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Assessing Disparities in Quality of Life and Depression Outcomes for People with Parkinson's Disease Participating in an Adaptango Dance or Walk Intervention.

By

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Master of Public Health

Epidemiology

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By

Alex W. Rodriguez

B.A., The University of Chicago, 2022

Thesis Committee Chairs: Madeleine Hackney, PhD; Regina Shih, PhD

An abstract of
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Abstract

Assessing Disparities in Quality of Life and Depression Outcomes for People with Parkinson's Disease Participating in an Adaptango Dance or Walk Intervention.

By Alex W. Rodriguez

Background: Parkinson's Disease is the second most common most common neurodegenerative disorder in the United States and negatively impacts quality of life. Medication alone is ineffective at slowing degeneration, necessitating exercise and other behavioral interventions to reduce morbidity and mortality from the disorder. In a meta-analysis of different exercise techniques in people with Parkinson's Disease, dance was found to be most effective at improving depressive symptoms, however, little is known if positive effects from dance and walk based exercise for people with Parkinson's Disease is effective in Black individuals in the United States.

Methods: An exploratory analysis comparing psychosocial and functional outcomes was conducted using data from the PAIRED Trial (NCT04122690). The trial includes a racially diverse sample of individuals with Parkinson's Disease participating in either a dance or walk-based exercise program over 16 months. Outcomes included depression, quality of life, social support, and parts I-III of the Movement Disorder Society's Unified Parkinson's Disease Rating Scale. Differences in each outcome were computed through statistical software and compared between White and Black individuals using a Mann-Whitney U Test and Fixed Effects Regression.

Results: Participants were assessed at both baseline and 3 months after they began classes. The sample was 68% non-Hispanic White (n=28) and 27% non-Hispanic Black (n=11). The mean (49-83) age was 70.6 (49-83) years. There were no significant differences for any observed psychosocial changes between Black and White individuals over the 3-month period except that disability and functional status as measured by the Role of Physical Functioning Score, improved more (Glass' Δ=1.06, 0.38-1.85) among Black compared to White individuals ($p<0.05$).

Discussion: Despite there being no statistically significant differences for 15 of the 16 outcomes variables assessed, the differential improvement in the Role of Physical Functioning Score may reveal the impact that access to free exercise classes have on self-perceived physical ability. Outside of a research setting, Black individuals may have fewer opportunities to participate in costly Parkinson's exercise classes outside of a research setting. Future studies with more participants are required to confirm or reject the results of this exploratory analysis.

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Literature Review

Background

Parkinson's Disease (PD), the second most common neurodegenerative disorder [1], affects more than 6 million people worldwide.[2–4] This condition is becoming more prevalent due to aging populations in middle, middle-high, and high income countries.[5] Despite PD being a non-communicable disease, PD is considered a pandemic by epidemiologists because of its increasing incidence and widespread prevalence.[3,6]

PD can significantly negatively impact an individual's quality of life (QoL). [7] PD often adversely affects postural stability, [8–10] resulting in reduced independence, [11] falls, and bone fractures. [12] Other symptoms such as the cardinal sign, bradykinesia, and cognitive impairment [4] are known to have significant negative effects on QoL. [13,14] PD's combination of motor and non-motor symptoms interrupts the ability of those who suffer from the condition from carrying out normal daily activities. These disabling symptoms (and others associated with PD) have been quantified by the Disability Adjusted Life Years (DALYs) as costing 5.8 million years of lost life. [4]

The most common clinical treatment used to alleviate symptoms from PD are two drugs (distributed as one pill) called Carbidopa and Levodopa.[15] Levodopa is a drug that is converted to dopamine in the body and imperfectly restores striatal dopaminergic transmission, a process that is increasingly degraded as PD progresses.[16] Carbidopa is a dopa decarboxylase inhibitor, working to promote Levodopa's conversion to dopamine in the central nervous system [17] while inhibiting Levodopa's conversion to dopamine outside of the central nervous system,

thus limiting Levodopa's negative side effects.[18,19] Because Carbidopa reduces Levodopa's side effects, these medications are distributed together as one pill. Still, Levodopa side effects worsen as PD progresses.[16,17,20] Most prominently, Levodopa's effects are often uneven throughout the day, due to its short half-life. [15,21] Levodopa's fluctuating effectiveness (called Medication-Related Motor Fluctuations in the literature, i.e. MRMFs) [22] results in "OFF-times" or times of deteriorated motor and cognitive control. [23] Nausea, somnolence, and insomnia are other commonly reported side effects of Levodopa and other anti-PD medications (like Ropinirole).[24] Furthermore, dyskinesias (twisting and writhing movements while on medication) and dystonia (painful cramping when the medication loses its effectiveness) are common long-term side effects of Levodopa, caused by the neurotoxic side-effects of the drug over time. [20,25–27] Levodopa's side effects show that there is a clear trade-off that individuals with PD must make when deciding to begin treatment.

Carbidopa/Levodopa's limitations necessitate behavioral rehabilitation for people with PD. Many exercise therapies have been found to be effective at slowing both motor and cognitive deterioration from PD. However, people with PD have struggled to maintain a scheduled regimen of calisthenics or other forms of traditional exercise in previous studies [28] Meta-analysis of various PD exercise rehabilitation strategies found that Music and Dance Based Exercise (MDBE) interventions were the most effective at reducing depressive symptoms and at keeping participants adherent to exercise classes. [29] However, the MDBE research studies included in this meta-analysis had small sample sizes and only included one research study in the United States. These studies have limited applicability to U.S. minoritized populations. [30,31]. Neither racial nor ethnic demographic information has been reported by any PD exercise meta-analysis to date [28,29,32], and only 17% of PD studies over the last 22 years have even reported

data on race and ethnicity. [33] This indicates a key gap in knowledge of how effective PD exercise is in historically minoritized populations.

The issue of small sample sizes and limited generalizability necessitates further research into how MDBE interventions in people with PD may improve outcomes in a diverse sample. Though several studies have investigated the relationship between participating in an exercise intervention and QoL and Depressive Symptoms for people with PD [34,35], few have investigated how these interventions may differentially affect racial and ethnic minorities such as Black individuals. The PAIRED trial [36] is an MDBE exercise RCT allocating participants into either an MDBE Adapted Tango (Adaptango) exercise regimen, or a walking-based intervention (WBI). To address the limited information about interventions for racial minorities, we recruited a new sample of non-Hispanic White and non-Hispanic Black/African American older adults from the Atlanta Metropolitan area for this study and evaluated depression, QoL, and social support outcomes among participants in the MDBE versus WBI arms. The PAIRED trial will be discussed further in the method section.

Racial Disparities in Parkinson's Disease Diagnosis and Outcomes

There is a major gap in knowledge of how PD affects African American or Black people. [37] Even though some studies report a lower prevalence of PD in Black individuals [38], researchers attribute this to disproportionately poor access to care, [39,40] lower life expectancy, [41,42] and mistrust in the medical community. [43] A study in Mississippi found that even though White Individuals were twice as likely to have a PD diagnosis in the older population sampled, Black and White Individuals had similar rates of PD as assessed by survey responses done by the

research staff. [44] This indicates a clear healthcare disparity that underestimates the true prevalence of PD in Black individuals. [40,45]

Regardless of whether the prevalence of PD is higher or lower in Black individuals because of lower access to screening and diagnosis, Black individuals with a PD diagnosis may fare worse on functional and quality of life outcomes compared to their White counterparts. A study investigating racial disparities in Deep Brain Stimulation (DBS) implementation revealed that Black individuals are 5 to 8 times less likely to receive the surgery than White individuals. [46] This surgery is costly and invasive, but has been found to be effective at improving PD symptoms, motor functionality, and quality of life in people with advanced PD. [47] Another study found that Black individuals with PD symptoms (regardless of a formal PD diagnosis) had significantly greater disease severity and disability than White individuals with PD symptoms. [48] Thus, exercise interventions that target those outcomes are important to test in diverse samples. [33]. Unfortunately, most currently available exercise interventions in the literature do not report race or ethnicity data [30,31,49–53], which raises the question whether these interventions have differential effects among people of different ethnic and cultural backgrounds. Many PD dance trials have been conducted outside of the United States, while PD dance trials conducted in the United States have not included racial and ethnic demographic information. [52–56] Recent meta-analyses on PD dance have also not considered race and ethnicity. [57] More research is needed to ensure that the encouraging results of PD exercise interventions are translatable to more diverse populations.

Methods

Study Population

The protocol of the PAIRED Trial has been previously described. [36] Briefly, the PAIRED Trial is an RCT (NCT04122690) that compares outcomes between a group randomized to a Music and Dance Based Exercise (MDBE) Adaptango exercise intervention to a group randomized to a Walking-Based Intervention (WBI). Both participants in the MDBE arm, and those in the WALK arm, are asked to participate by attending classes twice a week for 3 months during a training phase, and once a week for 13 months during a maintenance phase. Participants are also assessed at four-time intervals: at baseline, and at 3, 10, and 16 months after enrollment. The primary outcome of the PAIRED trial is Part IV of the Movement Disorders Society Unified Parkinson Disease Research Scale (MDS-UPDRS), which concerns Medication-Related Motor Fluctuations (MRMFs). A secondary question concerns whether MDBE, the experimental group, results in a greater reduction in OFF-times (times when PD medication wears off and symptoms return or worsen) [58] than observed in the WBI group. Several other outcomes are also assessed, including cognitive, motor and QoL measures. This thesis focuses on examining psychosocial and functional outcomes measured in the trial, including depressive symptoms, social support, and QoL, measured from baseline to 3 months, after participants were to have taken biweekly classes and attended at least 20 times.

The PAIRED Trial hosts classes in the Atlanta metropolitan area, allowing for the recruitment of a diverse patient population. Due to the demographics of the area, most of the sample included individuals who identified as either non-Hispanic White or Black. [59] This representation within the sample allowed for analysis of potential disparate outcomes between each population group.

Primary Measures

This analysis aimed to investigate potential disparate QoL and psychosocial outcomes between White and Black Participants in the PAIRED trial. Depression, QoL, and social support were compared between the two groups to assess the efficacy of either the MDBE or WBI at improving these measures for each subgroup. The timepoints for this sub-analysis were baseline measures and post-training measures taken at 3 months post-enrollment, and other reports will concern the primary outcomes measures, as well as other timepoints of the PAIRED trial. All measures, except for the MDS-UPDRS [60], were administered as electronic surveys to participants through REDCap [61], an electronic record system commonly used in Human-Studies Based research. Participants were sent email notifications to complete the surveys and then prompted to complete all items in the survey with the REDCap module.

Self-Reported Measures

Depression was assessed using the Beck Depression Inventory (BDI-II), [62] a comprehensive survey distributed to participants at baseline and at their 3-month follow-up visit. Standard scoring was used for the BDI-II.

QoL was assessed using two widely accepted questionnaires. The Parkinson's Disease Questionnaire (PDQ-39), the most common disease-specific health status measure used, assesses the quality of life and health status of people living with Parkinson's Disease. [63] Due to the comprehensive nature of this questionnaire, several sub-scores were analyzed to better depict aspects of life differentially affected in the comparison of the different racial subgroups. Specifically, the Activities of Daily Living (ADL) Score, the Mobility Score, the Emotional Wellbeing Score, the Communications Score, and the Bodily Discomfort score was analyzed

alongside the PDQ-39 total score and compared between the Black and White Individuals. The PDQ-39 significantly improved over 13 weeks in a previous study on MDBE exercise [52] so the PDQ-39 analysis in this study serves to determine if MDBE exercise improves PDQ-39 for Black individuals as well as it does for a predominantly white population of people with PD.

The 12-Item Short Form Survey was also used to measure QOL. The SF-12 is one of the most widely used QoL surveys, assessing both physical and mental wellbeing. [64] The SF-12 Physical Composite Score, Physical Component Summary, Role of Physical Functioning Score, and Mental Component Summary were analyzed.

MDS-UPDRS Parts I and II, cover non-motor and motor experiences of daily living of people with PD. Part I questions were assessed with an in person interview by trained research staff . Section I includes items related to non-motor experiences of daily living reported by the participant through staff-lead interviewing, while Section III includes items related to motor measures that were rated by the Principal Investigator (MEH) of the trial. The total scores from each part will be used in analyses.

Regarding social support, the Multidimensional Scale of Perceived Social Support (MSPSS) was used to assess sources of support from family, friends, and a significant other, and the perceived impact that support had on the participant's QoL. [65] Support from family, support from friends, and support from significant others were analyzed alongside the total score to detect potential differences in perceived support by the racial subgroups in the study.

Nonparametric Analysis

Data were exported as CSV files from "Research Electronic Data Capture" (REDCap), a record keeping software commonly used in research studies. [66] Data was then cleaned using

Microsoft Excel and imported into SPSS as an XLSX file. In SPSS, data was converted from a wide format to a long format to allow for longitudinal analysis in SAS. The SPSS long data was imported into SAS where statistical analysis was conducted. All tables were generated using a publicly available SAS macro. [67]

All primary measures in the analysis are ordinal surveys and scales. Difference scores from baseline to 3 months were calculated for each participant for each scale. These difference scores will be computed by subtracting pre-intervention scores from post-intervention scores taken after three months of treatment. Race (dichotomized as either Black or White Race) was the exposure, and score (or sub-score) for each item was the outcome. The PAIRED Trial's sample necessitated race dichotomization, since there were only two participants that identified as something other than non-Hispanic White or non-Hispanic Black (N=1 identified as Asian, N=1 identified as Hispanic). The difference scores were averaged for each racial subgroup and compared using a Mann-Whitney U Test. The Mann-Whitney U Test was chosen because it allows for the comparison of non-normally distributed groups with small sample sizes. A Shapiro-Wilk normality test was conducted for each difference score within each racial subgroup to determine if a two-sample t-test would be a viable comparison between subgroups (**Supplemental Table 2**). Two sample t-tests are preferred for normally distributed data, because they are more statistically efficient at detecting statistically significant differences between subgroups. However, only two variables (The PDQ Mobility Score and UPDRS Part I) had normally distributed difference scores for both White participants and Black participants ($p>0.05$). Thus, the normality assumption failed, and the Mann-Whitney U Test was a more appropriate statistical comparison technique. Effect size estimates for variables with notable mean differences by race

were reported as a Glass' Δ value. Glass' Δ was selected since it is robust to non-normally distributed data. Glass' Δ values and confidence intervals were computed through an applet. [68]

The PAIRED Trial's randomized design helps limit potential confounding bias for analysis by treatment group, but because this analysis will utilize a different method of separating the participants, confounding in the relationship between race and psychosocial measures is still an important consideration.

An important caveat in research investigating racial and ethnic disparities is that race and ethnicity rarely reflect biological differences between populations. In this research question, it is important to recognize that Black race is used as indicator for exposure to racism and different life experiences, rather than any meaningful biological distinction between Black individuals and White individuals.

Fixed Effects Analysis

The Mann-Whitney U Test generates an easily interpretable crude association between race and change in psychosocial outcomes, however it fails to account for some important potential confounders. A fixed effects linear modeling design was employed to generate parameter estimates for the relationships of interest. A fixed effects model was selected because the potential confounders are likely constant over the 3-month analysis period, and included measures taken only at baseline. Potential confounders were assessed through seven models using the PDQ-39 Summary Index (SI) score, which includes the average PDQ-39 score covering several QoL domains. The SF12 SI score was used to test for confounder influence because of its representation of the other psychosocial wellbeing scores assessed in this study.

Baseline values for the potential confounders were obtained from the Project Health Baseline Questionnaire, a survey that was administered through REDCap. Baseline and post-training outcomes were merged with a table of each participant's potential confounders in Excel. Data was cleaned using Excel and SPSS. Cleaned datasets were imported into SAS 9.4, where fixed effect models were generated. Parameter estimates were obtained for the interaction term between participant race and timepoint for the PDQ-39 SI score. Participant sex, years with PD, baseline Hoehn and Yarr score, years of education, number of comorbidities, and marital status were considered as potential confounders.

After several models were run including different sets of potential confounders (see **Supplement Table 1**), it was found that only baseline Hoehn and Yahr scores and marital status substantially influenced the interaction term's parameter estimate. Confounders were determined to be influential if their inclusion in the model caused the interaction term parameter estimate to change by 10% or greater. Since these two confounders were found to sufficiently change the interaction term parameter, they were included in future fixed effects models for other outcomes of interest.

Results

Of the 53 individuals who completed their baseline assessments, 41 participants were assessed after 3 months of participation in either the walk or MDBE intervention. Of the 41 participants who completed both assessments, there were 28 participants who self-identified as non-Hispanic White and 11 who self-identified as non-Hispanic Black or African American. The mean age of the baseline sample was 71 years (SD: ± 7.1), and the sample was 70.4% male. Complete demographic data can be found in **Table 1**. Overall, Black individuals had several demographic differences from White individuals at baseline ($p < 0.05$). Black individuals had higher BMIs, more comorbidities, fewer years of education, and a higher Hoehn and Yahr Stage at baseline. Black individuals in the sample were also significantly more likely to be single (31.3%) than White individuals (2.6%). These differences were pronounced in the sample, despite the small study population.

Of the 17 outcomes of interest, at baseline, four outcomes differed significantly between Black individuals and White individuals. Black individuals reported significantly worse emotional wellbeing, significantly worse cognition, and significantly higher scores on Part I of the MDS-UPDRS ($p < 0.05$), representing worse non-motor experiences of daily living. Black individuals also had significantly worse PD symptoms observed through Part 3 of the MDS-UPDRS. Black individuals also experienced more depressive symptoms at baseline and more motor and non-motor complications from PD, but these higher values did not reach the threshold for statistical significance ($0.05 < p < 0.1$). The observed differences indicate the Black individuals experienced more PD complications on average at baseline in several health spheres, including motor, cognitive, and mental wellness. Baseline characteristics are summarized in **Table 2**.

Mean difference scores from the Mann Whitney U Test for the 17 measures are summarized in **Table 3**. No difference score was significantly different at the alpha level of 0.05 except for the SF-12 Role of Physical Functioning Score (SF-12 RP, Glass' Δ=1.06, 0.38-1.85). The SF-12 RP Score improved significantly more for Black individuals than for White individuals over the 3-month study period. Many other measures also had observable differences in outcomes between White individuals and Black individuals in the study, but none reached the threshold for statistical significance.

The Fixed-Effects analysis did not produce different results from the Mann Whitney U Test. The parameter estimates for each outcome are summarized in **Table 4**. Like the Mann Whitney analysis, the difference in the change in the SF-12 RP score was sustained in the Fixed Effects analysis (p=0.01), even after adjusting for marital status and baseline Hoehn and Yarr Score.

Discussion

Overall, the results of the study should be considered exploratory, since the PAIRED trial was not originally powered to detect differences between racial and ethnic groups. Future studies powered to detect these differences are needed to determine if the findings from this analysis are clinically significant, or if there are other differences in functional and psychosocial outcomes that were not detected in this analysis. More research is also needed to verify that benefits in PD exercise are translatable to other minoritized groups not included in this analysis, like Hispanic, Asian, and Native American individuals in the United States.

The results suggest that, in general, psychosocial changes are not significantly different between White and Black individuals with PD after 3 months of participation in an exercise intervention. Some outcomes, like the PDQ39 Emotional Wellbeing and Cognitive scores, showed large mean improvements for both groups between baseline and after 3 months of participation (see **Table 3**). However, no improvements were statistically significant. This may be due to small sample sizes or high variability. Future analysis on the PAIRED trial's sample comparing baseline and outcomes at 16 months may provide further insight into whether functional and psychosocial changes continue to improve after participating in the intervention for a longer duration.

In this analysis, however, self-reported Role of Physical functioning (RP) in Black individuals improved significantly more than that reported by White individuals. The overall Physical Composite Score from the PDQ-39 also improved more for Black Individuals than for White Individuals, but this difference did not reach the threshold of statistical significance (Glass' Δ=0.50, -0.19-1.19, p=0.18). The difference in RP is also notable since RP scores in Black and White individuals were similar at baseline (p=0.87).

Considering statistically significant baseline differences observed between White individuals and Black individuals in the study, the SF12 RP difference is particularly interesting. Although income data was not obtained in the PAIRED trial, Black individuals had significantly fewer years of education, had higher BMIs, and were more likely to be single than White individuals in the sample. These demographic measures are all associated with lower income. [69,70] People with lower incomes face barriers when trying to manage their PD symptoms, since many forms of exercise are costly, requiring either gym membership, expensive exercise classes, or at the very least, a walkable and safe environment. PD exercise classes outside of research can be costly [71] and require access to transportation. If someone with PD either cannot drive or cannot afford to drive, having a significant other may be essential to managing PD symptoms through exercise. Overall, the SF12 RP score disparity may suggest that Black individuals with PD face less opportunities to improve physical wellness than White individuals with PD.

Once given an opportunity to exercise through free research-based exercise classes (especially programs that offer transportation), Black individuals may experience more functional improvements than White individuals who may have already been participating in external exercise programs. Future studies should record data on whether individuals participating in their program are also participating in external PD exercise programs and recruit enough individuals to allow for an analysis stratified on this measure.

However, Black and White individuals also differed on several other baseline characteristics despite the small sample size. The observed difference in the SF12 RP score may have been due to higher baseline Hoehn and Yahr scores, worse self-reported cognition, and/or poorer emotional wellbeing in Black individuals rather than cultural differences or different exposures to racism. This comparability problem also reveals an important gap in access to quality care that

Black individuals receive in the United States. As discussed in the Literature Review, Black individuals are underdiagnosed for PD, meaning that those that receive a PD diagnosis often experience more symptoms than White individuals at time of diagnosis.[44] In this way, the baseline characteristics of the PAIRED sample reflects the diagnosis gap shown in previous literature.

This study has several limitations. Overall, fewer Black individuals participated in the trial. This may have prevented large change scores between Black and White individuals on several psychosocial measures from reaching statistical significance. If there were more individuals in the study, comparisons that were non-significant with non-parametric tests may have reached statistical significance. Having more participants would have made it easier to achieve statistical significance by allowing for the use of less conservative tests. The limited sample size also prevented stratified analysis. Stratification by intervention arm could show if the MDBE or Walk intervention worked differentially for Black and White individuals. It was also difficult in this study to determine what baseline differences are attributed to exposure to racism and which are due to random chance. Although statistically different baseline characteristics may have affected the outcomes observed in the study, the differences observed may be indicative of the impact of exposure to racism in conjunction with PD's complications. Black individuals with confirmed PD have greater motor complications and psychosocial symptoms before engaging in treatment because they are often diagnosed later than White individuals. [37, 59] The baseline differences were reflected in the significantly different Hoehn and Yahr stages, PDQ-39 emotional wellbeing scores, PDQ-39 cognitive scores, and UPDRS Part 1 and Part III Scores.

Overall, this study shows that in a small sample of Black and White individuals with PD, both groups experience similar psychosocial changes from participation in an exercise intervention.

More research is needed to determine if these similarities are robust to larger participant samples and for people with PD of other racial and ethnic backgrounds. Further research would also serve to determine if the statistically significant difference in the SF12 Role of Physical Functioning Score is sustained or may have been due to random chance in this study population. Even with this study's limitations, this analysis serves to promote future disparities research projects for behavioral PD exercise programs. There are few studies that have investigated disparities in PD treatment, and more are needed to better understand what programs may be most effective for minoritized groups. Because of this gap in knowledge, funding agencies must prioritize PD disparities research, and health agencies and transportation authorities must work together to ensure people of low socio-economic status have access to PD behavioral interventions. [33] PD exercise programs have been found effective, now we need to make sure that these programs are attainable for everyone.

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Tables

Table 1: Baseline Demographics Stratified by Participant Race

	Participant Race			
	Black/African-American (N=16)	White/Caucasian (N=38)	Total (N=54)	P-value
Age				0.6759[1]
N	16	38	54	
Mean (SD)	69.9 (8.06)	70.9 (6.68)	70.6 (7.06)	
Median	72.0	73.0	72.0	
Range	49.0, 80.0	56.0, 83.0	49.0, 83.0	
BMI				0.0100[1]
N	16	38	54	
Mean (SD)	30.4 (5.49)	25.8 (4.34)	27.2 (5.10)	
Median	30.0	25.7	26.4	
Range	23.8, 40.9	17.8, 35.9	17.8, 40.9	
Number of Comorbidities				0.0226[1]
N	16	38	54	
Mean (SD)	4.7 (1.96)	3.5 (2.00)	3.9 (2.04)	
Median	4.0	3.0	3.0	
Range	2.0, 9.0	1.0, 10.0	1.0, 10.0	
Years of Education				0.0007[1]
N	16	38	54	
Mean (SD)	14.4 (2.45)	17.0 (2.17)	16.2 (2.54)	
Median	14.0	18.0	16.0	
Range	8.0, 18.0	12.0, 20.0	8.0, 20.0	
Years PD				0.3419[1]
N	16	38	54	
Mean (SD)	8.4 (6.58)	6.5 (5.10)	7.1 (5.58)	
Median	5.0	5.5	5.5	
Range	1.0, 20.0	0.0, 20.0	0.0, 20.0	
Current marital status:, n (%)				0.0048[2]
Married/Partner	7 (43.8%)	32 (84.2%)	39 (72.2%)	
Separate/Divorced	2 (12.5%)	3 (7.9%)	5 (9.3%)	
Single	5 (31.3%)	1 (2.6%)	6 (11.1%)	
Widowed	2 (12.5%)	2 (5.3%)	4 (7.4%)	

Veteran, n (%)				0.5517[2]
No	6 (37.5%)	19 (50.0%)	25 (46.3%)	
Yes	10 (62.5%)	19 (50.0%)	29 (53.7%)	
Gender, n (%)				0.5172[2]
Female	6 (37.5%)	10 (26.3%)	16 (29.6%)	
Male	10 (62.5%)	28 (73.7%)	38 (70.4%)	
Housing, n (%)				0.0730[2]
House/apartment/condominium	13 (81.3%)	37 (97.4%)	50 (92.6%)	
Relative's home	2 (12.5%)	0 (0.0%)	2 (3.7%)	
Senior housing (independent)	1 (6.3%)	1 (2.6%)	2 (3.7%)	
Hoehn and Yahr Stage, n (%)				0.0144[2]
1	1 (6.7%)	1 (2.6%)	2 (3.8%)	
1.5	2 (13.3%)	6 (15.8%)	8 (15.1%)	
2	1 (6.7%)	16 (42.1%)	17 (32.1%)	
2.5	3 (20.0%)	9 (23.7%)	12 (22.6%)	
3	8 (53.3%)	5 (13.2%)	13 (24.5%)	
4	0 (0.0%)	1 (2.6%)	1 (1.9%)	
Missing	1	0	1	

[1]Wilcoxon rank sum p-value; [2]Fisher Exact p-value;

Table 2: Baseline Demographics Stratified by Intervention Group

	Intervention				
	Dropped Before Randomization (N=2)	PDAE (N=29)	WALK (N=23)	Total (N=52)	P-value
Age					0.7675[1]
N	2	29	23	52	
Mean (SD)	75.0 (1.41)	70.7 (7.09)	70.1 (7.34)	70.4 (7.14)	
Median	75.0	72.0	72.0	72.0	
Range	74.0, 76.0	49.0, 83.0	56.0, 81.0	49.0, 83.0	
BMI					0.5679[1]
N	2	29	23	52	
Mean (SD)	25.9 (5.02)	26.7 (4.99)	27.9 (5.37)	27.2 (5.15)	
Median	25.9	26.4	26.5	26.4	
Range	22.3, 29.4	17.8, 38.3	19.8, 40.9	17.8, 40.9	
Number of Comorbidity					0.8579[1]
N	2	29	23	52	
Mean (SD)	3.5 (0.71)	3.9 (1.83)	3.9 (2.40)	3.9 (2.08)	
Median	3.5	3.0	3.0	3.0	
Range	3.0, 4.0	1.0, 9.0	1.0, 10.0	1.0, 10.0	
Years of Education					0.5367[1]
N	2	29	23	52	
Mean (SD)	16.0 (0.00)	16.5 (2.54)	15.9 (2.66)	16.2 (2.59)	
Median	16.0	16.0	16.0	16.0	
Range	16.0, 16.0	12.0, 20.0	8.0, 20.0	8.0, 20.0	
Years PD					0.0291[1]
N	2	29	23	52	
Mean (SD)	10.0 (4.24)	5.3 (4.12)	9.2 (6.56)	7.0 (5.63)	
Median	10.0	4.0	8.0	5.0	
Range	7.0, 13.0	0.0, 15.0	0.0, 20.0	0.0, 20.0	
Current marital status:, n (%)					0.4424[2]
Married/Partner	2	23 (79.3%)	14 (60.9%)	37 (71.2%)	
Separate/Divorced	0	2 (6.9%)	3 (13.0%)	5 (9.6%)	
Single	0	3 (10.3%)	3 (13.0%)	6 (11.5%)	
Widowed	0	1 (3.4%)	3 (13.0%)	4 (7.7%)	
Veteran, n (%)					1.0000[2]

No	1	13 (44.8%)	11 (47.8%)	24 (46.2%)	
Yes	1	16 (55.2%)	12 (52.2%)	28 (53.8%)	
Gender, n (%)					0.7652[2]
Female	1	9 (31.0%)	6 (26.1%)	15 (28.8%)	
Male	1	20 (69.0%)	17 (73.9%)	37 (71.2%)	
Housing, n (%)					1.0000[2]
House/apartment/condominium	2	27 (93.1%)	21 (91.3%)	48 (92.3%)	
Relative's home	0	1 (3.4%)	1 (4.3%)	2 (3.8%)	
Senior housing (independent)	0	1 (3.4%)	1 (4.3%)	2 (3.8%)	
Hoehn and Yahr Stage, n (%)					0.2571[2]
1	0	0 (0.0%)	2 (8.7%)	2 (3.9%)	
1.5	0	4 (14.3%)	4 (17.4%)	8 (15.7%)	
2	1	10 (35.7%)	6 (26.1%)	16 (31.4%)	
2.5	1	8 (28.6%)	3 (13.0%)	11 (21.6%)	
3	0	5 (17.9%)	8 (34.8%)	13 (25.5%)	
4	0	1 (3.6%)	0 (0.0%)	1 (2.0%)	
Missing	0	1	0	1	

[1]Wilcoxon rank sum p-value; [2]Fisher Exact p-value;

Table 3: Mann Whitney U Test Analysis Results. Results shown are values for difference scores, where pre-intervention values were subtracted from post-intervention values.

	Race			
	BLACK (N=11)	WHITE (N=28)	Total (N=39)	P-value
BDI				0.5349[1]
N	10	26	36	
Mean (SD)	0.9 (10.69)	-0.5 (5.16)	-0.1 (6.99)	
Median	1.0	-1.0	-0.5	
Range	-20.0, 20.0	-18.0, 7.0	-20.0, 20.0	
PDQ ADL				0.4725[1]
N	8	25	33	
Mean (SD)	3.6 (12.08)	0.0 (10.06)	0.9 (10.51)	
Median	2.1	0.0	0.0	
Range	-12.5, 29.2	-16.7, 20.8	-16.7, 29.2	
PDQ Mobility				0.5307[1]
N	9	25	34	
Mean (SD)	1.4 (16.64)	0.8 (11.54)	1.0 (12.81)	
Median	5.0	0.0	0.0	
Range	-30.0, 22.5	-20.0, 22.5	-30.0, 22.5	
PDQ Emotional Wellbeing				0.5683[1]
N	8	25	33	
Mean (SD)	-4.2 (23.88)	-4.8 (13.05)	-4.7 (15.89)	
Median	2.1	0.0	0.0	
Range	-50.0, 25.0	-37.5, 12.5	-50.0, 25.0	
PDQ Stigma				0.1725[1]
N	8	25	33	
Mean (SD)	-3.1 (12.05)	2.0 (10.00)	0.8 (10.57)	
Median	0.0	0.0	0.0	
Range	-18.8, 18.8	-18.8, 25.0	-18.8, 25.0	
PDQ Social				0.7629[1]
N	7	25	32	
Mean (SD)	6.0 (21.23)	-0.0 (12.21)	1.3 (14.45)	
Median	0.0	0.0	0.0	
Range	-12.5, 50.0	-41.7, 29.2	-41.7, 50.0	

PDQ Cognitive				0.6056[1]
N	8	25	33	
Mean (SD)	-5.5 (10.79)	-3.3 (11.57)	-3.8 (11.26)	
Median	0.0	0.0	0.0	
Range	-25.0, 6.3	-25.0, 12.5	-25.0, 12.5	
PDQ Communication				0.6389[1]
N	8	25	33	
Mean (SD)	1.0 (24.98)	0.3 (14.53)	0.5 (17.17)	
Median	0.0	0.0	0.0	
Range	-25.0, 58.3	-25.0, 41.7	-25.0, 58.3	
PDQ Discomfort				0.9495[1]
N	8	25	33	
Mean (SD)	3.1 (17.78)	2.0 (18.21)	2.3 (17.83)	
Median	4.2	8.3	8.3	
Range	-25.0, 33.3	-33.3, 25.0	-33.3, 33.3	
SF12 Physical Functioning				0.2642[1]
N	9	24	33	
Mean (SD)	-0.1 (0.93)	0.1 (0.68)	0.1 (0.75)	
Median	0.0	0.0	0.0	
Range	-1.0, 2.0	-1.0, 1.0	-1.0, 2.0	
SF12 Role of Physical Functioning*				0.0086[1]
N	9	24	33	
Mean (SD)	-1.7 (1.94)	0.6 (2.18)	0.0 (2.33)	
Median	-2.0	0.0	0.0	
Range	-4.0, 2.0	-5.0, 7.0	-5.0, 7.0	
SF12 Physical Composite				0.1757[1]
N	9	24	33	
Mean (SD)	-2.0 (6.76)	1.4 (6.83)	0.4 (6.88)	
Median	-5.4	1.7	1.4	
Range	-9.4, 8.6	-18.9, 15.6	-18.9, 15.6	
SF12 Mental Composite				0.2331[1]
N	9	24	33	
Mean (SD)	-3.3 (7.19)	0.2 (4.34)	-0.7 (5.39)	
Median	-1.6	-0.2	-0.6	
Range	-16.2, 6.0	-7.3, 10.8	-16.2, 10.8	

Social Support				0.4490[1]
N	8	25	33	
Mean (SD)	-0.1 (1.00)	0.1 (1.51)	0.0 (1.39)	
Median	-0.3	0.0	-0.2	
Range	-1.0, 2.3	-2.7, 6.0	-2.7, 6.0	
UPDRS Part I				0.5305[1]
N	11	28	39	
Mean (SD)	-1.6 (4.76)	-0.6 (3.97)	-0.9 (4.17)	
Median	-1.0	0.0	0.0	
Range	-10.0, 6.0	-10.0, 7.0	-10.0, 7.0	
UPDRS Part 2				0.9589[1]
N	10	27	37	
Mean (SD)	-1.9 (4.91)	-1.8 (6.48)	-1.8 (6.03)	
Median	-0.5	-1.0	-1.0	
Range	-12.0, 3.0	-22.0, 7.0	-22.0, 7.0	
UPDRS Part 3				0.6068[1]
N	10	28	38	
Mean (SD)	-3.5 (6.93)	-5.0 (9.42)	-4.6 (8.77)	
Median	-5.0	-5.5	-5.0	
Range	-12.0, 14.0	-21.0, 13.0	-21.0, 14.0	

[1]Wilcoxon rank sum p-value;

Table 4: Fixed Effects Analysis Results. Results shown are parameter estimates of the interaction term between participant race and timepoint in the study. All models adjusted for the participant's marital status and baseline Hoehn and Yahr Score.

Measure	Effect Estimate	Standard Error	Lower CI	Upper CI	p-value
BDI	-1.61	2.59	-6.6864	3.4664	0.53
PDQ ADL Score	-2.68	4.25	-11.01	5.65	0.53
PDQ Mobility Score	-0.27	5.04	-10.1484	9.6084	0.96
PDQ Emotional Score	2.38	6.38	-10.1248	14.8848	0.71
PDQ Stigma Score	5.58	4.23	-2.7108	13.8708	0.2
PDQ Social Score	-5.32	6.07	-17.2172	6.5772	0.39
PDQ Cognitive Score	3.6	4.57	-5.3572	12.5572	0.44
PDQ Communication Score	-0.38	6.94	-13.9824	13.2224	0.96
PDQ Discomfort Score	-2.28	7.11	-16.2156	11.6556	0.75
SF12 Physical Functioning Score	0.17	0.29	-0.3984	0.7384	0.57
SF12 Role of Physical Functioning Score	2.13	0.81	0.5424	3.7176	0.01*
SF12 Physical Composite Score	2.88	2.64	-2.2944	8.0544	0.28
SF12 Mental Composite Score	3.04	2.02	-0.9192	6.9992	0.14
Social Support Score	0.31	0.58	-0.8268	1.4468	0.6
UPDRS Part 1	0.99	1.49	-1.9304	3.9104	0.51
UPDRS Part 2	0.39	2.25	-4.02	4.8	0.86
UPDRS Part 3	-1.55	3.25	-7.92	4.82	0.64

Supplemental Table 1: Model Selection. This table shows the parameter estimates for the interaction term between participant race and timepoint for the PDQ39 Summary Index Score. The parameter estimate changed by more than 10% when marital status and baseline Hoehn and Yahr score were included, so these terms were included in all future fixed effects models for outcomes of interest.

Model	Effective Estimate
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint$	3.82
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint + \beta_4$Sex	3.84
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint + \beta_4$Sex+$+\beta_5$YearsPD	3.76
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint + \beta_4$Sex+$\beta_5$YearsPD+$\beta_6$Hoehn&Yarr	4.53
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint + \beta_4$Sex+$\beta_5$YearsPD+$\beta_6$Hoehn&Yarr +$\beta_7$YearsofEducation	4.59
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint + \beta_4$Sex+$\beta_5$YearsPD+$\beta_6$Hoehn&Yarr +$\beta_7$YearsofEducation+$\beta_8$NumberofComorbidities	4.65
$Y = \beta_0 + \beta_1 Ethnicity + \beta_2 Timepoint + \beta_3 Ethnicity * Timepoint + \beta_4$Sex+$\beta_5$YearsPD+$\beta_6$Hoehn&Yarr +$\beta_7$YearsofEducation+$\beta_8$NumberofComorbidities+$\beta_9$MaritalStatus	4.14

Supplemental Table 2: Normality Test for Outcome Distributions. A normality test was conducted to determine if it would be appropriate to run a t-test for the analysis. Only 2 outcomes (the PDQ-39 Mobility Score and UPDRS Part I) passed the Shapiro-Wilk Test, so a Mann Whitney U Test was employed instead.

Variable (Diffs)	Subgroup	p-Value	Normality Test Passes?	Are both subgroups normal?	Statistical Test to Use
BDI	Black	0.86	Yes	No	Mann-Whitney
	White	0.005	No		
PDQ ADL	Black	0.03	No	No	Mann-Whitney
	White	0.13	Yes		
PDQ Mobility	Black	0.63	Yes	Yes	T-test
	White	0.3	Yes		
PDQ Emotion	Black	0.77	Yes	No	Mann-Whitney
	White	0.0004	No		
PDQ Stigma	Black	0.28	Yes	No	Mann-Whitney
	White	0.02	No		
PDQ Social	Black	0.04	No	No	Mann-Whitney
	White	0	No		
PDQ Cognitive	Black	0.17	Yes	No	Mann-Whitney
	White	0.004	No		
PDQ Communication	Black	0.02	No	No	Mann-Whitney
	White	0.005	No		
PDQ Discomfort	Black	0.98	Yes	No	Mann-Whitney
	White	0.01	No		
SF12 PF	Black	0.01	No	No	Mann-Whitney
	White	0.0003	No		
PSF12 PCS	Black	0.04	No	No	Mann-Whitney
	White	0.2	Yes		
SF12 MCS	Black	0.11	Yes	No	Mann-Whitney
	White	0.78	Yes		
Social Support	Black	0.01	No	No	Mann-Whitney
	White	0	No		
UPDRS Part I	Black	0.98	Yes	Yes	T-test
	White	0.5	Yes		
UPDRS Part II	Black	0.08	Yes	No	Mann-Whitney
	White	0.02	No		
UPDRS Part III	Black	0.02	No	No	Mann-Whitney
	White	0.53	Yes		
SF12 RP	Black	0.15	Yes	No	Mann-Whitney
	White	0.0075	No		

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