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Validation of the Lifetime Total Physical Activity Questionnaire (LTPAQ) in Midlife and Older Adults with a History of Late-Onset Depression

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INTRODUCTION

Depression is the leading cause of disability worldwide and a major contributor to the overall global burden of disease (WHO, 2017). Depression and its health burdens reflect the complex allostatic and epigenetic pathways that alter brain circuitry and function (McEwen, 2017). Health promoting behaviors such as physical activity can be protective against allostatic load and alter gene expression, promoting healthy brain plasticity (McEwen, 2017). In addition, physical activity reduces the risk of circulation disorders such as hypertension, dyslipidemia, type 2 diabetes, metabolic syndrome and cardiovascular disease (CDC, 2015). Early life onset of these disorders gradually reduces blood flow to the brain, thereby contributing to the formation of ischemic areas in the brain that increase the risk of late-onset depression (Alexopoulos et al., 1997; Krishnan, Hays, & Blazer, 1997; Scott & Paulson, 2017). Physical activity early in life might decrease the risk of late-onset depression in later in life by decreasing age-related ischemic formation. Exploration of this link requires a measure of physical activity across the lifecourse, or lifetime physical activity.

Presently there are three measures of lifetime physical activity. The Historical Leisure Activity Questionnaire (Kriska et al., 1990), the Modified Historical Leisure Activity Questionnaire which added household physical activities (Chasan-Taber, Erickson, Nasca, Chasan-Taber, & Freedson, 2002) and the Lifetime Total Physical Activity Questionnaire (LTPAQ). The LTPAQ assesses all four domains of physical activity; occupation, transportation, household, and leisure-time (Friedenreich, Courneya, & Bryant, 1998; Sallis et al., 2006). A self-administered internet version of the LTPAQ was validated in adults age 50+ (De Vera, Ratzlaff, Doerfling, & Kopec, 2010). Errors are common in self-administered tools largely resulting from failure to read and/or understand instructions (Anderton et al., 2015). Such errors in reporting can be avoided by an interviewer-administered format (Anderton et al., 2015; Pettee Gabriel, Morrow, & Woolsey, 2012), which was the intent in the creation of the LTPAQ (Friedenreich et al., 1998). The LTPAQ has not been validated in

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face-to-face interviews, or in adults with a history of depression. One symptom of depression is diminished ability to think or concentrate (American Psychiatric Association, 2013), which could interfere with recalling information in the LTPAQ.

Nationally representative data collected with self-reports and objective assessments show that the majority of a typical adult's average day is spent engaged in sedentary activities, which account for more of the day than light intensity activities, which account for more of the day than moderate intensity activities, which account for more of the day than vigorous intensity activities (Hawkins et al., 2009; Schuna, Johnson, & Tudor-Locke, 2013). We evaluated the construct validity of the LTPAQ by determining if the responses of adults with and without late-onset depression correspond with nationally representative norms in the expected directions. In addition, when comparing all domains of physical activity, representative samples show that occupation, household, leisure-time, and transportation physical activity account for 41%, 37%, 21% and 1% of moderate and vigorous intensity physical activity, respectively (Welk and Kim, 2015). Construct validity was further assessed in the LTPAQ by comparing the percentages of participation in moderate and vigorous intensity physical activity across all domains with representative norms.

METHODS

Participants

This study is part of a large neuroimaging project examining ischemic areas of the brain related to late-onset depression. Adults were recruited from two sources. The first source was a study that compared functional magnetic resonance images of adults who reported their first episode with depression when they were age 50 or over (i.e. late-onset depression) to those without a history of depression (Paradiso, Naridze, & Holm Brown, 2012). History of depression was assessed with the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders 4th edition Text Revision Axis I Disorders Research version Non-patient Edition (First, Spitzer, Miriam, & Williams, 2002).

It was expected that the majority of these participants would report a lifetime of light-moderate physical activity as a previous study using the LTPAQ found that 96–98% of lifetime physical activity was light-moderate among adults aged 50–65 (Cust et al., 2008). Because of this expectation, the second source of recruitment was adults who were expected to report a lifetime of more vigorous physical activity, regardless of whether they had a history of depression. Individuals who completed a marathon in the last year were screened with the Rapid Assessment of Physical Activity (RAPA) among Older Adults (Topolski et al., 2006); inclusion criteria were participation in 20+ minutes/day of vigorous physical activity (defined as heart rate increasing a lot and/or can't talk or talk is broken up by large breaths) 3+ days/week during the year preceding the interview. This brief validated instrument for clinical practice assesses levels of physical activity among adults aged 50+ (Topolski et al., 2006). Individuals who completed the study were asked to refer a friend.

Inclusion criteria for everyone were a Mini-Mental Status Exam score ≥ 24, which was a proxy for no obvious cognitive impairment. This is a validated instrument that assesses memory, attention, orientation, language, and praxis (Lin, O'Connor, Rossom, Perdue, &

Eckstrom, 2013). Scores range from 0 to 30, with lower scores indicating greater cognitive impairment (Lin et al., 2013). This instrument was administered from an approved copy (Crum, Anthony, Bassett, & Folstein, 1993) and has a sensitivity of 88.3% and a specificity of 86.2% for a cut-point of 24 to detect dementia (Lin et al., 2013).

Exclusion criteria for everyone were contraindications to magnetic resonance imaging, reported claustrophobia, inability to answer questions in English, clinical depression at the time of the interview as indicated by a Hamilton Depression Scale score above 7 (Hamilton, 1967), and medical illness with potential for major repercussion on cognitive status, e.g., seizures, demyelinating disorder, stroke, and head injury with loss of consciousness >5 minutes. Institutional Review Board approval was obtained from the University of Iowa.

Physical activity

Participants were interviewed face-to-face with the LTPAQ, which was found to have test-retest correlations between 0.72 – 0.77 over a 6–8 week period (Friedenreich et al., 1998). A recall calendar specifically designed to be used with the LTPAQ was mailed to the participants to complete before the interview (Friedenreich et al., 1998). The recall calendar focused on major life events; medical and reproductive history; education, job and volunteer history, and physical activity. The completed calendar was used during the interview to improve recall. The interviewer was trained in the lab of Dr. Friedenreich, the creator of the LTPAQ, to use cognitive interviewing methods to improve participants' ability to report their past activity patterns. The interviewer was blinded to the MRI results. It took an average of two hours to administer the LTPAQ, with participants taking breaks as needed.

The LTPAQ measures occupation, transportation, household, and leisure-time physical activity (Friedenreich et al., 1998). Occupation physical activity examples include the job title and up to three descriptors of the activity such as standing, sitting, and/or walking. The occupation category also includes school, part time jobs such as babysitting, and volunteer activities. Transportation physical activity refers to active transportation to and from one's occupation and includes the examples of walking, biking, running or rollerblading. The personal household physical activity domain includes examples such as gardening, yard work, do-it-yourself jobs around the home, childcare, or any other activity completed in a typical day or week. The leisure-time physical activity domain includes examples such as sports and exercise.

The LTPAQ only measures sedentary behavior during occupation and defines sedentary behavior as those activities requiring only sitting with minimal walking (Friedenreich, Cook, Magliocco, Duggan, & Courneya, 2010; Friedenreich, McGregor, Courneya, Angyal, & Elliott, 2004). The LTPAQ measures light, moderate and vigorous physical activity across all four domains. Light activities are defined as requiring minimal physical effort and could be performed standing or with slow walking (Friedenreich, Courneya, & Bryant, 2001) with no increase in heart rate and no perspiration (Friedenreich et al., 1998). Moderate activities are defined as causing a slight increase in heart rate and light perspiration (Friedenreich et al., 2001) such as those that require carrying light loads (2–5 kilograms) or have continuous walking (Friedenreich et al., 1998). Vigorous activities are defined as those causing a substantial increase in the heart rate and heavy sweating (Friedenreich et al., 2001), e.g.,

lifting, carrying heavy loads (>5 kilograms), brisk walking, or climbing (Friedenreich et al., 1998).

Each activity was converted into energy expended by multiplying the hours spent by the metabolic equivalent of task (MET) of that activity abstracted from the *Compendium of Physical Activities* (Ainsworth et al., 1993). A MET value, which is routinely updated (Ainsworth et al., 2011), is the ratio of the metabolic rate for an activity to the resting metabolic rate. One MET is the average seated resting energy cost of an adult; 3.5 mL/kg/min of oxygen (Ainsworth et al., 2011; Ainsworth et al., 1993). The current study utilized the *2011 Compendium of Physical Activities* which characterizes sedentary behavior as 1.0–1.5 METs, light-intensity as 1.6–2.9 METs, moderate-intensity as 3.0–5.9 METs, and vigorous-intensity as ≥ 6 METs (Ainsworth et al., 2011).

Occupation physical activity was recorded for occurrences performed at least eight hours per week for four months of the year (or 8 hours × 16 weeks = 128 hours total per year). Transportation physical activity was recorded if they were done for at least two hours per week for four months of the year (or 2 hours × 16 weeks = 32 hours total per year). Personal household physical activity was recorded for activities completed in a typical day or week for at least seven hours per week four months of the year (or 7 hours × 16 weeks = 112 hours total per year). Leisure-time physical activities were recorded if they were done at least two hours per week for four months of the year (or 2 hours × 16 weeks = 32 hours total per year) at least ten times in a lifetime. The total number of hours per week for occupational, transportation, household, and leisure-time physical activity could not exceed 168 hours (24 hours × 7 days/week).

The patterns of physical activity recorded by the interviewer included the age started, age ended, number of hours per day, number of days per week, number of weeks per year, and number of years from the start of primary education up to the time participants received a MRI as part of the original study. The amount of each activity at each intensity for each domain was totaled and divided by the number of years covered by the interview, and then divided by 48 weeks in a year (average of 4 weeks in a month × 12 months) to come up with the average MET hours/week/year across the lifetime.

Statistical analyses

Descriptive statistics were used to describe the sample. Chi-square and Kruskal-Wallis was used to determine if there was a difference in demographic characteristics between groups. Wilcoxon signed-ranks test was performed to test the hypothesis that sedentary intensity was more common than light intensity, which was more common than moderate intensity, which was more common than vigorous intensity across the four domains of physical activity. Alpha = .05 for one-tailed tests.

Results

Respondents were mostly women (61.4%), White (100%), with a Bachelor's degree or higher (70.2%) and a mean age of 62.8 (Table 1). There were 15 respondents with a history of late-onset depression, 15 without a history of late-onset depression or control, and 27

active respondents. There was no statistically significant differences between the groups in terms of gender, education or age.

Per Table 2, there was less sedentary than light occupational physical activity in the depression (10.3 vs. 19.9) and control (14.9 vs. 19.6), but not the active group (21.2 vs. 16.8). (Sedentary intensity was only measured in the occupation physical activity domain.) There was less sedentary than moderate occupational physical activity in all three groups. There was less light than moderate physical activity across all four domains in all three groups.

In the late-onset depression group, there was more moderate than vigorous physical activity across occupational (54.8 vs. 25.4, $p = 0.04$), transportation (1.5 vs. 0, $p = 0.001$), household (88.7 vs. 1.0, $p = .001$) and leisure-time (6.3 vs. 5.7, $p > .05$). In the control group, there was more moderate than vigorous physical activity across occupational (44.9 vs. 13.5, $p = 0.011$), transportation (1.4 vs. 0.6, $p = 0.011$), and household (62.7 vs. 1.0, $p = .001$), but not leisure-time (7.1 vs. 7.7). In the active group, there was more moderate than vigorous physical activity across occupational (50.8 vs. 2.8, $p < 0.001$), transportation (2.5 vs. 0.1, $p < 0.001$), and household (43.7 vs. 0.1, $p < 0.001$), but not leisure-time (7.8 vs. 19.0).

Occupation comprised the most common domain of physical activity in the active group, with 53.6 MET hours/week/year (42% of total moderate and vigorous physical activity) followed by household with 43.8 MET hours/week/year (35% of total moderate and vigorous physical activity). Household comprised the largest domain of physical activity in the late-onset depression group with 89.7 MET hours/week/year (49% of total moderate and vigorous physical activity) and in the control group with 63.7 MET hours/week/year (46% of total moderate and vigorous physical activity). Occupation physical activity comprised the next common domain of physical activity in the late-onset depression group with 80.2 MET hours/week/year (44% of total moderate and vigorous physical activity) and in the control group with 58.4 MET hours/week/year (42% of total moderate and vigorous physical activity). Leisure-time comprised the next most common physical activity with 19.7 MET hours/week/year (14% of total moderate and vigorous physical activity) across all 3 groups. Transportation was the least common physical activity with 2.2 MET hours/week/year (0.2% of total moderate and vigorous physical activity) across all 3 groups.

Discussion

We evaluated the construct validity of the interview-administered LTPAQ by determining if the responses of adults with late-onset depression correspond with nationally representative norms in the expected directions: more sedentary activities, followed by light, followed by moderate, followed by vigorous (Hawkins et al., 2009; Schuna et al., 2013). In adults with a history of late-onset depression, moderate intensity levels of physical activity were more common than vigorous intensity levels. These data provide preliminary evidence of construct validity for the LTPAQ as a measure of moderate and vigorous lifetime physical activity in adults with a history of late-onset depression.

No evidence of construct validity was provided for sedentary or light activity. This is not surprising given that the LTPAQ was created to measure physical, not sedentary activity. Although the LTPAQ assesses sedentary activity during occupation, the original LTPAQ did not include sedentary activity in estimates of physical activity (Friedenreich et al., 1998). Indeed, most studies that used the LTPAQ did not report sedentary activity (Boisvert-Vigneault et al., 2016; Cust et al., 2008; De Vera et al., 2010; Friedenreich et al., 2011; Friedenreich et al., 2010; Friedenreich, Gregory, Kopciuk, Mackey, & Courneya, 2009; Friedenreich et al., 2001; Friedenreich et al., 2004; Tam et al., 2014). Only one study that measured sedentary activity in the LTPAQ found more sedentary than light activity (Gill et al., 2015). However, the same authors also found less light than moderate intensity (Gill et al., 2015), as did other studies (Friedenreich et al., 1998, 2001). The ability to accurately report time spent in sedentary or light intensity activities is typically poor (Haskell, 2012; Troiano, Pettee Gabriel, Welk, Owen, & Sternfeld, 2012), which may explain why there are no physical activity guidelines for sedentary or light activity.

The U.S. Physical Activity Guidelines suggest a minimum of 500–1000 MET minutes/week of assigned moderate to vigorous physical activity (Office of Disease Prevention and Health Promotion, 2017). In the current sample, the lifetime amount of moderate and vigorous physical activity across all domains averaged 145 MET hours/week/year, which is equivalent to 8,700 MET minutes/week. Thus, this sample far exceeded the national physical activity guidelines, suggesting the likelihood of over-reporting. It is also possible that there was selection bias in that those who were more active were more likely to agree to participate in the current study. This is particularly true for the control group who reported more vigorous than moderate leisure-time physical activity. This contradicts the literature where studies that use the LTPAQ typically report more moderate than vigorous physical activity (Cust et al., 2008; Friedenreich et al., 1998; Gill et al., 2015). Although the active group also reported more vigorous than moderate physical activity, this is due to the recruitment of individuals who were expected to report a lifetime of more vigorous physical activity by targeting individuals who completed a marathon in the previous year, suggesting successful recruitment. Adults with a history of late-onset depression reported more moderate than vigorous physical activity in all domains. Thus, evidence of construct validity was provided for moderate and vigorous physical activity in the LTPAQ in adults with a history of late-onset depression and active adults.

Construct validity was further assessed in the LTPAQ by comparing the percentages of participation in moderate and vigorous intensity physical activity across all domains with representative norms. Moderate and vigorous occupation and household physical activity together accounted for 93%, 88% and 77% of total MET hours/week/year in the late-onset depression, control and active groups, respectively, which is comparable to 80% in representative samples (Welk and Kim, 2015).

Household comprised the majority of physical activity, followed by occupation in the late-onset and control groups. This contradicts representative samples in the same state as the current sample, which found occupation was more common than household physical activity (Welk and Kim, 2015). Whereas the representative sample was evenly split between women and men, the current sample comprised 67% women in the late-onset group and 60% in the

control group. Women are less likely than men to be employed, and among those who are employed, women are more likely to work part-time than men (Krantz-Kent, 2009). Conversely, women are much more likely than men to spend their days in unpaid housework (Krantz-Kent, 2009). Post hoc analysis stratified by gender in the current sample found that in the late-onset depression and control groups, women reported 29–31% occupation and 61–62% household physical activity while men reported 70–74% occupation and 15–17% household physical activity. Thus, when women are following a historically traditional role of spending more time in housework and less time employed outside the home, such as the women in the late-onset depression and control groups, household will comprise the majority of physical activity, followed by occupation.

Occupation comprised the majority of physical activity (44%) followed by household (29%) in the active group, coinciding with 41% and 21% respectively in representative samples (Welk and Kim, 2015). Although the active group comprised 67% women, women in the active group reported more occupation physical activity (39%) than women in the late-onset depression and control groups (29–31%). While men reported comparable amounts of household physical activity across all three groups (15–17%), women in the active group reported less household physical activity (43%) compared to women in the late-onset and control groups (61–62%), presumably as a consequence of working more. Thus, when women are following a historically non-traditional role of being employed outside the home more and spending less time in housework, such as the women in the active group, occupation will comprise the majority of physical activity followed by household. These results suggest the importance of accounting for gender differences when examining a lifetime of physical activity.

Leisure-time and transportation comprised the third and fourth most common domains of physical activity, similar to representative samples (Welk and Kim, 2015). Thus, evidence of construct validity was provided for transportation and leisure-time physical activity, with gender differences explaining deviations from representative norms in occupation and household physical activity.

Interpretations of our major study findings are limited by the study's homogenous sample, self-report measures, and selection bias. Participants were English speaking, college-educated, white midlife and older adults without obvious cognitive impairment and no contraindications that might prohibit being assessed with magnetic resonance imaging. While this limits generalization to the general population, results are specific to the target group for the instrument (Hagströmer, Ainsworth, Kwak, & Bowles, 2012), participants in a neuroimaging project examining ischemic areas of the brain related to late-onset depression. Second, physical activity was based on self-report, as there are no known objective measures of lifetime physical activity. All self-report physical activity measures risk over-reporting (Sternfeld & Goldman-Rosas, 2012). Given that participants were asked to remember lifetime physical activity, there is the potential for recall bias. To mitigate this, participants were given a recall calendar to complete in advance for use during the interview. In addition, the interviewer used cognitive interviewing skills to administer the LTPAQ. Third, there appeared to be selection bias in that those who were physically active agreed to participate in the current study.

There are several strengths of this study. First, this is the first study to assess construct validity of the face-to-face interview-administered LTPAQ. Second, individuals with and without a history of late-onset depression plus an active group were assessed. Third, although the LTPAQ has been used in population-based studies in major cities in Canada (Boisvert-Vigneault et al., 2016; De Vera et al., 2010; Friedenreich et al., 1998, Friedenreich et al., 2001; Friedenreich et al., 2004; Friedenreich et al., 2009; Friedenreich et al., 2010; Friedenreich et al., 2011; Gill et al., 2015; Tam et al., 2014) and Australia (Cust et al., 2008), this is the first time the LTPAQ has been used and validated in a U.S. sample. Fourth, this is the first time the LTPAQ has been used and validated in a nursing study.

In conclusion, physical activity across the life course can be protective against late-onset depression by decreasing the risk of allostatic load and altered gene expression and increasing blood flow to the brain. This is the first study to find evidence of construct validity for moderate and vigorous intensity physical activity in the LTPAQ as well as all the domains in a targeted sample of U.S. adults with a history of late-onset depression and an active group. The LTPAQ appears to be useful in health promotion to examine physical activity earlier in life and risk of late-onset depression, which may contribute to reducing the health burden of depression in aging adults.

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Highlights

- The validity of the Lifetime Total Physical Activity Questionnaire was examined.
- Evidence of validity was provided for moderate and vigorous intensity.
- Evidence of validity was provided for transportation physical activity.
- Evidence of validity was provided for leisure-time physical activity.
- Validity is enhanced when results are stratified by gender.

Table 1

Sample Characteristics

	Total (N = 57)	Late-Onset Depression (N = 15)	Non-Depressed Control (N = 15)	Active (N = 27)
No. (%)				
Women	35 (61.4)	10 (66.7)	9 (60.0)	16 (59.3)
Men	22 (38.6)	5 (33.3)	6 (40.0)	11 (40.7)
High School	5 (8.8)	2 (13.3)	1 (6.7)	2 (7.4)
Some college (no degree)	7 (12.3)	2 (13.3)	3 (20.0)	2 (7.4)
Associates degree (2 year college)	5 (8.8)	1 (6.7)	3 (20.0)	1 (3.7)
Bachelor's degree (4 year college)	21 (36.8)	8 (53.3)	3 (20.0)	10 (37.0)
Master's degree	12 (21.1)	2 (13.3)	3 (20.0)	7 (25.9)
Professional degree (i.e. JD, MD, PhD)	7 (12.3)	0	2 (13.3)	5 (18.5)
M (SD)				
Minimum - Maximum				
Age	62.8 (7.5) 51 – 82	63.5 (7.3) 54 – 75	64.1 (6.4) 53 – 76	61.7 (8.2) 51 – 82

Table 2

Physical Activity Intensities (MET hours/week/year)

	All Groups (N = 57)	Late-Onset Depression (N = 15)	Non-Depressed Control (N = 15)	Active (N = 27)
Mean (SD)				
Occupation Physical Activity				
Sedentary	16.7 (12.6)	10.3 (9.2)	14.9 (11.1)	21.2 (13.6)
Light	18.2 (12.6)	19.9 (18.6)	18.9 (10.8)	16.8 (9.5)
Moderate	50.3 (30.9)	54.8 (35.7)	44.9 (29.8)	50.8 (30.0)
Vigorous	11.6 (41.9)	25.4 (65.6)	13.5 (47.9)	2.8 (6.5)
Transportation Physical Activity				
Light	0.2 (0.4)	0.1 (0.2)	0.1 (0.2)	0.2 (0.5)
Moderate	2.0 (1.8)	1.5 (1.5)	1.4 (1.0)	2.5 (2.1)
Vigorous	0.2 (1.1)	0	0.6 (2.1)	0.1 (0.2)
Household Physical Activity				
Light	11.1 (18.2)	8.2 (12.2)	7.4 (11.8)	14.7 (23.1)
Moderate	60.6 (63.8)	88.7 (71.4)	62.7 (56.0)	43.7 (59.9)
Vigorous	0.6 (2.5)	1.0 (4.0)	1.0 (2.6)	0.1 (0.7)
Leisure-time Physical Activity				
Light	0.4 (1.5)	0.1 (0.3)	0.8 (2.6)	0.4 (0.9)
Moderate	7.2 (6.2)	6.3 (3.8)	7.1 (5.4)	7.8 (7.6)
Vigorous	12.5 (15.8)	5.7 (7.6)	7.7 (8.8)	19.0 (19.5)
Total Physical Activity				
Light	29.8 (23.2)	28.3 (20.9)	27.3 (17.9)	32.1 (27.3)
Moderate	120.1 (70.3)	151.3 (81.1)	116.0 (62.2)	105.0 (64.8)
Vigorous	24.9 (44.8)	32.1 (68.9)	22.8 (48.1)	22.0 (22.0)