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A pilot study evaluating the association between physical activity and cognition among individuals with Parkinson's disease

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ABSTRACT

Background: Few studies have examined the association between daily physical activity and cognitive function among older adults with Parkinson's disease (PD).
Objective: Here we evaluate the association between accelerometer-assessed physical activity and cognition among older patients with PD.
Methods: Cognition assessed via the Montreal Cognitive Assessment (MoCA). Moderate-to-vigorous physical activity (MVPA) was assessed via accelerometry over a 1–2 week monitoring period.
Results: After adjusting for motor impairment severity, for every 1 min/day increase in MVPA, participants had a 0.09 unit increase in MoCA-determined cognitive function ($\beta = 0.09$; 95% CI: −0.003–0.19; $P = 0.05$). When further adjusting for motor impairment, age and gender, results were unchanged ($\beta = 0.09$; 95% CI: 0.004–0.19; $P = 0.04$).
Conclusion: The present study provides suggestive evidence of a favorable association between daily physical activity behavior and cognitive function among adults with PD.

Introduction

Related to a loss of dopamine cells in the basal ganglia, Parkinson's disease (PD) is the second most common neurodegenerative disease among older adults. Dopamine depletion in the basal ganglia contributes to the hallmark characteristics of PD, including bradykinesia (slowness of movement), tremor, rigidity, and postural instability.[1] Ultimately, these features may reduce functional independence and quality of life.[1] Encouragingly, research in the broader population[2–7] as well as those with PD[8] demonstrates favorable effects of daily physical activity on functional mobility and quality of life.

Another feature of PD includes some degree of cognitive impairment, occurring in approximately 5–20% of individuals with PD,[9] with approximately 80% of patients developing dementia after 15–18 years.[10] These cognitive impairments in PD may involve difficulty with psychomotor and cognitive slowing, set-shifting, working memory, and forgetfulness, ultimately attributed to deregulation of dopamine-mediated frontostriatal circuitry.[11] Cognition, specifically impaired executive function and dual-tasking, has been linked to recurrent falls and increased falls risk[12,13] making it vitally important to address in this population. Encouragingly, regular physical activity, including light-to-moderate intensity activity, is associated with improved cognitive function in various populations,[14–17] including humans with PD[18–24] as well as rodent PD models.[25] Collectively, the findings from these animal and human studies suggest that physical activity may help to improve cognitive function (e.g., spatial cognition, executive function) and other parameters (e.g., motor function) among those with PD. Although emerging work is starting to demonstrate physical activity-induced cognitive benefits among those with PD, additional work in this area is needed. Specifically, while extending research performed in a structured setting,[18] additional research in an unstructured (i.e., participant's natural environment) setting, is warranted. Further, no studies on this topic, to our knowledge, have employed an objective measure of physical activity (e.g., accelerometry). Previous work demonstrates that self-report physical activity is prone to considerable measurement error,[26] and serious concerns have been raised regarding the validity of this method.[27] Validation studies examining the association between self-report physical activity and some gold-

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standard (e.g., accelerometry, indirect calorimetry, and doubly labeled water) typically show a poor correlation in the range of 0.3–0.5.[28] Thus, the purpose of this pilot study, written here as a brief report, was to examine the association between daily, accelerometer-assessed physical activity and cognitive function among adults with PD.

Methods

Design and participants

Given the limited research on this topic, a cross-sectional study design was employed to inform the development of our future work using a more robust design (e.g., prospective/experimental). Twenty-five individuals with PD were recruited to participate in this study. This sample size was selected as it is similar to other observational and experimental studies evaluating the association between physical activity and cognition in PD (e.g., N = 10[20]; N = 15[21]; N = 19[22]; N = 16[23]; N = 22[24]). Additionally, our selected sample size (N = 25) is consistent with other PD studies that employed accelerometer methodology to evaluate the association of physical activity with non-cognition outcomes (e.g., N = 20[29]; N = 15[30]; N = 17[31]; N = 12[32]). Ultimately, in the present study, 23 of the 25 participants constituted our analytic sample given that 2 participants had malfunctioning accelerometer data.

Participants were recruited from the local community, such as through a local movement disorders clinic, PD support groups, and PD community-based fitness programs. Each participant had a neurologist-confirmed diagnosis of PD. All study procedures were approved by the authors' institutional review board and all participants provided informed consent.

Assessment of cognitive function

The Montreal Cognitive Assessment (MoCA) was used to assess cognitive function, which demonstrates evidence of convergent validity when compared to other neuropsychological measures.[33,34] The MoCA is designed as a rapid screening tool for mild cognitive dysfunction, that assesses various cognitive domains, including attention and concentration, executive function, memory, language, visuoconstructional skills, conceptual thinking, and recall. The MoCA takes approximately 10 min to administer. The total points possible for the MoCA is 30, with a higher score indicative of better cognitive function. Generally, a MoCA score <26 is considered abnormal cognition. In the present study, however, for the primary analyses we expressed the MoCA score as a continuous variable as only 9 (of the 23) participants had a MoCA score < 26.

Assessment of physical activity

After the participants' cognitive function assessment, participants were asked to wear an ActiGraph GT1M accelerometer during all activities, except water-based activities and while sleeping. They were instructed to wear the monitor for the subsequent 1–2 weeks. An up-to-two week monitoring period was chosen to provide a reasonable assessment of their habitual physical activity patterns as well as to accommodate the participant's schedule for returning the monitor. The accelerometer was worn on an elastic belt at the mid-axillary line at the level of the iliac crest. This objective measure of physical activity has previously demonstrated evidence of reliability and validity.[35,36] For example, the ActiGraph accelerometer has demonstrated reasonable test-retest reliability (r = 0.85) and is associated (r = 0.85–0.92) with measures of energy expenditure (e.g., indirect calorimetry).[37]

The accelerometer output is digitized using an analog-to-digital converter, and once digitized, the signal passes through a digital filter that detects accelerations ranging from 0.05 to 2.00 g in magnitude with frequency responses ranging from 0.25 to 2.5 Hz to filter motion outside normal human movement. The filtered signal is then rectified and summed over a pre-determined epoch period. After the activity count is sorted into an epoch, it is stored in the internal memory and the integrator is reset to zero. Activity counts per minute of ≥1952 were used to denote moderate-to-vigorous physical activity (MVPA) intensity.[38] Sedentary activities, such as television viewing, generally generate activity counts/min <100, whereas brisk walking, for example, generate activity counts/min ≥1952. Nonwear was defined by a period of a minimum of 60 consecutive minutes of zero activity counts, with the allowance of 1–2 min of activity counts between 0 and 100.[39] For the analyses described here, and to ensure habitual movement patterns were captured, only those participants with at least 4 days with 10 or more hours per day of monitoring data were included in the analyses.[39] Notably, all 23 participants were adherent with accelerometer use, with the average number of valid days (i.e., at least 10 + hrs/day of wear time) being 6.82 days (SD = 0.98) and the average wear time was 13.9 h/day (SD = 1.2).

Statistical analyses

All statistical analyses were computed in Stata (v. 12; College Station, TX). Multivariable linear regression analysis was employed to examine the association between MVPA (independent variable) and cognitive function (outcome variable). Covariates include age, gender and motor function in PD. The motor function assessment included the Hoehn and Yahr scale,[40] which ranges from 1 to 5, with higher scores indicative of greater progressive motor impairment. Other covariates, such as body mass index, race-ethnicity, education and income, were considered but ultimately not included in the analyses. These were not included because they did not appreciably change the findings and it was important to minimize the inclusion of too many covariates in the model given the relatively small sample size. Statistical significance was established as $P < 0.05$.

Results

Participants, on average, were 68.7 years and the sample was equally distributed by sex (56.5% men). The sample included 91.3% being married, 60.9% were college graduates, 47.8% had an annual income >$70,000, 82.6% were not currently working, 100% were non-smokers, and 62% consumed ≤2 alcoholic drinks/week. Participants, on average, engaged in 10.6 min/day of MVPA, the mean Hoehn and Yahr score was 2.2, and the mean MoCA score was 25.9. Thus, participants engaged in relatively little MVPA, despite a relatively low Hoehn and Yahr score, indicating minimal motor impairment.

With regard to the main findings, and after adjusting for motor impairment severity, for every 1 min/day increase in MVPA, participants had a 0.09 unit increase in MoCA-determined cognitive function ($\beta = 0.09$; 95% CI: −0.003–0.19; $P = 0.05$; $R^2 = 16.8\%$). When further adjusting for motor impairment, age and gender, results were similar to those adjusting for only impairment ($\beta = 0.09$; 95% CI: 0.004–0.19; $P = 0.04$; $R^2 = 39.2\%$). When expressed as a larger interval change, for a 10 min/day (sample mean) increase in MVPA, participants had a 1 unit increase in MoCA-determined cognitive function ($\beta = 1.0$; 95% CI: 0.04–1.9; $P = 0.04$). Notably, the mean (SE) MVPA among those with normal (≥26 MoCA) and abnormal (<26 MoCA) cognitive function, respectively, was 12.7 min/day and 7.5 min/day. Further, in a logistic

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