks in Parkinson disease? A randomized controlled trial. *Clin J Sport Med*. 2008;18(3):289-291.
9. Steffen T, Petersen C, Dvorak L. Community-based exercise and wellness program for people diagnosed with Parkinson disease: experiences from a 10-month trial. *J Geriatric Phys Ther*. 2012;35(4):173-180.
10. Prodoehl J, Rafferty MR, David FJ, et al. Two-year exercise program improves physical function in Parkinson's disease: the PRET-PD randomized clinical trial. *Neurorehabil Neural Repair*. 2015;29(2):112-122.
11. States RA, Spierer DK, Salem Y. Long-term group exercise for people with Parkinson's disease: a feasibility study. *J Neurol Phys Ther*. 2011;35(3):122-128.

12. Corcos DM, Robichaud JA, David FJ, et al. A two-year randomized controlled trial of progressive resistance exercise for Parkinson's disease. *Mov Disord.* 2013;28(9):1230-1240.
13. Schenkman M, Hall DA, Baron AE, Schwartz RS, Mettler P, Kohrt WM. Exercise for people in early- or mid-stage Parkinson disease: a 16-month randomized controlled trial. *Phys Ther.* 2012;92(11):1395-1410.
14. Duncan RP, Earhart GM. Randomized controlled trial of community-based dancing to modify disease progression in Parkinson disease. *Neurorehabil Neural Repair.* 2012;26(2):132-143.
15. Grazina R, Massano J. Physical exercise and Parkinson's disease: influence on symptoms, disease course and prevention. *Rev Neuro.* 2013;24(2): 139-152.
16. Neesemann C. Brooklyn Parkinson Group Fitness Program. Unpublished manuscript, October 31, 2007.
17. Pescatello LS, American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription.* 9th ed. Philadelphia, PA: Wolters Kluwer-Lippincott Williams & Wilkins; 2014.
18. Chobanian AV, Bakris GL, Black HR, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *JAMA.* 2003;289(19):2560-2571.
19. Bilney B, Morris M, Webster K. Concurrent related validity of the GAITRite walkway system for quantification of the spatial and temporal parameters of gait. *Gait Posture.* 2003;17(1):68-74.
20. McDonough AL, Batavia M, Chen FC, Kwon S, Ziai J. The validity and reliability of the GAITRite system's measurements: a preliminary evaluation. *Arch Phys Med Rehabil.* 2001;82(3):419-425.
21. Podsiadlo D, Richardson S. The timed "up & go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc.* 1991;39(2):142-148.
22. Agre JC, Magness JL, Hull SZ, et al. Strength testing with a portable dynamometer: reliability for upper and lower extremities. *Arch Phys Med Rehabil.* 1987;68(7):454-58.
23. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health.* 1992;83(Suppl 2):S7-11.
24. Butland RJA, Pand J, Gross ER, Woodcock AA, Geddes DM. Two-, six-, twelve-minute walking tests in respiratory disease. *Br Med J.* 1982;284: 1607-1608.
25. Steffen T, Seney M. Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified Parkinson disease rating scale in people with parkinsonism. *Phys Ther.* 2008;88(6):733-746.
26. Campbell C, Rowse J, Ciol M, Shumway-Cook A. The effect of cognitive demand on timed up and go performance in older adults with and without Parkinson disease. *Neurol Rep.* 2003;27(1):2-6.
27. Bohannon RW, Schaubert KL. Test-retest reliability of grip-strength measures obtained over a 12-week interval from community-dwelling elders. *J Hand Ther.* 2005;18(4):426-428.
28. Portney LG, Watkins MP. *Foundations of Clinical Research: Applications to Practice.* 3rd ed. Upper Saddle River, NJ: Prentice Hall; 2008.
29. Ziv E, Patish H, Dvir Z. Grip and pinch strength in healthy subjects and patients with primary osteoarthritis of the hand: a reproducibility study. *Open Orthop J.* 2008;2:86-90.
30. Allen NE, Schwarzel AK, Canning CG. Recurrent falls in Parkinson's disease: a systematic review. *Parkinsons Dis.* 2013;2013:906274.
31. Schenkman M, Ellis T, Christiansen C, et al. Profile of functional limitations and task performance among people with early- and middle-stage Parkinson disease. *Phys Ther.* 2011;91(9):1339-1354.
32. Li F, Harmer P, Fitzgerald K et al. Tai Chi and postural stability in patients with Parkinson's disease. *N Engl J Med.* 2012;366(6):511-519.
33. Cavanaugh JT, Ellis TD, Earhart GM, et al. Toward understanding ambulatory activity decline in Parkinson disease. *Phys Ther.* 2015;95(8):1142-1150.
34. International Parkinson and Movement Disorders Society—19th International Congress of Parkinson's Disease and Movement Disorders. Regular exercise found to slow decline in Parkinson's disease. http://www.mdscongress2015.org/Congress-2015/Press/News-Releases/LBA15-Exercise-and-PD.htm. June 17, 2015. Accessed July 30, 2015.
35. Hirsch MA, Iyer SS, Englert D, Sanjak M. Promoting exercise in Parkinson's disease through community-based participatory research. *Neurodegen Dis Manag.* 2011;1(5):365-377.
36. Hermanns M. The invisible and visible stigmatization of Parkinson's disease. *Am Assoc Nurse Prac.* 2013;25(10):563–566.
37. Khlebtovsky A, Rigbi A, Melamed E, et al. Patient and caregiver perceptions of the social impact of advanced Parkinson's disease and dyskinesias. *J Neural Transm.* 2012;119(11):1367-1371.