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Short communication

Comparing self-reported and objective monitoring of physical activity in Parkinson disease

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ABSTRACT

Introduction: Monitoring physical activity is important in Parkinson disease (PD), but patient recall may be unreliable. We examined relationships between self-reported activity, objective monitoring, and clinical characteristics.

Methods: Participants completed the self-reported Physical Activity Scale in the Elderly (PASE) to determine subjective minutes of moderate-vigorous physical activity (MVPA); a subset wore an Actigraph monitor capturing step count and objective MVPA using a PD-specific algorithm. Relationships between subjective and objective measurements were determined using partial correlations controlling for age and disease stage.

Results: Sixty-six subjects completed subjective reporting; median age (interquartile range [IQR]) was 70 (69–74) years and median disease duration (IQR) was 4 (1.5–7.5) years. Age-adjusted median PASE was 135.3. Median daily step count was 3615 (IQR 1772–4870), which was moderately well-correlated with PASE ($\rho = 0.56$, $p = 0.003$). Median MVPA was 8.1 min/day (IQR 2.2–23.2), which was not correlated with PASE ($\rho = -0.003$, $p = 0.98$).

Conclusions: Physical activity in this cohort of Veterans with PD is low and consists mostly of low-intensity steps rather than MVPA. The symptomatic and disease-modifying potential of lower intensity activity is uncertain. These data emphasize the need for interventions to increase MVPA in PD and the importance of objective monitoring using wearable technology.

1. Introduction

Physical activity, which encompasses both routine daily activity (e.g. household chores, walking) and dedicated exercise (e.g. aerobics, strength training), is vital to the management of Parkinson disease (PD). The benefits of exercise as a symptomatic therapy are well-described [1,2]; mid-life exercise is associated with lower future risk of PD and patients who exercise regularly also demonstrate a slower rate of decline over time [3], suggesting a potential neuroprotective effect. Thus, activity levels are a potentially impactful modifiable lifestyle factor in the management of PD.

Despite recognition of the disease-modifying potential of physical activity, achieving adequate exercise levels can be challenging for people with PD. Activity habits in early disease are comparable to healthy controls [4], but activity declines as disease progresses [5,6]. Thus, early- and mid-stage disease represents a critical window when intervention to increase activity may have lasting impact on symptoms as well as disease progression.

One major obstacle to improving exercise counseling and designing appropriate interventions is incomplete knowledge of baseline activity habits. Retrospective self-report is subject to both recall bias and social desirability bias. Accelerometers, which assess movement along multiple axes, provide an opportunity to objectively assess both baseline daily step count as well as minutes of higher-intensity MVPA. Wearable devices are increasingly used to monitor motor fluctuations in PD [7]; wearables also provide objective assessment of activity counts, although reliability varies depending on device placement and algorithm [8,9] In this study, we assessed self-reported and objective activity habits among Veterans with PD in order to examine the relationship between self-report, objective data, and clinical characteristics.

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2. Methods

2.1. Subjects

This study was approved by the Institutional Review Board of the Corporal Michael J. Crescenz Veterans Affairs Medical Center (CMCVAMC) in Philadelphia, Pennsylvania. The study cohort and some of the assessments have been previously described [10]. Briefly, community-dwelling Veterans were recruited in consecutive fashion between January 2017 and April 2018 from the CMCVAMC Parkinson Disease Research, Education, and Clinical Center (PADRECC), one of six national centers providing comprehensive care to US military Veterans with PD and other movement disorders. Inclusion criteria were a clinical diagnosis of PD by a movement disorders specialist, with Hoehn & Yahr (HY) stage ≤ 3 (i.e. mild-moderate disease). We excluded individuals with atypical parkinsonism, drug-induced parkinsonism, dementia, or severe medical comorbidities preventing exercise.

2.2. Assessments

Activity habits were assessed with the Physical Activity Scale in the Elderly [11], a validated self-reported questionnaire querying the frequency, duration, and intensity of various activities over the previous seven days. Subscales for household activity (e.g. indoor chores, outdoor lawn or garden work) and leisure activity (e.g. walking, sports, strength training) can be calculated; there is also a “work” item which is not included in either subscale. Total PASE score ranges from 0 to 500, with higher scores indicating increased levels of physical activity. PASE is moderately well correlated with calorimetric data [12], with health measures such as balance assessment and length strength [11] and with digitally-tracked step counts in a healthy elderly population [13]. Clinical and demographic features, including age, disease duration, disease stage, body mass index (BMI), Unified Parkinson Disease Rating Scale-part 3 (UPDRS-3) score indicating motor impairment, and recent (within 6 months) Montreal Cognitive Assessment (MoCA) were extracted from the subject's clinical chart. Questionnaires including the PASE, Parkinson Disease Questionnaire (PDQ-8), and Non-Motor Symptoms Questionnaire (NMSQ) were provided to subjects at study enrollment and were returned via prepaid mailers.

A subset of subjects also opted in to wear a research-grade accelerometer (Actigraph GT3X, FI; Actigraph, Pensacola, FL) for seven days. Subjects wore the monitor at waist level (clipped to a belt or in a magnetic pouch for elastic-waist trousers or a skirt) during waking hours. Wrist wear was discouraged to minimize the impact of decreased arm swing or tremor on triplanar displacement of the device. Actigraphs were provided to the subject at enrollment and were returned via prepaid padded mailers. Sample size calculations undertaken prior to the study revealed that at least 29 subject Actigraphs would provide 80% power for a moderate (0.5) correlation between PASE and accelerometry.

Actigraph data was downloaded and interpreted using ActiLife software (Actilife LLC, Pensacola FL). Days with at least 10 h of wear time that did not contain excessively high counts (> 20 000 cycles per second) were considered valid. Raw activity data was analyzed in 30-sec epochs using a previously described PD-specific algorithm to define steps and activity intensity [14]. Moderate-vigorous physical activity (MVPA) was defined as > 3.0 METs, or the equivalent of > 1.31 m/s (2.9 mph) brisk walk. We calculated the average daily minutes spent in MVPA.

Data was analyzed using Stata/SE version 13.1 (StataCorp LP, College Station TX). Because questionnaire responses were not normally distributed, non-parametric tests were used (chi-square tests for categorical variables, Mann-Whitney *U* test for continuous variables, Spearman correlations to assess the relationship between PASE and MVPA/steps). As this was an exploratory/descriptive analysis of questionnaires, we did not adjust for multiple comparisons [15]. Because PASE declines with age, we adjusted raw scores using median regression. Lastly, we determined daily step count and minutes of MVPA as measured by the Actigraph and examined their relationship with self-reported activity levels and clinical characteristics using partial Spearman correlations controlling for age and disease severity.

Table 1
Demographic characteristics of total cohort and objective sub-cohort.

	Total Cohort (n=66)	Actigraph Wearers (n=30)	Non-Actigraph Wearers (n = 33)	p
Age, y	70 (69–74)	70 (69–74)	70 (69–76)	0.51
Disease duration, y	4 (1.5–7.5)	4 (2–8)	3 (1–7)	0.49
Male sex, %	97.8	93.3	97.8	0.38
BMI	26.5 (24.4–29.7)	26.9 (24.8–29.8)	26.5 (24.8–29.8)	1.0
MoCA	25 (24–30)	25 (23–27)	24 (21–26)	0.24
HY	2 (2–2)	2 (2–2.5)	2 (2–2.5)	0.75
UPDRS-3	18 (11–23.5)	16.5 (10–23)	21 (14–30)	0.11

Data are median (interquartile range [IQR]) unless otherwise indicated. BMI = body mass index; MoCA = Montreal Cognitive Assessment; HY = modified Hoehn & Yahr stage; UPDRS-3 = Unified Parkinson Disease Rating Scale-3 (motor subscale). P-values are by Mann Whitney test comparing Actigraph wearers and non-wearers.

3. Results

Demographics of the cohort are shown in Table 1. Seventy-six subjects were recruited; one withdrew prior to completing the questionnaires, leaving 75 active subjects. Sixty-six fully completed questionnaire packets were returned, for a response rate of 88%; of these, 30 subjects (45.4%) opted in to the Actigraph objective monitoring. There were no significant differences in clinical or demographic characteristics between those who did and those who did not wear an Actigraph (Table 1).

3.1. Self-reported activity levels

Raw median PASE (IQR) was 120.4 (68.8–165.7); age-adjusted PASE was 135.3. Subscale analysis revealed that leisure PASE (median 39.0, IQR 17.0–76.1) was significantly lower than household PASE (median 80.0, IQR 25.0–116.0, $p = 0.005$). Within the leisure subscale, the proportion of subjects reporting “often” performing an activity (i.e. 5–7 days/week) declined significantly with increasing activity intensity ($\chi^2 = 253.3$, $p < 0.001$). Seasonality did not impact PASE. We previously did not see any correlations between total PASE and any of the clinical assessments [10].

3.2. Objective activity monitoring

In the objective monitoring sub-cohort, median daily steps were 3615 (IQR 1772–4870) and median MVPA was 8.1 min (IQR 2.2–23.2). Table 2 shows partial correlations controlling for age and disease stage between self-reported PASE (total and subscales) and objective parameters. Step count was significantly correlated with total PASE ($\rho = 0.56$, $p = 0.003$) as well as subscales for both leisure ($\rho = 0.44$, $p = 0.02$) and household ($\rho = 0.49$, $p = 0.01$) activity; however, minutes of MVPA was not correlated with self-reported total, leisure, or household activity. Partial correlations between objective metrics and clinical characteristics revealed that step count was moderately well-correlated with PDQ-8 ($\rho = -0.43$, $p = 0.03$) and there were trends toward inverse association between MVPA and PDQ-8 ($\rho = -0.33$, $p = 0.09$) as well as UPDRS-3 ($\rho = -0.34$, $p = 0.07$).

Table 2
Partial correlations, controlling for Age and Hoehn & Yahr stage, between self-reported PASE and objective activity parameters.

	Step Count		Minutes MVPA	
	Correlation	p	Correlation	P
PASE				
PASE Total	**0.56**	**0.003**	−0.003	0.98
PASE Leisure	**0.44**	**0.02**	−0.15	0.46
PASE Household	**0.49**	**0.01**	0.15	0.45
PASE Work	−0.06	0.77	−0.01	0.96
Clinical features				
PDQ-8	**−0.43**	**0.03**	−0.33	0.09
NMSQ	−0.21	0.29	−0.16	0.43
BMI	0.17	0.40	0.13	0.50
MoCA	0.31	0.14	0.08	0.70
UPDRS-3	−0.25	0.19	−0.34	0.07

Bold text identifies significant correlations. PASE= Physical Activity Scale in the Elderly; MVPA = moderate-to-vigorous physical activity; PDQ-8 = Parkinson Disease Questionnaire; NMSQ = Non-Motor Symptoms Questionnaire; BMI = body mass index; MoCA = Montreal Cognitive Assessment; UPDRS-3 = Unified Parkinson Disease Rating Scale-3 (motor subscale).

4. Discussion

In this study, we identified important discrepancies between self-reported and objectively monitored physical activity among US Veterans with mild-to-moderate PD. Although step count was moderately-well correlated with PASE as well as subscales, minutes of MVPA, did not correlate with PASE self-report. There are several possible explanations for this. PASE is a retrospective self-administered questionnaire, and individuals may over-estimate or under-estimate the intensity of various activities, in part because they may perceive activity as more intense (or less intense) than it actually is. We previously audited PASE responses from the PPMI cohort and found that miscategorization was common [4]. We also found that household activity (e.g. chores, gardening) far exceeds leisure activity (e.g. walking, sports), similar to other cohorts with PD [4]. As with all retrospective questionnaires, recall bias and social desirability bias may also impact the validity of PASE. Characteristics particular to PD or to Veterans may also affect questionnaire validity. We attempted to minimize disease-related effects on accelerometer displacement by encouraging participants to wear the device around the waist rather than on the arm, and we minimized the impact of festination or bradykinesia by using a PD-specific algorithm [14] to determine step counts and minutes of MVPA. Lastly, although PASE was previously validated against 3-day accelerometry in healthy older adults [16], analysis of other cohorts suggests poor correlation between PASE and objective data in the setting of physical disability [17,18]. This may limit the application of PASE when assessing a population with neurological illness.

Alternatively, both PASE and objective metrics may be valid, but the discrepancy between correlations with step counts and with minutes of MVPA may reflect that most steps are derived from low-intensity activity (e.g. walking around the house, doing chores) rather than the higher-intensity activity that is typically considered "exercise" (e.g. jogging). This is of particular importance because PASE is used clinically to assess exercise habits; PASE is also frequently used to quantify activity habits in population-based cohort studies of Parkinson disease progression [19,20]. Data from other, non-PD cohorts suggest that low-intensity steps do not carry the same benefits as higher-intensity movement [21,22], which also has the most potential for disease modification. However, data from our Actigraph cohort as well as other cohorts of people with PD [23] suggests that most real-world daily activity is low-intensity. An accelerometer algorithm isolating lower intensity activity would be useful in assessing the impact of such activity on PD symptomatology; however developing such an algorithm was outside the scope of the current study. It is worth noting that objective measurements were associated with quality of life (PDQ-8) whereas self-reports were not [10]; these findings should be replicated in other cohorts. With increasing focus on physical activity and exercise as a potential modifiable risk factor for disease progression, it is important to ensure that assessment of "real-world" physical activity levels is as accurate as possible.

This study is, to our knowledge, the first attempt to validate a commonly used patient-reported outcome measure assessing physical activity and exercise in a PD population. Nevertheless, some important limitations should be noted. The cohort was derived from a single Veterans Affairs Medical Center, was nearly all male and was demographically homogeneous, limiting the generalizability of our findings; results may not reflect activity levels among non-Veterans, women or in different geographic areas The correlation, or lack thereof, between self-report and objective parameters should be assessed in other groups. Our cross-sectional study design did not allow analysis of the impact of low-intensity steps on disease progression, but the addition of activity monitoring to large longitudinal cohort studies will allow for a better understanding of the interactions between self-reported activity, objective activity parameters, and important disease outcomes including both motor and non-motor symptoms.

5. Conclusion

This study uncovered important discrepancies between self-reported activity and objective activity parameters in patients with PD. Because exercise is a potential disease-modifying therapy in PD, the low levels of exercise identified in this study are a major area of concern; effective interventions to increase exercise are a crucial unmet need in the care of individuals with PD and may require objective monitoring beyond patient self-report.

Author roles

SM: 1ABC, 2AB, 3AB SW: 1BC, 3B JED: 2C, 3B JFM: 1A, 2C, 2B.

1) Research project: A. Conception, B. Organization, C. Execution;
2) Statistical Analysis: A. Design, B. Execution, C. Review and Critique;
3) Manuscript: A. Writing of the first draft, B. Review and Critique.

Disclosures

SM has received consulting fees from the Michael J. Fox Foundation for research unrelated to the current manuscript. SW, JED, JFM are employees of the Department of Veterans Affairs.

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the United States government.

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