

Individuals With Parkinson Disease Are Adherent to a High-Intensity Community-Based Cycling Exercise Program

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Background and Purpose: Parkinson disease is a progressive neurological disorder with no known cure or proven method of slowing progression. High-intensity, laboratory-based aerobic exercise interventions are currently being pursued as candidates for altering disease progression. The aim of this project was to evaluate the translation of a laboratory-based intervention to the community by monitoring exercise adherence (eg, attendance) and intensity (eg, heart rate [HR] and cadence) in 5 established Pedaling for Parkinson's exercise classes. A secondary aim was to determine the impact of disease severity and demographics variables on exercise adherence.

Methods: A 12-month pragmatic design was utilized to monitor attendance, HR, and cadence during each Pedaling for Parkinson's class session. Over the course of 1 year, approximately 130 sessions were offered. Forty-nine ($n = 30$ males) persons with mild to moderate Parkinson disease from 5 community fitness facilities participated.

Results: Out of the approximately 130 cycling sessions offered at each site over 12 months, 37% of the participants attended greater than 2 classes per week (80-130 total sessions), 47% attended 1 to 1.9 classes per week (40-79 total sessions), and less than 17% attended less than 1 class per week (<40 total sessions). Average pedaling cadence was 74.1 ± 9.6 rpms while average percentage of HR maximum was $68.9 \pm 12.0\%$. There were no significant differences between cycling adherence and intensity variables based on disease severity, age, or sex.

Discussion and Conclusions: Consistent attendance and exercise performance at moderate to high intensities are feasible in the context of a community-based Pedaling for Parkinson's class. Consistency and intensity of aerobic exercise have been proposed as critical fea-

tures to elicit potential disease modification benefits associated with exercise. Community-based fitness programs that bring laboratory protocols to the "real world" are a feasible intervention to augment current Parkinson disease treatment approaches. See the Supplementary Video, available at: <http://links.lww.com/JNPT/A357>.

Key words: community-based exercise, cycling, group exercise, exercise adherence, Parkinson disease

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INTRODUCTION

Parkinson disease (PD) is a neurodegenerative disorder that results in a progressive decline of motor and nonmotor function. Persons with PD (PwPD) generally live with the disease for 1 to 3 decades following diagnosis,¹ highlighting the need for sustainable treatment options that decrease disability, promote mobility, and maintain quality of life throughout the disease process. Data from animal²⁻⁶ and human⁷⁻¹¹ models suggest that high-intensity exercise is a promising approach to facilitate changes in the central nervous system and potentially slow the neurodegenerative processes associated with PD.

Overall, less than 50% of the healthy adult population meets the exercise recommendations from the American College of Sports Medicine (ACSM).¹² As individuals age, there is a precipitous decline in physical activity; approximately 60% of those 60+ years of age are considered physically inactive.¹³ The presence of a neurological disease further decreases levels of activity.¹⁴ Building on general aerobic exercise recommendations from the American Academy of Neurology,¹⁵ recently the ACSM partnered with the Parkinson's Foundation to create comprehensive PD exercise recommendations.¹⁶ It was recommended that PwPD participate in a minimum of 90 minutes of moderate to vigorous aerobic exercise per week. Notably, aerobic exercise recommendations were a component of a multifactorial exercise program that also included weekly sessions of strength training, balance, and multitasking and stretching.

Despite its importance, physical activity level in PwPD is significantly less than in those without PD.¹⁴ Barriers to exercise such as low-outcome expectations, lack of time, and fear of falling are specific to PwPD that prevent regular exercise adherence.¹⁷ Disease-specific community-based exercise programs may be one strategy to improve exercise adherence in PwPD by enabling social support and provide a sense of purpose and belonging, which may improve exercise

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self-efficacy and one's ability to cope with the disease.¹⁸⁻²¹ Furthermore, disease-specific community-based exercise programs may overcome barriers such as equipment location and adaptability, feeling self-conscious in a group setting, and instructor disease-specific knowledge.²²

Several studies have examined the short-term effects of disease-specific group exercise classes in PwPD. McGough and colleagues²³ reported 96% attendance rate and improvements in gait, balance, and mobility following a 10-week high-intensity tandem cycling program for PwPD. Others have reported similar attendance in group exercise programs over a 2- to 3-month duration in this patient population.^{24,25} When examining year-long group exercise compliance in a community-based program for PwPD, States and colleagues²⁶ reported that 59% of PwPD attended at least half the classes, 33% completed fewer than half, and 9% did not attend any classes. A study examining a year-long Tango program for PwPD demonstrated a reduction in motor symptoms measured by the Movement Disorder Society—Unified Parkinson's Disease Rating Scale III (MDS-UPDRS III).²⁷ The reduction in motor symptoms following a long-duration exercise program in PwPD is promising; however, the project experienced a 37% attrition rate in the no-intervention control group and a 50% attrition rate in the Tango group,²⁷ raising questions regarding the translatability and sustainability of long-term adherence to group exercise programs for PwPD.

The previous studies provide initial, and mixed, insight into the feasibility of PwPD participating in and adhering to community-based exercise programs. The role of demographic variables such as sex,²⁸ age,²⁶ and PD disease severity²⁹ has been suggested to play a role in exercise adherence. Thus, important gaps regarding PD-specific community-based exercise programs remain: (1) What is exercise attendance in a PD-specific, community-based exercise class that is held continuously in a “real-world” setting without investigator oversight? (2) At what intensity do PwPD exercise in a community-based setting? (3) What is the impact of demographic variables on community-based exercise attendance and intensity?

A fundamental gap exists in understanding the role and efficacy of community-based exercise interventions to enable PwPD to meet aerobic exercise recommendations. Multiple studies have been published that use a community-based exercise model^{25,30-32}; results from these projects provide great insight into the potential of group and community-based classes to affect PD symptoms and quality of life. However, many of these interventions are created for the purpose of conducting a research study for a finite period of time and include exercise supervision from a member of the study team. Therefore, it is likely that the exercise behaviors exhibited in the studies may not accurately represent “real-world” exercise behaviors of PwPD. An alternative experimental design to a laboratory- or community-supervised paradigm is a pragmatic study design. Pragmatic study designs, as opposed to explanatory study designs, are intended to assess the effectiveness of an intervention under the typical conditions that it will be or is intended to be applied.^{33,34} Pragmatic study designs aim to ultimately reflect the population who will be utilizing the intervention by including all participants who have the condition

of interest, offering interventional flexibility in a range of environmental settings, and implementing unobtrusive measures of compliance.³⁴ In an effort to gain an initial understanding of the dose of moderate to vigorous exercise completed in a true community-based, PD-specific cycling program, a pragmatic study design was employed to monitor 5 Pedaling for Parkinson's (PFP) community-based exercise programs. The PFP program is unique, as it is based on a laboratory-based exercise protocol^{35,36} specifically aimed to meet the physical needs of PwPD, offered continuously throughout the year, and available in 150+ YMCAs and community-based centers throughout the United States. Across all sites, there is a uniform protocol that promotes high-intensity aerobic exercise, making it an ideal setting to observe “real-world” exercise behaviors in PwPD. The aim of this project was to evaluate long-term exercise adherence (eg, attendance) and intensity, measured by heart rate (HR) and cycling cadence over 12 months of observation of PFP classes delivered at 5 community fitness facilities located throughout the United States. A secondary aim was to determine the impact of disease severity on exercise adherence and intensity.

METHODS

A 12-month pragmatic design was employed to evaluate PwPD exercise adherence and intensity under true community-based “real-world” conditions.³⁷ Five community-based facilities (2 in northern Washington and 3 in central Colorado) with established PFP programs agreed to participate. The sites were selected on the basis of geographical diversity (eg, 1 site was located in a rural setting, 1 was urban, and 3 were suburban), stability of program, and administrative accommodation of each facility. All 5 sites conducted their PFP classes on upright, stationary bicycles; the brand of exercise cycles varied by site. Study personnel made an initial visit to each site to gather demographic and disease-specific information and to set up the exercise-monitoring systems. Notably, study personnel did not provide feedback or instruction to the participants or the cycling instructors. The instructors of these programs had various fitness backgrounds (eg, group fitness instructors, personal trainers, and experienced cyclists with and without PD).

Participants

In accordance with a pragmatic design, PwPD who attended the PFP class regardless of their frequency of participation were offered the opportunity to participate in the study. Notably, electing not to participate in the study did not preclude individuals from participating in PFP classes. Inclusion criteria were as follows: diagnosis of idiopathic PD, participation in a PFP program, and ability to provide informed consent. Exclusion criteria were as follows: participation in another pharmaceutical or interventional PD-related study, diagnosis of dementia, deep brain stimulation, and neurological disease other than PD.

This project was approved by the Cleveland Clinic Institutional Review Board and all participants provided written informed consent prior to the initiation of data collection. The participants were asked to attend PFP classes as their schedule allowed. In accordance with the pragmatic study

design, study personnel did not provide specific instructions about attendance or exercise intensity.

PFP Exercise Protocol

Each of the 5 sites had an established PFP program (length of establishment ranged from 8 months to 4.5 years). To establish a PFP program, fitness centers completed a no-cost licensing agreement (<https://www.pedalingforparkinsons.org>) that detailed the PFP cycling exercise protocol, inclusion and exclusion criteria, safety considerations, general overview of PD, and tips to delivering an effective group exercise to PwPD. The exercise protocol specifies 45 to 60 minutes of cycling (including a 5- to 10-minute warm-up and cooldown), a target pedaling cadence between 80 and 90 revolutions per minute (rpm), and an aerobic intensity between 60% and 80% of their age estimated HR maximum or a rate of perceived exertion between 4 and 7 on a 10-point rate of perceived exertion scale. The PFP protocol details safety measures such as how to mount and dismount a cycle based on physical ability and provides a pre-exercise participation medical screen and physician clearance form. General instructor training is outlined, as classes are typically taught by a group fitness instructor who may not have PD-specific training.

Exercise Monitoring

For all participants, exercise date, exercise time, cadence, and HR were recorded for all exercise classes. The 5 sites were unique in their physical setup, Internet connectivity, and brand of stationary bike. To accommodate environmental differences, 3 exercise-monitoring systems were used to monitor and record exercise performance outcomes during each PFP class. Three of the sites used the FitMetrix Indoor Cycling System (Atlanta, Georgia), 1 site utilized the Stages Cycling Flight System (Boulder, Colorado), and a final site utilized the Wahoo Fitness Mobile Application (Atlanta, Georgia). The participants at all sites were provided Wahoo Fitness HR and cadence monitors with Bluetooth connection, which they donned at the beginning of each class. The participants were assigned a unique study ID, and all data were associated with the ID in their respective monitoring systems.

Data collection for the 2 group-monitoring systems, FitMetrix and Stages Flight, was initiated and terminated by the group fitness instructor using a mobile device for each session. Data were transmitted to the respective commercial Web site via wireless Internet connection, labeled under a unique study ID, downloaded by the study team, and stored on a secure server accessible only to the study team.

For the 1 site using the Wahoo Fitness Mobile Application, the app was installed to each participant's mobile device (ie, Apple or Android smartphone). The Wahoo HR and cadence monitor Bluetooth connected to the app and HR and cadence were recorded continuously. Following each class, the individual's data were transmitted to the study coordinator via secure email.

Regardless of the monitoring system, common data elements across sites included attendance, HR, and cadence for each session.

Data Analysis

Summary statistics were compiled for demographic information. Mean cadence and HR data from each cycling session were compiled for each participant. Rarely, technology failure occurred producing outlying data points. Data falling outside 2 standard deviation of the individual's mean HR and cadence were excluded from analysis (<5% of data points). Summary statistics were computed on attendance, HR, and cadence data. Percentage of maximum HR was estimated on the basis of age-predicted maximal HR: $220 - \text{age}$.³⁸ For those on β -blockers ($n = 7$), the following equation was used to estimate maximum HR: $(164 - 0.7 \times \text{age})$.³⁹ Finally, Welch's 2 sample t tests or Spearman rank-order correlation analyses were used to describe the relationship between cycling adherence variables and demographic variables.

RESULTS

Study Participants

A total of 50 individuals participated in the 12-month pragmatic, observational study. One participant was excluded from analysis as he or she attended the enrollment session but never attended a subsequent PFP class and could not be reached for follow-up. Demographics from the 49 remaining participants are shown in Table 1.

Table 1. Baseline Demographic Variables (N = 49)

Characteristic	Value ^a
Age, y	69.0 \pm 6.8
Race	
White	47 (95.9%)
Two or more races	2 (4.1%)
Ethnicity	
Non-Hispanic or Latino	48 (98.0%)
Hispanic or Latino	1 (2.0%)
Sex	
Male	30 (61.2%)
Female	19 (38.8%)
Years of education	16.9 \pm 2.8
More affected upper extremity	
Right	28 (57.1%)
Left	21 (42.9%)
Years since diagnosis	5.4 \pm 4.5
Years attending PFP class	1.4 \pm 1.5
Falls over the previous 6 mo	1.1 \pm 1.8
Exercise frequency, days per week	5.4 \pm 1.3
Employment status	
Employed full time	2 (4.1%)
Employed part time	3 (6.1%)
Retired due to PD	14 (8.6%)
Retired by choice	30 (61.2%)
Levodopa equivalent daily dose, mg	614.2 \pm 407.0
Prescribed β -blocker	7 (14.3%)
MDS-UPDRS III score, off-PD medication	38.0 \pm 12.5
Hoehn & Yahr, off-PD medication	
H&Y I	2 (4.1%)
H&Y II	35 (71.4%)
H&Y III	12 (24.5%)

Abbreviations: H&Y, Hoehn & Yahr; MDS-UPDRS, Movement Disorder Society—Unified Parkinson's Disease Rating Scale; PD, Parkinson disease; PFP, Pedaling for Parkinson's.

^aValues are reported as mean \pm SD or n (%).

Table 2. Cycling Adherence Metrics^a

	All Subjects (N = 49)	Site 1 (N = 19)	Site 2 (N = 9)	Site 3 (N = 7)	Site 4 (N = 11)	Site 5 (N = 3)
Number of visits (out of 130 potential visits)	69.1 ± 29.4	63.6 ± 32.1	63.0 ± 27.7	74.9 ± 21.4	71.0 ± 29.5	101.4 ± 22.6
Average heart rate (% of maximum) ^b	68.9 ± 12.0	68.2 ± 9.1	75.9 ± 15.5	73.0 ± 15.5	63.2 ± 10.7	65.3 ± 6.62
Average cadence (rpm)	74.1 ± 9.6	76.3 ± 10.0	73.7 ± 6.0	72.4 ± 7.7	73.6 ± 11.1	67.3 ± 15.5

Abbreviation: rpm, revolutions per minute.

^aValues are reported as mean ± SD.^bOne participant was in chronic atrial fibrillation and heart rate was not recorded.

Cycling Adherence and Intensity

Each facility offered classes 3 times per week; however, accounting for facility closures due to inclement weather, instructor vacation or illness, and scheduled and unscheduled maintenance, approximately 130 sessions were offered annually at each site.

Exercise adherence and intensity by site is shown in Table 2. Notably, one of the sites had only 3 participants, one of whom attended more than 120 sessions over the 12-month period, which influenced the group mean. Overall, participants completed 69.1 ± 29.4 sessions during the 12-month period (53.1% of all available sessions). Of the 130 sessions offered, 18 participants attended on average 2 or more classes per week (80-130 total sessions), 23 PwPD on average attended 1 to 1.9 classes per week (40-79 total sessions), and 8 participants averaged less than 1 class per week (<40 total sessions).

Heart rate data were used to classify exercise intensity using ACSM guidelines.⁴⁰ Heart rate data were averaged for each participant over all of their attended classes. Eleven participants exercised at vigorous intensity (76+% of HR maximum), 20 participants exercised at a moderate intensity (64%-76% of HR maximum), and the remaining 17 participants exercised at a low intensity (<64% of HR maximum).

Cadence data were calculated for each individual over all attended classes. Pedaling rate was classified as high (80+ rpms), medium (60-79 rpms), and low (<60 rpms) based on our previous cycling interventional study.³⁶ Cadence classification for high, medium, and low was 13, 30, and 6 participants, respectively.

Demographic variables, such as age, years since diagnosis, and disease severity, between low performers in HR (<64% of HR maximum, $n = 17$) and cadence (<60 rpms, $n = 6$) and moderate-high performers were not statistically different from one another.

Cycling Adherence as a Function of Disease Severity

Mean baseline MDS-UPDRS III scores off antiparkinsonian medication were 38.0 ± 12.5 points with a range of 16 to 69 points, indicating that there was a wide range of motor symptoms and disease severity among the participants. Based on disease severity classification using the MDS-UPDRS III score⁴¹; the majority of participants were classified as moderate. In sum, 15, 30, and 4 patients were classified as mild (MDS-UPDRS III score of ≤ 32 points), moderate (MDS-UPDRS III score of 33-57 points), and severe (MDS-UPDRS

III score of ≥ 58 points). The relationship between disease severity measured by the MDS-UPDRS III and cycling attendance and intensity variables is displayed in the Figure. There were no significant correlations between disease severity and cycling attendance, HR, or cadence data ($\rho \leq 0.20$, $P > 0.05$ for all).

Cycling Adherence as a Function of Sex and Age

Exercise adherence and intensity variables were separated by sex to determine whether differences existed between males and females. Across all measures of cycling adherence and intensity variables, males and females performed similarly. Percentage of maximum HR was $71.2 \pm 12.9\%$ for females and $67.4 \pm 11.4\%$ for males ($t = 1.04$, $df = 35.2$, $P = 0.30$). The average number of total sessions attended was 72.8 ± 30.7 sessions for males and 63.1 ± 27.0 sessions for females ($t = -1.15$, $df = 42.0$, $P = 0.25$). The mean cadence across all exercise sessions was 76.2 ± 8.0 rpms for males and 70.7 ± 10.9 rpms for females ($t = -1.86$, $df = 30.2$, $P = 0.07$). Finally, there was no significant correlation between the age of the participants and number of sessions attended ($\rho = -0.14$, $P > 1.0$), mean cadence ($\rho = -0.20$, $P > 1.0$), or percentage of maximum HR ($\rho = 0.10$, $P > 1.0$).

DISCUSSION

The timely and important exercise recommendations set forth by the ACSM and Parkinson's Foundation reflect a major advancement in helping PwPD and clinicians operationalize the concept that exercise is medicine for PD. The goal of completing a minimum of 90 minutes of moderate to vigorous exercise along with stretching, strength training, and balance and agility training is ambitious considering that the vast majority of the healthy adult population fails to exercise with this level of frequency or intensity. Recent data indicate that PwPD are currently not meeting these requirements of activity in general as total activity, based on steps per day, in PwPD was 56% less than that in healthy older adults.⁴² Furthermore, only half of those with PD were achieving more than 30 minutes of moderate or high intensity on a daily basis compared with 86% of healthy peers. Ambitious exercise recommendations coupled with internal and external barriers to exercise in those with PD require novel and innovative methods to deliver high-intensity exercise to PwPD and maintain adherence. The historic resistance of third-party payors supporting preventive or augmentative exercise programs necessitates the development of true community-based

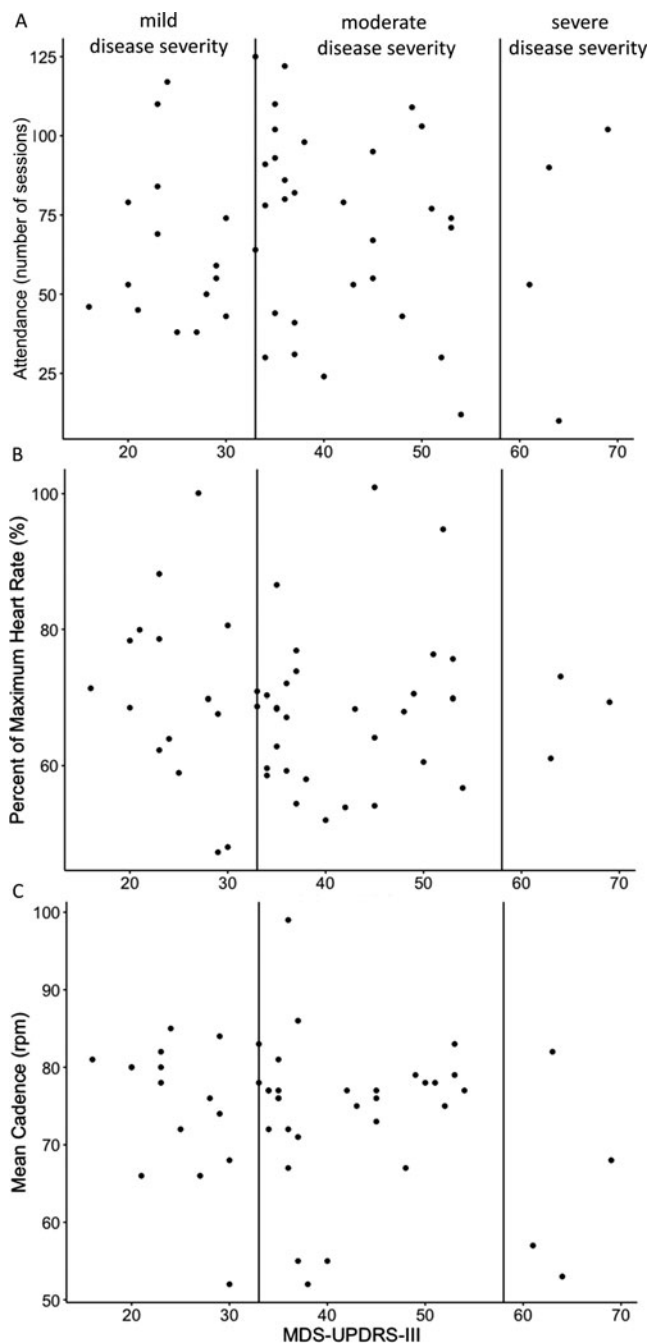


Figure. There was no significant correlation between disease severity and (A) mean cadence, (B) mean percentage of maximum heart rate, and (C) attendance. One participant was in chronic atrial fibrillation and heart rate was not recorded. MDS-UPDRS III indicates Movement Disorder Society—Unified Parkinson's Disease Rating Scale III.

programs to deliver evidence-based high-intensity exercise. The current results support a community-based PFP program as a key component for PwPD to achieve or approach the recommended exercise frequency and intensity set forth by ACSM and the Parkinson's Foundation. We are unaware of

any other long-term data characterizing PwPD exercise habits, importantly aerobic intensity, in a true community setting.

Participants' self-reported exercise was 5.4 ± 1.3 days per week, suggesting that participation in the PFP program is part of well-balanced approach to exercise in this PD cohort. The high level of self-reported physical activity reported by participants in this study is consistent with those reported by McKee and colleagues,⁴³ who reported that PwPD who elect to participate in a PFP program tend to have a moderate to high level of self-reported physical activity prior to joining the class. Attending more than 50% of annual available cycling classes, fairly evenly distributed throughout the 12-month period, suggests that the exercise behavior was in the maintenance phase of adopted behavior⁴⁴ and habitual in nature.⁴⁵ While other year-long studies report dropout rates up to 50%,²⁷ our project had only 1 participant who did not attend any PFP classes and could not be reached for follow-up, suggesting that the intervention and the environment in which exercise was delivered were engaging. Future studies to systematically evaluate the characteristics of successful community-based exercise programs that facilitate regular attendance and achievement of moderate to vigorous aerobic exercise are warranted.

Notably, adherence and intensity reported in this study may not be generalizable to those PwPD who may be new to a PFP program. Participants in this project had been attending a PFP class for an average of 1.4 years prior to enrollment. Those who attended the class tended to be older, Caucasian adults with moderate PD who had a high level of education and were retired. The demographic variables that were examined (age, sex, and disease severity) were not significantly associated with exercise adherence and intensity and low-intensity exercisers were evenly distributed across sites. A future direction includes examining the influence of demographic variables and exercise self-efficacy on exercise adherence and intensity. Future studies are planned to more precisely characterize and dissociate exercise from physical activity in PwPD participating in PFP and other exercise programs. Importantly, recommendations from the ACSM and Parkinson's Foundation and the American Academy of Neurology both recommend that individuals with PD complete 90+ minutes of moderate to vigorous aerobic exercise and not simply be physically active for that time. Conflating exercise and physical activity must be avoided in the delivery and monitoring of a PD-specific exercise program if PwPD are to derive the maximum benefit of using exercise as an adjunct to the treatment of PD.

The PFP protocol is based on a successful laboratory exercise protocol^{35,36} and can be successfully translated to a community setting. Importantly, the pragmatic design of this project makes it unique compared with previous supervised community-based studies.^{23,25,30,31} By truly measuring exercise performance and attendance in an unobtrusive manner, we were able to evaluate true community-based exercise behavior. Understanding exercise behavior under "real-world" conditions will facilitate the development of additional methods of engagement to ensure that PwPD have the opportunity and support to ensure that the exercise they are completing meets the recommendations set to derive the greatest benefit.

Attendance data indicate that when disease-specific exercise classes, such as PFP, are accessible in a community setting, PwPD will attend on a regular, habitual basis. Furthermore, the majority of those who attend the class are capable of exercising at moderate-vigorous aerobic intensities with guidance from a group fitness instructor. When examining HR maximum, 65% of the participants were able to exercise in a moderate-vigorous intensity; when examining cadence, 88% were able to exercise a moderate-high cadence. These intensity data indicate that community-dwelling PwPD are capable of reaching the intensity that may be necessary for promoting disease-modification in a group exercise setting. Notably, the percentage of HR maximum was estimated on the basis of age. In a cross-sectional study examining metabolic and cardiovascular response to maximal cardiopulmonary stress test in PwPD, only 35.4% of PwPD achieved 90% of predicted maximal HR, compared with 95.0% of controls.⁴⁶ In light of these findings, it is possible that exercise intensity in this project was underestimated on the basis of HR alone. Future community-based studies in PwPD should consider additional modes of measuring intensity, such as rate of perceived exertion.⁴⁷

There is a need to observe and study interventions that promote intensity during exercise in PwPD, as intensity appears to be a key factor to controlling motor symptoms of the disease, altering central nervous system function, and potentially modifying the disease process. Using cadence as a measure of intensity, Shah and colleagues⁷ reported a positive correlation between pedaling rate and change in functional connectivity from the more affected M1 to the ipsilateral thalamus following an 8-week stationary cycling intervention. Following a 16-week tandem cycling intervention in PwPD, Segura and colleagues⁴⁸ reported exercise-induced activation of the occipitotemporal lobes (fusiform gyrus) and increased plasma brain-derived neurotrophic factor levels, which correlated with an improvement in the UPDRS. The results of the aforementioned studies are supported by animal models of PD indicating that aerobic exercise may support activity-dependent neuroplasticity via preservation of tyrosine hydroxylase, increased D2 receptors, and upregulation of neurotrophic factors including brain and glial-derived neurotrophic factors.^{5,6,49,50} Collectively, these data indicate that if individuals are capable of achieving and sustaining high-intensity exercise, there is a possibility of controlling motor symptoms and potentially altering the course of the disease. Our data suggest that effective laboratory exercise research protocols can be translated and operationalized to a community-based setting. The results demonstrate that PwPD can sustain moderate- to high-intensity exercise in a community-based exercise class, giving rise to the possibility that exercise of sufficient intensity to produce disease-modifying effects can be achieved without formal oversight of research or health care professionals.

Cycling may be a valuable mode of aerobic exercise for PwPD, as our study demonstrated that moderate-vigorous exercise was feasible with varying levels of disease severity, regardless of age and sex. This is important because it can be challenging to identify appropriate modes of exercise as the disease progresses and disability increases.⁵¹ Aerobic exercise such as walking overground or on a treadmill requires a

high level of postural control in PwPD.⁵² Because of the ability to remain seated, stationary cycling reduces the postural stability requirements and may allow individuals to focus on the desired lower extremity pedaling motion, potentially facilitating individuals to reach a higher level of intensity through cadence or HR. The preservation of cycling abilities is seen even in PwPD who experience freezing.⁵³ A small number of participants ($n = 4$) were classified as having severe disease severity based on MDS-UPDRS III score, and the results should be interpreted with that limitation. However, 25% of participants who successfully participated in the study were classified as H&Y III, indicating gait and balance deficits. Our data support that stationary cycling is a viable mode of aerobic exercise in PwPD throughout the disease spectrum.

The effects of exercise on PD are largely derived from well-controlled, short-term laboratory studies. Importantly, short-term exercise exhibits a limited reach on symptom modification, as improvements appear to dissipate after 4 weeks of inactivity,³⁶ highlighting that aerobic exercise must be habitual to achieve consistent benefit. In addition, much of what is understood about exercise behaviors in PwPD is often based on self-report questionnaires related to physical activity behaviors.^{17,18,54} It is important to note that the positive laboratory studies related to exercise and PD symptoms generally report benefit associated with performing high-intensity, not low-intensity, aerobic exercise.^{36,55,56} Ongoing, community-based classes, such as PFP, provide an opportunity for PwPD to engage in aerobic exercise regardless of their geographical location or access to major medical or academic centers. Considering that one of the main reasons PwPD participate in a fitness program is to reduce the impact of their PD symptoms,⁵⁷ next steps involve measuring the potential efficacy of a community-based fitness program to mitigate disease symptoms. The PFP program poses an ideal model to study the impact of community-based exercise in PwPD, as the protocol is uniform across the 150+ national sites. Current complimentary studies are underway examining exercise adherence and intensity with PwPD in the home setting, as a community-based setting does require a mode of transportation that may have a limiting factor for some PwPD. The ongoing project leverages a commercially available platform-based exercise cycle to deliver a high-intensity exercise intervention.

Limitations

At the end of the study (spring of 2020), the worldwide COVID-19 pandemic restricted our ability to travel to 3 of the 5 sites to gather 12-month outcome data. However, all sites completed their 12-month exercise observational period prior to the United States initiating face mask mandates, travel restrictions, and social distancing; therefore, the exercise adherence and compliance outcomes were not impacted by the pandemic.

Importantly, the license between the site delivering the PFP class and PFP does not specify that attendee must attend or should attend a certain number of classes per week. Rather, it requires the site to offer, as practical, based on facilities, weather, staff vacations, and so forth, classes 3 times per week. Because of the nature of the pragmatic design, the

study team did not intervene or provide feedback as to the frequency, duration, or intensity of exercise sessions to either the instructor or the participant. Rather, to categorize the dose of exercise in a “real-world” setting and increase the external validity of the study,⁵⁸ the study team remained unobtrusive to the site delivery of PFP. Hence, comparing attendance and intensity to prescriptive, explanatory trials, especially those of short duration, is inappropriate.

We acknowledge that there may be selection bias in the study. For successful completion of this project, it required a concerted effort from both the study team and the community facility administration. We initially contacted administrators at various facilities that conducted PFP classes in geographically diverse locations to request collaboration. Of those who responded, the 5 selected sites were willing to allow the study team to visit their facility on several occasions, provide space for the participant assessments, utilize Internet and space resources to implement an exercise-monitoring system, and employ exercise instructors willing to assist with using HR monitors to assess exercise intensity. As mentioned previously, the cohort of PwPD in this study was already involved in the PFP program; attendance and intensity variables in exercise-naïve PwPD have yet to be determined.

CONCLUSIONS

Parkinson disease is unrelenting and there is no known method of slowing its progression. Aerobic exercise may be a potential disease-modifying intervention to the disease if the dose of exercise is habitual and of adequate intensity. Our attendance and exercise intensity data demonstrate that a wide range of PwPD are capable of attending a community-based PFP exercise class and sustaining moderate to high intensities on an upright stationary cycling, regardless of disease severity. Community-based, disease-specific exercise classes overseen by a fitness instructor provide a promising way to promote activity and potentially manage the disease process in a cost-effective manner, in particular, for those living in rural or underserved areas. The class sizes in this study ranged from 3 to 19. Regardless of size, the community aspect and intensity were present across all sites. Disease-specific, community-based exercise programs that demonstrate exercise adherence pose an exciting and unique opportunity to expand the circle of care for PwPD.

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