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Validity of Sitting Time Scores from the International Physical Activity Questionnaire-Short Form in Multiple Sclerosis

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Abstract

Purpose: The current study examined the validity of scores from the sitting time item on the International Physical Activity Questionnaire-Short Form (IPAQ-SF) in a sample of persons with multiple sclerosis (MS).

Method: Persons with MS were recruited through the distribution of printed letters to a random sample of 1,000 persons from the North American Research Committee on MS registry. 295 persons with MS were interested and volunteered to wear an ActiGraph accelerometer for a seven-day period and complete a battery of questionnaires that included the IPAQ-SF and Godin Leisure-Time Exercise Questionnaire over this period of time.

Results: IPAQ-SF sitting time scores were consistently and moderately correlated with all of the sedentary behavior metrics from the accelerometer (range of r between .295 & .431), and the correlations were stronger than those between self-reported physical activity and sedentary metrics from the accelerometer (range of r between −.087 & .163). The correlations between IPAQ-SF sitting time scores with the accelerometer-derived sedentary behavior metrics were still statistically significant in the analyses when controlling for physical activity (range of pr between .281 & .411).

Conclusions: The correlation analysis indicated consistent, moderate correlations between IPAQ-SF sitting time scores and device-measured estimates of both the volume and pattern of sedentary behavior, and the correlations were (a) stronger than those for self-reported physical activity and (b) independent of self-reported physical activity. Such results provide initial evidence for the validity of inferences from IPAQ-SF sitting time scores as an overall measure of sedentary behavior in persons with MS.

Keywords

multiple sclerosis; psychometrics; measurement; sitting time; sedentary behavior

There has been recent interest in sedentary behavior and its association with comorbidity, neurological disability, walking dysfunction, symptoms, and quality of life in persons with multiple sclerosis (MS; Motl & Bollaert, 2019; Veldhuijzen van Zanten, Pilutti, Duda, &

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Motl, 2016). Sedentary behavior is defined as any waking activity performed while sitting or lying that does not increase energy expenditure above 1.5 metabolic equivalents of task (METs; one MET is the resting metabolic rate) (Owen, Healy, Matthews, & Dunstan, 2010). Sedentary behavior, by definition, represents the non-exercise end of the activity continuum (Manns, Dunstan, Owen, & Healy, 2012) **and can be a focus for rehabilitation psychologists interested in a new behavioral target for the application of psychological knwledge and skills and improving health, independence, and function among persons living with disability and chronic health conditions**.

The majority of research on sedentary behavior in MS has been conducted using a single, self-report item that measures the amount of time spent sitting on a usual weekday during the past week (i.e., item 7 from the International Physical Activity Questionnaire-Short Form (IPAQ-SF; Motl & Bollaert, 2019). For example, one descriptive study administered the IPAQ-SF for estimating the prevalence of sedentary behavior among 6483 persons with MS, and reported a median value of 480 minutes spent sitting per day for the entire sample (Sasaki et al., 2018); this estimate was twice the value observed for the general population of adults in the United States (median = 240 minutes; Bauman et al., 2011). One cross-sectional study administered the IPAQ-SF for examining the association between sedentary behavior and blood pressure (BP) in a sample of 31 persons with MS and 31 healthy controls, and sitting time was associated with systolic BP ($r = .365$), diastolic BP ($r = .382$), and mean arterial pressure ($r = .425$) in MS, but not in controls (Hubbard, Motl, & Fernhall, 2018). One experimental study examined the efficacy of a behavior intervention for reducing sedentary behavior based on IPAQ-SF sitting time scores in a sample of 70 people with MS (Klaren, Hubbard, & Motl, 2014). There was a significant reduction in sitting time of 98.9 minutes per day after the 6-month, behavioral intervention condition compared with the control condition (Klaren et al., 2014).

To date, we are unaware of research that has validated the inferences from scores on the IPAQ-SF sitting time item in persons with MS. We identified one study that has examined the validity of scores from the sitting time item on the IPAQ-SF in healthy adults from 3 counties (Rosenberg, Bull, Marshall, Sallis, & Bauman, 2008). The sample included 289 adults (mean age = 35.8 years, 55.4% female) who completed the abbreviated IPAQ and wore an accelerometer during the waking hours for a seven-day period as a device-based assessment of sedentary behavior. The researchers reported a moderate correlation between sitting time from the IPAQ-SF and sedentary time from the accelerometer ($r = .34$), and concluded that scores from the measure of sitting time were approximately as valid as self-reported physical activity. We do recognize, however, that there is concern with the criterion validity of IPAQ scores for measuring the intensity of physical activity in samples other than persons with MS (Hagströmer, Oja, & Sjöström, 2006; Chastin, Culhane, & Dall, 2014; Rosenberg et al., 2008), although some evidence supports the validity of scores from the IPAQ for measuring physical activity in MS (Sandroff, Dlugonski, Weikert, Suh, Balantrapu, & Motl, 2012).

The current study examined the validity of scores from the sitting time item on the IPAQ-SF in a sample of persons with MS. The examination of validity was based on the presence of correlations with device-based estimates of both the volume and pattern of sedentary behavior derived from ActiGraph accelerometers worn on a belt around the waist over a seven-day period. The data from ActiGraph accelerometers can be processed using validated cut-points for providing a metric of the total volume of sedentary behavior over the day (i.e., minutes per day), and can further capture metrics describing the pattern of sedentary behavior over the course of the day, including number of breaks in sedentary time, sedentary bout length, number of long sedentary bouts, and total time spent in long sedentary bouts per day. This examination is important as the lack of evidence regarding the validity of IPAQ-SF sitting time scores as a measure of sedentary behavior in MS might represent a "house of cards" for the current evidence on rates, consequences, and behavioral interventions.

Method

Participants

The study methodology was approved by the University of Alabama at Birmingham, Institutional Review Board and the North American Research Committee on Multiple Sclerosis (NARCOMS). Participants were recruited through the distribution of printed letters by NARCOMS staff among a random sample of 1,000 persons with MS who completed the biannual Fall, 2017 NARCOMS registry update survey; the sample size of 1,000 was selected based on an estimate that 25% of invitees would participate in the actual study. Those who were interested in participating contacted the research team through either e-mail or telephone, and the research team described the study and its procedures, and then undertook a screening for inclusion criteria: (a) randomly selected member of the NARCOMS registry and (b) willingness to complete the questionnaires, wear the accelerometer, and return the materials via the United States postal service (USPS). **Of the 1,000 persons with MS who were potentially eligible and mailed flyers, 316 persons contacted the research team, and 296 of them underwent screening for eligibility; one person declined participation after the description of the study. The research team distributed the study materials among the remaining 295 persons who were confirmed as eligible, and 284 of them retuned the packet; we contacted the 11 persons who did not return the packet three times through a telephone call, email, and USPS sent letter.** Of those who returned the packet, eight declined participation based on not signing the informed consent document, and one person declined participation based on not being interested in wearing the accelerometer. The final sample consisted of 275 persons with MS who provided complete **(n=219)** or partial **(n=56)** data for the analyses in this paper; partial data was defined as full completion of one or more, but not all, measures.

Measures

IPAQ-SF, sitting time.—The IPAQ-SF has 7 items, and 6 of the items measured the frequency and duration of vigorous, moderate, and walking activities during the last 7 days. The 7th item on the IPAQ-SF measures the duration (minutes per day) of time spent sitting on a usual weekday. This includes time spent sitting at a desk, visiting friends, or reading, or sitting or lying down while watching television across various contexts including work, home, or leisure.

Device-measured sedentary behavior.—The ActiGraph model GT3X+ accelerometer provided a device-based measurement of sedentary behavior. The accelerometer was placed in a pouch on an elastic belt worn around the waist above the nondominant hip during the waking hours of the day, except while showering, bathing, and swimming, during a seven-day period. The participants recorded the time that the accelerometer was worn daily in a log, and this log as inspected for verifying wear time during data processing. The accelerometer data were downloaded, processed into one-minute epochs with low frequency extension, and then scored for minute-by-minute activity counts for scoring time spent in sedentary behavior (<100 counts/min) per day and organized from Monday through Sunday. We applied the Troiano Algorithm and considered a day as valid if there was a minimum of 10 hours of total wear time without continuous zeros exceeding 30 minutes. Participants with 1 or more valid days of data were included in the analyses. The outcomes of interest were (1) total time spent sedentary per day, (2) average number of breaks in sedentary time per day, defined as at least 2 minutes where the accelerometer registers ≥100 counts/min following a sedentary bout, (3) average sedentary bout length where a bout is a period of consecutive minutes that the accelerometer registers <100 counts/min, (4) average number of long sedentary bouts (>30 minutes) per day, and (5) average total time spent in long sedentary bouts in minutes per day.

Self-reported physical activity.—We included a separate self-report measure, namely the Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985), for an independent assessment of health-promoting physical activity for inclusion in the validity analysis. The GLTEQ has been widely applied in MS (Sikes et al., 2018) and includes 3-items that measure the frequency of engagement in mild, moderate, or strenuous physical activity for at least 15 minutes during one's leisure-time in the previous week. We computed the health contribution score (HCS) for the GLTEQ by multiplying the frequency of strenuous and moderate activity by 9 and 5 METs, respectively, and then summing the weighted scores into a total score of arbitrary units between 0 and 98 (Motl, Bollaert, & Sandroff, 2018).

Demographic and clinical variables.—The demographic variables included sex, race, age, and years of education. We measured disease duration (years since diagnosis) and clinical course (i.e., relapsing-remitting, secondary progressive) as clinical end-points for MS. We measured disability status using the Patient Determined Disease Steps (PDDS) scale (Hadjimichael, Kerns, Rizzo, Cutter, & Vollmer, 2007). The PDDS contains a single item for measuring self-reported disability status. PDDS scores ranged between 0 (normal) and 8 (bedridden), and the scores have been validated as a measure of disability status in persons with MS based on being linearly and strongly correlated with physician-rated Expanded Disability Status Scale scores (Learmonth, Motl, Sandroff, Pula, & Cadavid, 2013).

Procedure

After initial telephone contact and screening, we sent all participants who verbally volunteered a packet containing the informed consent document, questionnaire battery, accelerometer along with instructions and log, and a pre-stamped and pre-addressed envelope for return service through the USPS. The researchers contacted the participants and ensured the documents were received and the directions were understood. The participants were instructed to wear the accelerometer for a seven-day period and complete the battery of questionnaires over this period of time. After wearing the accelerometer and completing the questionnaires, participants returned a signed copy of the informed consent along with the study materials through the USPS. All questionnaires were checked for completeness within 48 hours of receipt. In the event of missing data, a member of the research team contacted participants and collected the data over the phone by reading the scale instructions, item, and rating scale for the missing data. All participants received $10 for voluntary participation.

Data Analysis

The data were analyzed using SPSS statistics, Version 25. We provided descriptive statistics for study variables as frequency and percentages, mean scores with standard deviations, and medians with interquartile range, as appropriate for the outcomes. We further provided distributional statistics, namely skewness and kurtosis estimates, for the measures included in the correlation analyses. We examined the bivariate associations between IPAQ-SF sitting scores, scores for the accelerometer-derived sedentary behavior metrics, and GLTEQ HCS scores using parametric, Pearson product-moment (r) and non-parametric, Spearman rho rank-order correlations (ρ); **the Spearman correlations were reported for confirming that possible outliers and non-linearity were not influencing the associations.** We lastly performed partial correlation analyses between IPAQ-SF sitting scores and sedentary metrics from the accelerometer controlling for GLTEQ HCS scores **using parametric correlations** (pr). All correlations were interpreted as statistically-significant using a standard p-value of .05, and the correlation coefficients were interpreted with guidelines of .1, .3, and .5 as representing small, moderate, and large correlations, respectively.

Results

Sample Characteristics

The sample consisted mostly of women (n=223, 81.1%) who were Caucasian (n=261, 95.3%) and late middle-aged (59.7 ± 10.1 years of age) with 16.9 ± 2.2 years of education. The sample further consisted of mostly relapsing-remitting MS (n=181, 65.8%) with a mean disease duration of 20.4 ± 9.7 years and a median PDDS score of 3 (IQR=5); the median score corresponded with moderate disability (i.e., gait disability). The sample demographic characteristics regarding sex and race are not entirely consistent with the general population of MS, whereas the mean age aligns with the recent shift in the demographic of MS (Nelson et al., 2019). There were no differences between those with complete or partial data regarding sex, race, age, education, MS type, or disease duration; those with partial missing data had significantly (p=.02) higher PDDS scores (median=4) than those with complete data (median=3) based on non-parametric t-test. This suggests that the presence of missingness was partially dependent on disability status (i.e., non-random).

Descriptive and Distributional Statistics

The descriptive and distributional statistics for the IPAQ-SF sitting time, sedentary behavior metrics from the accelerometer, and GLTEQ HCS are provided in Table 1. Importantly, the median IPAQ-SF sitting time score was identical with a previous estimate in a large, national sample of MS (Sasaki et al., 2018).

Bivariate Correlations

The bivariate correlations among scores from the IPAQ-SF sitting time, sedentary behavior metrics from the accelerometer, and GLTEQ HCS are provided in Table 2. Importantly, IPAQ-SF sitting time scores were consistently and moderately correlated with all of the sedentary behavior metrics from the accelerometer (range of r between .295 & .431), and the correlations were stronger than those between GLTEQ HCS and sedentary metrics from the accelerometer (range of r between −.087 & .163). There further were no differences between the parametric and non-parametric correlations suggesting that outliers and non-linearity were not biasing the estimates.

Partial Correlations

We undertook partial correlations as there were associations between both IPAQ-SF scores and accelerometer-derived sedentary behavior metrics with GLTEQ HCS scores. The correlations between IPAQ-SF sitting time scores with the accelerometer-derived sedentary behavior metrics were still statistically significant in the analyses when controlling for physical activity based on GLTEQ HCS scores: IPAQ-SF sitting time and average minutes per day spent sedentary ($pr = .304$, $p < .01$), average number of breaks in sedentary time per day ($pr = .281$, $p < .01$), average sedentary bout length in minutes ($pr = .329$, $p < .01$), average number of long sedentary breaks per day ($pr = .287$, $p < .01$), and average total time spent in long sedentary bouts per day ($pr = .411$, $p < .01$); those associations were stable in follow-up partial Spearman correlation analyses that controlled for GLTEQ HCS scores.

Discussion

We undertook an examination of the validity of inferences from IPAQ-SF sitting time scores as a measure of sedentary behavior in persons with MS. This was undertaken through examination of correlations between IPAQ-SF sitting time scores and device-based estimates of both the volume and pattern of sedentary behavior derived from ActiGraph accelerometers worn on a belt around the waist over a seven-day period. The correlation analysis indicated consistent, moderate correlations between IPAQ-SF sitting time scores and device-measured estimates of both the volume and pattern of sedentary behavior, and the correlations were (a) stronger than those for self-reported physical activity and (b) independent of self-reported physical activity. Such results provide initial evidence for the validity of inferences from IPAQ-SF sitting time scores as an overall measure of sedentary behavior in persons with MS.

We observed a moderate correlation between IPAQ-SF sitting time scores and total sedentary time from the accelerometer in this study of persons with MS. Such a correlation is consistent with previous research reporting a moderate association between IPAQ-SF sitting time scores and total sedentary time from the accelerometer in a sample of healthy controls from 3 countries (Rosenberg et al., 2008). We further reported that the correlation between IPAQ-SF sitting time scores and total sedentary time from the accelerometer was not attenuated when controlling for self-reported physical activity based on GLTEQ HCS scores. Collectively, this indicates that IPAQ-SF sitting time scores are similarly valid in MS and controls, and therefore can be appropriately compared and interpreted between these samples **– this is important as it supports the meaningful interpretation of substantial differences in sedentary behavior between MS and healthy controls** (Sasaki et al., 2018).

We further reported that IPAQ-SF sitting time scores were correlated with other metrics of sedentary behavior from the accelerometer, including average number of breaks in sedentary time per day, average sedentary bout length in minutes, average number of long sedentary breaks per day, and average total time spent in long sedentary bouts per day. This extends previous research conducted in the general population, and suggests that IPAQ-SF sitting time scores are providing a general measure of sitting time in MS, and this too was not attenuated when controlling for self-reported physical activity based on GLTEQ HCS scores. Collectively, such evidence further strengthens conclusions regarding the validity of inferences from IPAQ-SF sitting time scores as a measure of sedentary behavior in MS.

The present study focused on the validity of IPAQ-SF sitting time scores in MS. An important next step should focus on the reliability of IPAQ-SF sitting time scores over short (e.g., 1–2 weeks) and long periods (e.g., 3–6 months) of time. This will be important for establishing the reliability of scores from the IPAQ-SF sitting time item and the behavior itself over time, and will inform power calculations within interventions using this measure of sedentary behavior.

The value of this research is that it provides support for meaningful interpretations of existing research on the prevalence, correlates, and interventions focusing on sedentary behavior in MS. **This research further supports the application of the IPAQ-SF sitting time measure by rehabilitation psychologists who are interested in sedentary behavior as a target within clinical research and practice. This might be a behavioral target for the application of psychological knowledge and skills and improving health, independence, and function among persons living with disability and chronic health conditions**.

There are some weaknesses of this study. One weakness is that we only included accelerometer metrics of total sedentary behavior, rather than sedentary behavior in focal postures of the body (e.g., sitting vs. lying down). This is important as the IPAQ-SF focuses on sitting time, and perhaps the pattern of correlations with accelerometer-derived metrics would be even stronger if these too focused on sitting behavior only. The sample further consisted of mostly women who were late middle-aged and Caucasian with relapsing-remitting MS, and the results should be carefully extended amongst other demographic and clinical segments of the MS population. We further recognize that the sample was recruited solely through a research registry and that the participants might be more engaged in the self-management of MS as well as aware of health and health behaviors; this may not align with the general MS population. We did not collect data on obesity-based metrics (e.g., weight, body mass index, or neck circumference) for consideration as covariates in the analysis of the validity of IPAQ-SF sitting time scores. The sample had relatively low levels of disability, and the degree of validity of IPAQ-SF sitting time scores might differ in those with more severe disability.

Overall, we provide the first evidence supporting the validity of inferences from IPAQ-SF sitting time scores as a measure of sedentary behavior in persons with MS. The analysis indicated consistent, moderate correlations between IPAQ-SF sitting time scores and device-measured estimates of sedentary behavior, and the correlations were (a) stronger than those for self-reported physical activity and (b) independent of self-reported physical activity. Such results provide initial evidence for the validity of inferences from IPAQ-SF sitting time scores as an overall measure of sedentary behavior in persons with MS. Such a measure could be applied by rehabilitation psychologists who are interested in sedentary behavior as a target within clinical research and/or practice for improving health, independence, and function among persons living with disability and chronic health conditions.

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Impact:

- There is an abundance of research on physical activity in multiple sclerosis, but much less is known about sedentary behavior.
- This study provides evidence for the validity of inferences from the International Physical Activity Questionnaire-Short Form sitting time scores as a measure of sedentary behavior in multiple sclerosis.
- The evidence provides support for meaningful interpretations from existing and future research on the prevalence, correlates, and interventions focusing on sedentary behavior in multiple sclerosis.

Table 1.

Descriptive and distributional statistics for the primary outcome variables included in the validity analyses.

	Mean	SD	Median	IQR	Skewness	Kurtosis
IPAQ-Sitting (minutes/week)	505.6	262.5	480.0	360.0	0.611	0.592
Average minutes/day spent sedentary	548.5	90.4	553.3	107.6	−0.105	0.601
Average # of breaks in sedentary time per day	6.8	1.9	7.0	2.7	−0.249	−0.304
Average sedentary bout length (minutes)	49.7	13.8	46.7	9.3	3.754	22.179
Average # of long sedentary bouts (30+ minutes)	6.1	2.0	6.1	2.7	−0.190	−0.281
Average total time spent in long sedentary bouts (minutes/day)	304.4	127.7	293.9	164.8	0.661	0.752
GLTEQ-HCS (arbitrary units, 0–98)	15.1	20.5	0.0	27.0	1.457	1.867

Note. N=242 for IPAQ-Sitting, N = 253 for accelerometer-derived outcomes, and N=272 for GLTEQ-HCS. SD=standard deviation. IQR=interquartile range. IPAQ-Sitting = Sitting item from the abbreviated version of the International Physical Activity Questionnaire. GLTEQ-HCS = Godin Leisure-Time Exercise Questionnaire, Health Contribution Score.

Table 2.

Bivariate correlations between self-report measures of sitting time and physical activity with device-measured sedentary behavior metrics.

	IPAQ-Sitting		GLTEQ- HCS	
	r	***P***	***r***	***P***
Average minutes/day spent sedentary	.332**	.356**	−.163*	−.215**
Average # of breaks in sedentary time	.295**	.328**	−.096	−.164*
Average sedentary bout length	.339**	.271**	−.087	−.123**
Average # of long sedentary bouts	.304**	.337**	−.107	−.174**
Average total time spent in long sedentary bouts	.431**	.411**	−.144*	−.190**
GLTEQ-HCS	−.261**	−.306**	n/a	n/a

Note. N=219 with complete data **on all outcomes**. IPAQ-Sitting = Sitting item from the abbreviated version of the International Physical Activity Questionnaire. GLTEQ-HCS = Godin Leisure-Time Exercise Questionnaire, Health Contribution Score. *r* = Pearson product-moment correlation; ρ = Spearman rho rank-order correlation.

$^{*}p$<.05.

$^{**}p$<.01.