

**BRIEF COMMUNICATION**

Sedentary Time is Associated with Worse Attention in Parkinson's Disease: A Pilot Study

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Objective Cognitive symptoms of Parkinson's disease (PD) may be alleviated by moderate-to-vigorous physical activity (MVPA), but no published research has characterized the relationship between objectively measured sedentary behavior and cognitive symptoms of PD. Therefore, the objective of this study was to assess the cross-sectional relationship between sedentary time and cognitive performance in a small pilot sample of individuals with mild-to-moderate PD.

Methods Objective measures of sedentary time were obtained using an armband accelerometer. Cognition was assessed with the Parkinson's Disease Cognitive Rating Scale and a computerized task-switching paradigm.

Results The percentage of awake time spent in sedentary activities was negatively correlated with attention ($\beta = -14.20$, $t(12) = -2.47$, $p = 0.03$) but not other cognitive domains ($p > 0.05$) after controlling for MVPA and medication dosage.

Conclusion Sedentary activity may have unique associations with cognition, particularly attention, over and above MVPA in individuals with PD.

Key Words Cognitive function; Parkinson's disease; Sedentary behavior.

Parkinson's disease (PD) is characterized by motor symptoms such as tremor, rigidity, and gait disturbances¹ as well as cognitive decline in the areas of cognitive flexibility,² inhibition, and selective attention.³ Physical activity, particularly moderate-to-vigorous physical activity (MVPA; e.g., jogging), is linked to better cognition in healthy older adults⁴⁻⁶ and in individuals with PD.⁷⁻⁹ However, sedentary behavior (e.g., sitting)^{10,11} may have distinct associations with cognition independent of MVPA.¹² For instance, Kesse-Guyot et al.¹² found that in midlife, more self-reported sedentary behavior predicted poorer global cognition and verbal memory, even though self-reported physical activity was not related to cognition. In PD, initial evidence has shown physical activity may alleviate the cognitive symptoms of PD,⁸ but the relationship between sedentary behavior and cog-

niton in PD is unclear. This pilot study assessed the relationship between the percentage of awake time spent in sedentary behavior (compared to active behavior) and cognition using an objective measure of physical activity (armband accelerometry) and neuropsychological tests. We hypothesized that more sedentary time would predict poorer cognition (i.e., attention, memory, cognitive flexibility, and overall cognition) while accounting for variation in physical activity.

PATIENTS AND METHODS**Standard protocol approvals, registrations, and patient consents**

This study was approved by the University of Pittsburgh In-

Received: February 12, 2020 Revised: March 26, 2020 Accepted: April 10, 2020

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stitutional Review Board (PRO14020309), and all participants provided informed consent documented by their signature on consent forms.

Participants

Participants were recruited from the University of Pittsburgh Movement Disorders Clinic registry for a cross-sectional study. Individuals were eligible if they were between the ages of 50 and 80, fluent in English, had a diagnosis of idiopathic PD, and had a stable medication regimen. Exclusion criteria included self-reported neurological or psychological conditions (outside of PD symptoms), physical activity contraindications such as significant cardiovascular disease or conditions limiting ambulation (Supplementary Material in the online-only Data Supplement), simultaneous participation in another physical activity study, and magnetic resonance imaging contraindications (due to eligibility for another study). We did not access medical records for study participants and instead relied on self-reports of neurologic, vascular, or psychiatric illness (e.g., dementia, multiple sclerosis, etc.). Participants reported having few depressive symptoms on the Center for Epidemiological Studies Depression Scale (CES-D; average = 8.85, SD = 5.86). Any participants who scored below 22 on the Montreal Cognitive Assessment (MoCA)¹³ were excluded due to significant cognitive impairment. Participants completed assessments while in the “ON” phase of their medication schedules (i.e., within 1–2 hours of ingesting medications), such that assessments reflected participants’ medication-adjusted performance.

Cognitive assessments

Inclusion based on the level of overall cognitive ability was determined using the MoCA. Cognitive domains that have been shown to decline in PD, including memory, working memory, verbal fluency, and attention, were assessed using the Parkinson’s Disease-Cognitive Rating Scale (PD-CRS). The immediate and delayed verbal memory measures were averaged to provide a composite score for memory (memory composite).¹⁴ Averaging the memory composite and attention scores created a measure of overall cognitive function, per PD-CRS recommendations (global cognition). Participants also completed a computerized task-switching paradigm to measure cognitive flexibility. In this paradigm, a single number (one to nine, excluding five) was presented and surrounded by either a circle or a square. If the number was surrounded by a circle, participants were asked to indicate whether the number was odd or even. If the number was surrounded by a square, participants were to indicate if the number was greater than or less than five. Each trial would either be the same (i.e., repeat trial) or different (i.e., switch trial) as the preceding trial. The difference between reaction time in

repeat and switch trials provides a measure of local switch cost. Higher scores on this measure (greater switching costs) indicate poorer cognitive flexibility.

Physical activity measures

Participant’s activity levels were measured for 7–10 days using a Sensewear Pro armband (Body Media Inc., Sensewear Version 7.0, Pittsburgh, PA, USA). Consistent with field standards, data were included if participants had at least 72 hours of usable data.¹⁵ The Sensewear armband uses a proprietary algorithm to calculate METs and has been externally validated using a variety of methods.¹⁶ The armband collected data such as number of steps, sleep time, and energy expenditure continuously in 1-minute epochs. In line with field standards, observations were classified as sedentary behavior if energy expenditure was below 1.5 METS, light activity if expenditure was between 1.5 and 3 METS, and MVPA if expenditure was 3 or more METS.¹⁰ For all three behavior types (i.e., sedentary, light, and MVPA), we counted the total minutes in each category and calculated the percentage of awake time spent in each state by dividing the total minutes amassed for each category by the total minutes of awake time.

Data analysis

Local switch cost on the task-switching paradigm, memory composite, attention, and global composite were dependent variables in four separate linear regression models. Predictor variables included the primary variable of interest, namely, percent awake sedentary time (PAST; total number of minutes in sedentary time divided by total number of awake minutes); PD medication dosage (LED)¹⁷ was used as a proxy variable, controlling for disease stage and age; and percent MVPA time (PMVPA; total number of minutes in MVPA divided by the total number of awake minutes) was used to control for the effects of MVPA. Significance was set at $p = 0.05$.

RESULTS

Participants

After an initial screening of 84 individuals in mild-to-moderate PD stages (i.e., Hoehn & Yahr score of 1–2),¹ 20 participants met the criteria. Two participants dropped out for unknown reasons, one had a MoCA score of < 22 points; thus, 17 participants successfully enrolled in the study (female = 3; White, non-Hispanic = 17; average age = 65.07; average UPDRS motor score = 20.26) (Supplementary Table 1 in the online-only Data Supplement). Of these 17 participants, one could not learn the task-switching paradigm and was excluded from task-switching analyses. Both men and women were recruited, but since PD is

most prevalent in Caucasian men,¹⁸ this demographic group was most represented in the registry and in the final sample.

Cognitive measures

Controlling for the effect of PMVPA and LED, PAST was negatively correlated with attention (Table 1, Figure 1). Task-switching, memory, and global cognition were not significantly related to PAST. PMVPA and LED were not significantly related to any cognitive measures.

DISCUSSION

This pilot study provides evidence linking sedentary behaviors (PAST) and attention independent of the effect of percent time spent in moderate-to-vigorous physical activity (PMVPA). As expected, participants who spent more of their waking hours in sedentary time showed worse attention. This effect was over and above MVPA, suggesting that the relationship between sedentary behavior and cognition is different than the relationship between MVPA and cognition. This link between sedentary behavior and attention is consistent with previous evidence suggesting that sedentary behavior is associated with poorer cognitive performance in healthy individuals, independent of physical activity.¹² Thus, the current findings extend this relationship to individuals with PD. Inconsistent with previous literature, however, we found no evidence linking sedentary behavior and task-switching, memory, or overall cognitive performance.

This pilot trial has implications for our understanding of the difference between sedentary behavior and physical activity. Physical activity is positively associated with task-switching, memory, attention, and overall cognition.²³ If inactivity was simply the inverse of physical activity, we would expect inactivity to lead to worse outcomes on all of these measures, which is not what we found. Moreover, MVPA was not associated with cognition in this sample. This could be because this sample was very inactive, thus limiting MVPA variability. With only 17 participants, this study only had enough power to detect very large effects ($f^2 = 0.71$), which may explain the null association between sedentary behavior and attention, memory, or overall cognition. Moreover, the significant relationships observed in this study would not survive a Bonferroni correction ($p > 0.01$). Even so, these results suggest that, relative to other aspects of cognition, sedentary behavior may be independently related to attention over and above MVPA in individuals with PD.

It is likely that our results are not purely an artifact of disease stage and age of the participant. We accounted for these possibilities by covarying for the effect of LED, which has been shown to be a statistical proxy for disease stage and age in PD.¹⁷ Moreover, this sample did not include individuals with motor complications that precluded their ability to exercise or individuals with other comorbid pathologies (e.g., multiple sclerosis, dementia; Supplementary Table 1 in the online-only Data Supplement). Still, these results represent a contribution to the literature, as individuals with PD spend more time in sedentary behavior than individuals without PD.¹⁹ The finding that sedentary behavior is independent of MVPA in predicting atten-

Table 1. Regressions predicting cognition from PAST, controlling for LED and PMVPA

	β	t	p-value	95% CI
Local switch cost				
PAST	-29.88	-0.50	0.63	-160.68 to 100.93
PMVPA	24.72	0.55	0.60	-73.87 to 123.30
LED	< -0.01	-0.23	0.82	-0.03 to 0.02
Memory composite				
PAST	-14.30	-1.38	0.19	-160.68 to 100.93
PMVPA	-12.89	-1.70	0.11	-73.87 to 123.30
LED	< -0.01	1.17	0.26	-0.03 to 0.02
Attention				
PAST	-14.20	-2.47	0.03	-26.63 to -1.77
PMVPA	-8.38	-1.99	0.07	-17.49 to 0.72
LED	< -0.01	-2.06	0.06	-0.01 to 0.00
Global cognition score				
PAST	-66.63	-1.57	0.14	-158.49 to 25.23
PMVPA	-45.64	-1.47	0.17	-112.94 to 21.67
LED	< -0.01	-0.88	0.40	-0.03 to 0.01

PAST: percent awake sedentary time, LED: levodopa equivalent daily dosage, PMVPA: percent moderate-to-vigorous activity, CI: confidence interval.

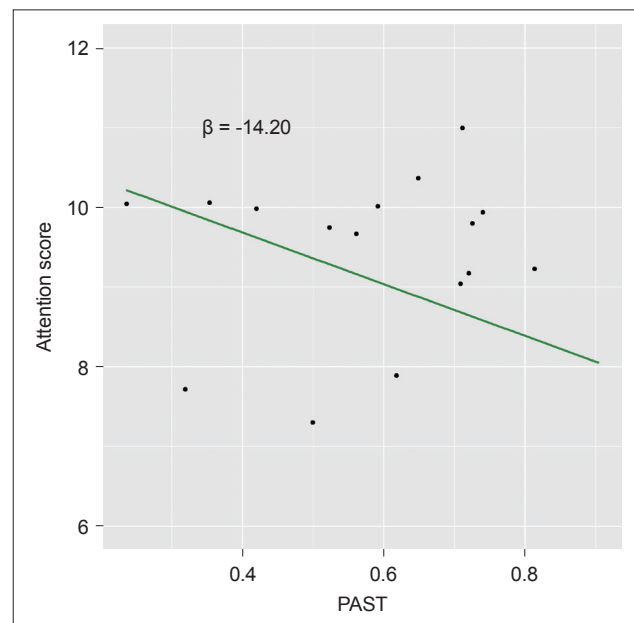


Figure 1. Parkinson's Disease-Cognitive Rating Scale (PD-CRS).

tion ability indicates the need for future intervention studies to focus not simply on increasing physical activity but also on the potential contribution of reducing sedentary time. In short, this pilot study points to the need to further study the consequences of sedentary behavior in individuals with PD.

Supplementary Materials

The online-only Data Supplement is available with this article at <https://doi.org/10.14802/jmd.20015>.

Conflicts of Interest

The authors have no financial conflicts of interest.

Acknowledgments

We thank the staff and students of the Brain Aging and Cognitive Health lab at the University of Pittsburgh, the Language and Aging Lab at the Pennsylvania State University, and the Center for Healthy Aging at the Pennsylvania State University for their support of this work. We also thank Michele T. Diaz, PhD for her helpful feedback on the writing.

This project was funded by National Institutes of Health (NIH) grants P30 AG024827 (KIE), F31NS089111 (AMW), and T32-AG049676 (SBWT).

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