Correlation of Physical Activity with Perceived Cognitive Deficits in Relapsing-Remitting Multiple Sclerosis

Ruchika Shaurya Prakash, PhD; Erin M. Snook, PhD; Arthur F. Kramer, PhD; Robert W. Motl, PhD

Cognitive difficulties represent a core symptom experienced by individuals with relapsing-remitting multiple sclerosis (RRMS). The field of gerontology has provided evidence that physical activity may moderate the decline in cognitive functioning that occurs with increasing age. Based on that evidence, we examined the association between physical activity and perceived cognitive impairment in people with RRMS. The study sample consisted of 82 individuals with RRMS who completed an initial battery of questionnaires, including the Perceived Deficits Questionnaire (PDQ), wore an accelerometer for 7 days, and then completed the Godin Leisure-Time Exercise Questionnaire (GLTEQ). Physical activity, measured by either an accelerometer or the GLTEQ, was inversely associated with overall PDQ scores, even after controlling for clinical and demographic factors. Additional studies are needed on physical activity as a modifiable behavior with a potential impact on cognitive impairment in individuals with RRMS.

Multiple sclerosis (MS) has been found to result in impairment in cognitive functioning.1-4 One recent meta-analysis of 57 studies showed that individuals with relapsing-remitting MS (RRMS) experience cognitive decline in nearly all cognitive domains, with the largest deterioration noted on tasks of motor functioning, memory, and attention/concentration.5 Such a ubiquitous decline in cognitive functioning underscores the importance of identifying factors that might slow cognitive deterioration in people with RRMS. Researchers in the field of cognitive neuroscience have provided a basis for considering physical activity as a modifiable behavioral factor that is positively associated with cognitive function in older adults.6-8 Based on that literature, we previously provided evidence of an association between cardiorespiratory fitness and measures of cognitive functioning using neuroimaging and behavioral methods in individuals with RRMS.9 One limitation of that previous study was the use of cardiorespiratory fitness as a physiologic surrogate for physical activity rather than direct measurement of physical activity behavior using self-report surveys or motion sensors such as an accelerometer. Another limitation of our previous research was the lack of control for fatigue, depression, and disability status. Those variables are likely to be covariates of cardiorespiratory fitness, physical activity, and cognitive function in people with RRMS. Therefore, the present study examined the association between physical activity and perceived cognitive impairment in people with RRMS, after controlling for the covariance associated with demographic and clinical variables. The goal was to buttress the findings of our previous research9 and provide support for further investigation of exercise training and cognitive function in people with RRMS.

Methods

Participants

The sample of individuals with RRMS was recruited through contact with support groups of two Midwestern chapters of the National Multiple Sclerosis Society (NMSS). We attended 13 support group meetings and described the study as “an examination of physical activity behavior in individuals with MS.” All individuals

From the Department of Psychology, Ohio State University, Columbus, USA (RSP); Department of Kinesiology, University of Massachusetts, Amherst, USA (EMS); and Beckman Institute & Department of Psychology (AFK) and Department of Kinesiology and Community Mental Health (RWM), University of Illinois at Urbana-Champaign, USA. Correspondence: Robert W. Motl, PhD, Department of Kinesiology and Community Mental Health, University of Illinois, 350 Freer Hall, Urbana, IL 61801; e-mail: robmotl@uiuc.edu.
with RRMS who attended the meetings were eligible to participate in the study. A total of 140 people were initially considered for enrollment. Of these 140 people, 7 (5%) chose not to participate. We did not identify reasons for nonparticipation. We further excluded from the analyses 51 individuals who had secondary progressive, primary progressive, or benign MS. This yielded a final sample size of 82 individuals with RRMS.

Procedure
The study procedure was approved by a university institutional review board, and all participants provided written informed consent. Participants completed a battery of questionnaires that included the demographic scale, Perceived Deficits Questionnaire (PDQ), Expanded Disability Status Scale (EDSS), Fatigue Severity Scale (FSS), and Center for Epidemiologic Studies Depression Scale (CESD) before, during, or after support group meetings. Each participant was then provided with an accelerometer that was to be worn during waking hours (ie, from getting out of bed in the morning until getting into bed in the evening) across a 7-day period. After the 7-day period, participants completed the Godin Leisure-Time Exercise Questionnaire (GLTEQ). The participants returned the accelerometer and GLTEQ in a prestamped and preaddressed envelope through the US postal service. Participants received $10 remuneration for completing the study.

Instruments
Physical activity was measured using an ActiGraph accelerometer (model 7164 version, Health One Technology, Fort Walton Beach, FL) and the GLTEQ; previous studies have provided evidence for the validity of scores from both measures in individuals with MS. The ActiGraph accelerometer contains a single, vertical axis piezoelectric bender element that generates an electrical signal proportional to the force acting on it and provides an objective measure of physical activity. The accelerometer has the advantage of being an objective motion sensor that is not susceptible to self-report or recall bias, but has the limitation of measuring only ambulatory-based physical activity. The accelerometer was in a pouch that was worn on an elastic belt around the waist on the nondominant hip during waking hours, except while showering, bathing, and swimming, for a 7-day period. The minute-by-minute counts across each of the 7 days were summed, and then the total daily movement counts across the 7 days were averaged. This yielded accelerometer data in total movement counts per day, with higher scores representing more physical activity. The GLTEQ is a self-administered two-part measure of usual physical activity, and we used only the first part in this study. The first part has three items that measure the frequency of strenuous (eg, jogging), moderate (eg, fast walking), and mild (eg, easy walking) exercise for periods of more than 15 minutes during one’s free time in a typical week. The weekly frequencies of strenuous, moderate, and mild activities are multiplied by 9, 5, and 3 metabolic equivalents, respectively, and summed to form a measure of total leisure activity.

Perceived cognitive impairment was measured using the PDQ. The PDQ consists of 20 items that assess the frequency of perceived cognitive dysfunction during the preceding 4 weeks. The items are self-rated on a 5-point scale of 0 (never) to 4 (almost always), and item scores can be summed to generate an overall score for perceived cognitive dysfunction or subscale scores for attention/concentration, retrospective memory, prospective memory, and planning/organization. The PDQ is part of the Multiple Sclerosis Quality of Life Inventory (MSQLI), and some evidence of its internal reliability and construct validity has been presented. We did not include the other parts of the MSQLI in this study.

Disability was measured using a self-reported version of the Kurtzke EDSS. The scale contains 17 self-rated items that reflect the components of a physician-administered EDSS. Scores from this version of the EDSS have strongly correlated with scores from a physician-administered Kurtzke EDSS scale (r = 0.92). Fatigue was measured with the FSS. The FSS contains nine items that measure the perceived severity of fatigue symptoms during the preceding week. The items are rated on a 7-point scale of 1 (strongly disagree) to 7 (strongly agree), and item scores are averaged for a measure of fatigue severity. Depressive symptoms were measured with the CESD scale. The CESD contains 20 items that measure the frequency of depressive symptoms during the past week. The items are rated on a 4-point scale of 0 (rarely or none of the time) to 3 (most or all of the time), and scores can be summed to generate an overall measure of depressive symptoms.

Data Analysis
Descriptive data are presented as mean ± standard deviation. The relationship between physical activity (GLTEQ and accelerometer counts) and perceived cog-
tive impairment (PDQ scores) was initially examined using Pearson product moment correlation coefficients (r). The bivariate correlation analysis was followed by estimation of partial correlation coefficients (pr) between physical activity and perceived cognitive impairment, controlling for EDSS, FSS, and CESD scores; duration of MS; and age. Those variables are possible confounders of the association between physical activity and perceived cognitive impairment. The analyses were performed using SPSS, version 15 (SPSS, Chicago, IL), and we did not correct alpha based on the estimation of multiple correlation coefficients. Effect size guidelines of .1, .3, and .5 were used for judging the magnitude of the correlations as small, moderate, and large, respectively; those same guidelines may not apply for making clinical interpretations about the correlation coefficients.

Results

Sample Characteristics

The sample included 82 individuals with RRMS. The mean age of the participants was 47.5 years (SD = 11.3), and the sample consisted mainly of women (83%) with advanced education (77% had 1 or more years of college education) and a median annual income exceeding $40,000 (68%). The mean duration since diagnosis of MS was 10.0 years (SD = 8.7), and the median EDSS score was 4.5 (range, 1–7.5).

Descriptive Statistics

Mean scores, standard deviations, and ranges of scores for all measures are provided in Table 1.

Correlation Analyses:

Objective Physical Activity

Bivariate correlations between scores from the measures of physical activity, perceived cognitive impairment, disability, fatigue, and depressive symptoms are provided in Table 2. A statistically significant moderate correlation was found between accelerometer counts and overall PDQ scores (r = −0.32, P = .006; pr = −0.26, P = .03), even after removing variance associated with EDSS, FSS, and CESD scores; duration of MS; and age. Regarding the PDQ subscale scores, significant moderate correlations were found between accelerometer counts and attention/concentration (r = −0.34, P = .004; pr = −0.29, P = .02) and prospective memory (r = −0.28, P = .01; pr = −0.23, P = .05) scores, even after removing variance associated with EDSS, FSS, and CESD scores; duration of MS; and age. The correlations between accelerometer counts and PDQ subscale scores for retrospective memory (r = −0.24, P = .03; pr = −0.20, P = .08) and planning/organization (r = −0.31, P = .007; pr = −0.22, P = .06) were not statistically significant after controlling for the covariates.

Correlation Analyses:

Self-reported Physical Activity

A statistically significant moderate correlation was found between GLTEQ scores and overall PDQ scores (r = −0.31, P = .004; pr = −0.27, P = .03), even after removing variance associated with EDSS, FSS, and CESD scores; duration of MS; and age. Regarding the PDQ subscale scores, significant moderate correlations were found between GLTEQ scores for attention/concentration (r = −0.34, P = .001; pr = −0.32, P = .01) and planning/organization (r = −0.20, P = .05; pr = −0.24, P = .04) subscales, even after removing variance associ-

Table 1. Descriptive statistics for the six measures in the sample of 82 individuals with relapsing-remitting multiple sclerosis

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerometer</td>
<td>207,420</td>
<td>110,993</td>
<td>53,151–691,233</td>
</tr>
<tr>
<td>GLTEQ</td>
<td>30.7</td>
<td>43.1</td>
<td>0–119</td>
</tr>
<tr>
<td>PDQ</td>
<td>33.8</td>
<td>14.3</td>
<td>0–72</td>
</tr>
<tr>
<td>EDSS (median)</td>
<td>4.5</td>
<td></td>
<td>1–7.5</td>
</tr>
<tr>
<td>FSS</td>
<td>5.1</td>
<td>1.5</td>
<td>1–7</td>
</tr>
<tr>
<td>CESD</td>
<td>16.3</td>
<td>10.8</td>
<td>0–43</td>
</tr>
</tbody>
</table>

Abbreviations: CESD, Center for Epidemiologic Studies Depression Scale; EDSS, Expanded Disability Status Scale; FSS, Fatigue Severity Scale; GLTEQ, Godin Leisure-Time Exercise Questionnaire; PDQ, Perceived Deficits Questionnaire; SD, standard deviation.

Table 2. Correlations between scores from the six measures in the sample of 82 individuals with relapsing-remitting multiple sclerosis

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Accelerometer</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2. GLTEQ</td>
<td>.76a</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3. PDQ</td>
<td>−.32a</td>
<td>−.31a</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4. EDSS</td>
<td>−.53a</td>
<td>−.25a</td>
<td>.13</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5. FSS</td>
<td>−.30a</td>
<td>−.25a</td>
<td>.47a</td>
<td>.28a</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6. CESD</td>
<td>−.29a</td>
<td>−.18</td>
<td>.31a</td>
<td>.16</td>
<td>.46a</td>
<td>—</td>
</tr>
</tbody>
</table>

Abbreviations: CESD, Center for Epidemiologic Studies Depression Scale; EDSS, Expanded Disability Status Scale; FSS, Fatigue Severity Scale; GLTEQ, Godin Leisure-Time Exercise Questionnaire; PDQ, Perceived Deficits Questionnaire.

*aStatistically significant correlation (P ≤ .05, two-tailed).
cognitive functioning and more efficient utilization of neural resources. The strengths of this study include the measurement of physical activity using self-report and objective measures of physical activity as well as a relatively large sample of individuals with RRMS. Nevertheless, we recognize a rather significant limitation in the inclusion of a self-report measure of perceived cognitive impairment based on PDQ scores. Conflicting evidence exists regarding the validity of self-reported cognitive complaints based on correlations with scores from neuropsychological tests. For example, some researchers have indicated that self-reported cognitive complaints correlate significantly with objective measures of cognitive functioning, whereas other researchers have reported weak or nonsignificant correlations. Our results should be interpreted with caution until they are verified using well-validated neuropsychological batteries. Moreover, we did not include data on quality of life, and the symptoms addressed were limited to fatigue and depression. Such factors might have influenced physical activity and/or perceived cognitive deficits. An additional limitation is the focus on RRMS; our results should not be extended to other types of MS until verified in subsequent research. Finally, we included a self-report version of the EDSS rather than a neurologist-administered EDSS for measuring disability.

Discussion

The current study supports an inverse association between physical activity and perceived cognitive impairment in individuals with RRMS. Those individuals with RRMS who were more physically active reported experiencing fewer perceived cognitive difficulties, and the relationships were statistically significant even after controlling for EDSS scores, duration of MS, age, depressive symptoms, and fatigue. These findings provide novel evidence for an association between physical activity behavior and perceived cognitive impairment in individuals with RRMS. Moreover, the results are consistent with our previous research that demonstrated an association between cardiorespiratory fitness as a surrogate for physical activity and measures of cognition in a small sample of people with RRMS. Such results provide additional evidence for a possible role of physical activity in people with RRMS in the domain of cognitive functioning, although we acknowledge that this association is not causal and cognitive function could influence physical activity behavior. Indeed, physical activity is increasingly being recognized as a lifestyle factor that could mitigate the decline in cognitive function in people with MS, thereby resulting in improved cognitive functioning and more efficient utilization of neural resources.

The strengths of this study include the measurement of physical activity using self-report and objective measures of physical activity as well as a relatively large sample of individuals with RRMS. Nevertheless, we recognize a rather significant limitation in the inclusion of a self-report measure of perceived cognitive impairment based on PDQ scores. Conflicting evidence exists regarding the validity of self-reported cognitive complaints based on correlations with scores from neuropsychological tests. For example, some researchers have indicated that self-reported cognitive complaints correlate significantly with objective measures of cognitive functioning, whereas other researchers have reported weak or nonsignificant correlations. Our results should be interpreted with caution until they are verified using well-validated neuropsychological batteries. Moreover, we did not include data on quality of life, and the symptoms addressed were limited to fatigue and depression. Such factors might have influenced physical activity and/or perceived cognitive deficits. An additional limitation is the focus on RRMS; our results should not be extended to other types of MS until verified in subsequent research. Finally, we included a self-report version of the EDSS rather than a neurologist-administered EDSS for measuring disability.

Our results suggest an inverse, cross-sectional association between physical activity and perceived cognitive impairment in individuals with RRMS. The veracity of this association should be evaluated in longitudinal observational studies that examine the link between changes in physical activity and cognitive functioning in RRMS. Such an examination will be a critical next step in providing further insights into the relationship between physical activity and cognition in people with RRMS, particularly in light of a recent review referring to this link as currently “speculative.” Such a step is necessary before conducting intervention trials on exercise and cognitive function in RRMS. Nevertheless, further examinations of physical activity as a correlate of cognitive function in RRMS are warranted given the prevalence and severity of cognitive impairment and the relative dearth of alternative methods of staving off cognitive declines in this population.

Financial Disclosures: The authors have no conflicts of interest to disclose.

Practice Points

- Individuals with relapsing-remitting MS (RRMS) who are more physically active have fewer perceived cognitive difficulties than those who are less active.
- These findings may demonstrate a prophylactic effect of physical activity on cognitive decline in individuals with MS.
- People with RRMS should be encouraged to modify their lifestyle to include increased physical activity as a means of maximizing their cognitive functioning.
References


Naturally COOL (just like you)

Polar’s body cooling systems offer natural cooling relief to people with multiple sclerosis and other conditions that cause heat intolerance.

With over 25 years of experience providing quality body cooling vests and systems our products are simply the best! The Polar system is lightweight and may be efficiently worn under clothes. Our cooling kits include the Kool Max vest, wraps for the neck and wrists plus extra packs for all.

Contact us and be Naturally Cool.