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Measurement Properties of the Late Life Disability Index among Individuals Who Use Power Wheelchairs as Their Primary Means of Mobility

W. BEN MORTENSON, PhD, OT,

Assistant Professor, Department of Occupational Science and Occupational Therapy, Rehabilitation Research Program, GF Strong Rehabilitation Research Lab, University of British Columbia, Vancouver, BC, Canada

WILLIAM MILLER, PhD, OT, and

Associate Professor, Department of Occupational Science and Occupational Therapy, Rehabilitation Research Program, GF Strong Rehabilitation Research Lab, University of British Columbia, Vancouver, BC, Canada

JAN MILLER POLGAR, PhD, OT

Associate Professor and Acting Director, School of Occupational Therapy, Western University, London, Ontario, Canada

Abstract

Objective—To examine the reliability, validity and factor structure of the disability subscale of the Late Life Function Disability Index (LLFDI) in individuals who use power wheelchairs as their primary means of mobility.

Design—A four week, test-retest study design.

Setting—Five Canadian cities.

Participants—The validity sample included 115 new and experienced power mobility users, and the reliability sample included 85 experienced users. These volunteer samples, included individuals who were 50 years of age and independently used power mobility as their primary means of mobility.

Interventions—Not applicable.

Main Outcome Measure—The LLFDI measures participation in two dimensions of 16 life activities: frequency and perceived limitations. Validity measures included the Wheelchair Skills Test – power version (WST-P), the Assistive Technology Outcomes Profile for Mobility (ATOP/M), the Hospital Anxiety and Depression Scale (HADS), the Power Mobility Wheelchair Confidence Measure (Wheelcon-P) and the Life Space Assessment (LSA).

Results—For the reliability sample, raw intraclass correlational coefficients for limitation and frequency dimension scores ranged from .855 [95% CI .781 – .905] to .883 [95% CI .822 – .924] respectively. For the validity sample, scores on the LLFDI were correlated as hypothesized with scores on validity measures. The factor structure that was identified with the original sample was not replicated among power wheelchair users. For LLFDI frequency, exploratory factor analysis

indicated that five of the original 16 items did not perform similarly among power wheelchair users. For LLFDI limitations a one factor, rather than two-factor solution was identified.

Conclusions—The study provides evidence in support of the reliability and validity of the measure, but suggests that the original sub-scale scores may not be applicable to power wheelchair users.

Keywords

Social Participation; Psychometrics; Mobility Limitation; Durable Medical Equipment; Power Wheelchairs

Power mobility is becoming an increasingly common means of mobility. In 2005, in the United States, an estimated 3.3 million people (i.e., 1.4% of the population) used wheeled mobility, which included manual and power wheelchairs and scooters.¹ From 1990–2005, wheeled mobility use increased 5% annually.² In 1994–1995 it was estimated that 9% of those who used wheeled mobility mobilized using a power wheelchair.³ Between 2000 and 2001 the relative percentage of power wheelchairs provided by Veterans affairs in the United States increased from 8–14%.⁴ Given that mobility disability increases exponentially with age^{5, 6} and world populations are rapidly ageing,⁷ power mobility represents a potential means to ameliorate this problem.

Measuring participation among power mobility users is important as a means of understanding participation related issues that users may encounter and to justify provision of these devices. Power mobility prescription has been associated with increased social participation among users.⁸ However, power mobility users may also experience a) problems negotiating the physical environment^{9–11} and b) discrimination, especially among older users.^{11–13}

Although there are a number of generic measures of participation, none has been tested specifically with power mobility users. It is important to have generic participation measures to enable scores among different populations to be compared.¹⁴ For example, the Late Life Functioning and Disability Index (LLFDI) measures respondents' perceived frequency of performance and limitations in performance of life tasks¹⁵; however, initial psychometric testing of this measure was performed in a sample of 150 community dwelling individuals, only four of whom used wheelchairs.¹⁶

Given that psychometric properties vary across populations, it is unclear if the LLFDI would perform similarly among individuals who use power wheelchair. Therefore, as part of a longitudinal study, we explored the psychometric properties of the LLFDI with older adults who use power wheelchairs as their primary means of mobility. Specifically we wanted to examine the reliability, validity and factor structure of the LLFDI in this population.

METHODS

This paper draws on data from a longitudinal multi-site study design that was approved by ethics boards in all jurisdictions where the research took place. The study employed a test-retest design.

Samples

To be included in the longitudinal study wheelchair users needed to be 50 years of age; able to follow three step commands in French or English; able to provide their own consent and able to operate their power chair independently. The study included new (<6 months experience) and experienced wheelchair users from five Canadian cities. For the current study only participants who used power mobility as their primary means of mobility were included. The validity sample included all participants. The reliability sample included only experienced users, as it was anticipated that participation would fluctuate among new users.

Recruitment

Recruitment began May 2010 and concluded December 2012. We recruited subjects from rehabilitation facilities, wheelchair seating programs, and wheelchair equipment vendors (customer lists of stores who sell wheelchair equipment) via invitation from third party recruiters and via posters. We also recruited participants via social media, advertisements in newsletters and newspapers, and word of mouth. When contacted by interested individuals, research coordinators at each site provided study details, answered questions, confirmed eligibility and scheduled appointments for data collection.

Measures

The LLFDI measures frequency and perceived limitation of participation in 16 life tasks (e.g., keeping in touch with others, preparing meals, active recreation, taking care of errands).^{15, 16} In the preliminary validation study, factor analysis indicated that frequency of performance dimension had two domains: personal and social roles and perceived limitations dimension had two domains: instrumental and management. Test-retest intraclass correlation coefficients (ICC) were ICC=0.68 for the frequency dimension and ICC=0.82 for limitation dimension and ICC=0.44 for management role, ICC=0.63 for personal role, ICC=0.75 for social role and ICC=0.83 for the instrumental role domain scores.¹⁵ Based on data from the preliminary validation study, standardized scores can be calculated for the dimension and domain scores. A French version of the measure has been developed and validated.¹⁷

Demographic information was collected on each participant including age, sex, education (1= no formal education, 11=post-graduate degree), income (\$15,000 increments), marital status, living situation, and power wheelchair experience (experienced or new (< 6 months use)). Data from five other measures were collected for investigating validity. Preliminary evaluation of the measures indicated that they were very reliable.¹⁸ At the time of baseline data collection, all measures except the Wheelchair Confidence Measure were available in French and English.

The objective Wheelchair Skills Test 4.1 – power version (WST-P) - is a comprehensive performance based evaluation of wheelchair skills.¹⁹ It is comprised of 32 skills that assess the individual's ability to overcome environmental obstacles (e.g., potholes and curbs), perform transfers and other basic power wheelchair operations (e.g., turning the chair). Trained raters provide a pass/fail for each item score. The overall score represents the average of performance scores for all applicable items.

The Assistive Technology Outcomes Profile for Mobility (ATOP/M) is a scale developed based on item response theory (IRT) with a sample of 1037 adults with cerebral palsy, multiple sclerosis, spinal cord injury and stroke. The tool assesses two domains: activities and participation. It evaluates the self-perceived difficulties that mobility device users encounter performing various activities and roles with and without devices with a five-point scale (1= unable to do, 5= without any difficulty).²⁰ Computer assisted testing was used in the administration of this measure, and a T score ranging from 0 to 100 for each sub-domain was calculated. Only the “with device” scores were analysed.

The Hospital Anxiety and Depression Scale (HADS) is a 14-item, self-report scale that measures anxiety and depression.²¹ Responses from each item are assessed on a 4-point scale (0–3) with higher scores indicating increasing symptom frequencies. Scores for each domain range from 0–21. The measure has good psychometric properties among individuals with spinal cord injuries (i.e., adequate to excellent internal consistency and construct validity).²² A systematic review by Bjelland et al.²³ indicated that a score of 8 was the best cut-off for anxiety or depression.

The 59-item Wheelchair Confidence Measure for Power Wheelchairs Users (Wheelcon-P)^{24, 25} measures power mobility users’ self-efficacy in five areas: negotiating the physical environment, wheelchair-related activities, problem solving, advocacy and managing social situations. Item responses are recorded on a scale ranging from 0 (low confidence) to 100 % (high confidence). A mean score is calculated to represent overall confidence.

The Life Space Assessment (LSA) measures participants’ frequency and independence of mobility in increasingly larger life spaces (e.g., within their 1) home, 2) yard, 3) neighbourhood, 4) city or town and 5) beyond) over the past month. Frequency is measured on a 4-point scale, 1=< once per week, 2=1–3 × per week, 3= 4–6 × per week, 4= daily.²⁶ Independence is measured on a three point scale (1=personal assistance required, 1.5= assistive device used, 2= independent). A total composite life space score, which ranges from 0–120, can be calculated by multiplying the frequency by the independence by the weighting for each life space (1–5) and adding these together. The measure has excellent test-retest reliability among power mobility users.²⁷

Procedure

During their first visit, raters obtained informed written consent from each participant. Baseline data were then collected and re-test data were collected approximately four weeks later. To allow collection of standardized WST-P scores, baseline data were collected using a standardized wheelchair course in research facilities at each site. Re-test data were collected either in person, in the person’s home or via phone, depending on the preference of the participant.

Analyses

Prior to analysis, data were screened for accuracy. Data were reviewed by research coordinators at each site and checked again by the overall project coordinator, looking for out of range values and correcting any anomalies. Initially, descriptive variables and graphic presentation were used to characterize the findings. Means were calculated for continuous

variables, such as age, and proportions were calculated for categorical variables. For the LLFDI, raw and scaled LLFDI scores were calculated. Diagnostic procedures were used to test that the assumptions necessary for the following statistical techniques were not violated beyond the tolerance allowed.

We used intra-class correlation coefficients (ICCs) [2, 1] to assess test-retest reliability. An ICC > 0.75 is considered high, and between 0.75 and 0.40 is considered moderate.²⁸ Internal consistency was assessed by calculating Cronbach's alpha. A minimum acceptable value of .7 has been recommended.²⁹

Pearson's correlation coefficients were used to assess the validity of the LLFDI. Baseline data were used for validity testing. We hypothesized that frequency of participation would have positive, moderate correlations ($r=0.3-0.6$) with life space mobility and wheelchair skills, as the former is measure of mobility frequency and the latter is a measure of mobility capacity. We hypothesized that LLFDI limitations would have positive moderate correlations with wheelchair confidence and ATOP activity and participation difficulty, and negative moderate correlations with HADS anxiety and depression, as appraisals of limitations are likely related to other measure of more subjective constructs such as affect, difficulty and self-efficacy.

We used confirmatory factor analysis to determine if the original factor structure was a good fit for the data. For this analysis, missing values were imputed using expectation maximization. To examine goodness of fit we calculated four indices: the overall Chi square, the Goodness-of-fit index, the adjusted-goodness-of-fit index and the Hoelter .05. The overall model Chi square is significant if the model's covariance structure is statistically different from the observed covariance structure. Good fitting models should have a Goodness-of-fit index and an adjusted-goodness-of-fit index above .9.³⁰ A value of >200 is recommended for the Hoelter.05.³¹

A priori, it was decided to conduct exploratory factor analysis, if confirmatory factor analysis did not support the original factor structure. Principal component analysis was the method of extraction and direct oblimin with Kaiser normalization was the method of rotation. For the exploratory factor analysis a Bartlett's statistic was calculated and a Kaiser-Meyer-Olkin test was performed.³² The Bartlett's statistic tests the null hypothesis that correlation matrix is an identity matrix and should be rejected to proceed with factor analysis. The Kaiser-Meyer-Olkin test evaluates sampling adequacy and a minimum value of .5 is recommended, .60-.69 is considered mediocre, .70-.79 is considered fair and .80-.89 is considered good.³² With factor analysis, loadings >.71 are considered excellent, >.63 are considered very good, >.55 are considered good, and .45 are considered fair.³³

SPSS 19 was used for descriptive statistics, ICC calculations, correlational analyses, imputation, and determination of factor structure. The number of factors was selected using the Hull method of parallel analysis.³⁴ AMOS [16.0] was used for confirmatory factor analysis.

RESULTS

Descriptive information about participants in both samples is provided in Table 1. Approximately half of participants were female and living with others. The most common living situation was married or common law. Spinal cord injury, multiple sclerosis and other were the most common primary diagnoses. Most participants had a gross annual income between \$30,000–45,000 (CAN) per year. On average, participants had power wheelchair skill and confidence scores around 80%.

Reliability

Reliability estimates for the raw and transformed LLFDI dimension and domain scores are presented in Table 2. All of the ICCs are considered high. The lower bound of the 95% confidence interval was above .75 for 6 of the 12 estimates. The lowest values were for management role for both raw and scaled scores. The Cronbach's alpha was considered acceptable for both dimension scores and the instrumental role domain score

Validity

The validity correlations are presented in Table 3. As the scaled and raw LLFDI frequency and limitation scales were correlated at .998 and .999 respectively ($p < .001$), only the correlations for the raw LLFDI dimensions are presented. All correlations were as hypothesized.

Confirmatory Factor Analysis

For LLFDI frequency the overall model Chi square was 151.042 (103 degrees of freedom, $p = .001$), which indicates that the model's covariance structure is statistically different from the observed covariance structure. The goodness-of-fit index was .862 and the adjusted-goodness-of-fit index was .817. The Hoelter.05 was 88.

Likewise, for LLFDI limitation the overall model Chi square was 152.043 (103 degrees of freedom, $p = .001$), the goodness-of-fit index was .842, the adjusted-goodness-of-fit index was .791 and the Hoelter.05 was 88.

Exploratory Factor Analysis

Parallel analysis³⁵ recommended a two-factor solution for LLFDI frequency and a one-factor solution for LLFDI limitation. The pattern matrix for LLFDI frequency is presented in Table 4. Two items had loadings of less than .45 (items 3 and 11). When these were removed the Bartlett's statistic was 313.681 ($df = 91$; $p < 0.001$) and the Kaiser-Meyer-Olkin (KMO) test was 0.736 (fair).³² The cumulative proportion of variance explained was 0.404. With this revision, the first factor includes items related to social activities and physical activity, whereas the second factor includes items about personal and home-based activities. For LLFDI limitation the Bartlett's statistic was 482.1 ($df = 120$; $p < 0.001$) and the KMO test was 0.832 (good). The total variance explained was .321.

DISCUSSION

This is the first study to examine the measurement properties of the LLFDI among individuals who use power wheelchairs as their primary means of mobility. The measure demonstrates very good test-retest reliability, and all the values exceed those found during preliminary testing of the measure among a sample of community dwelling older adults. These results indicate that power wheelchair users can report both the frequency and perceived limitation participating in life activities over a four-week period with a high degree of consistency. This is critical if the measure is to be used longitudinally, either before or after an intervention or as part of a natural history study.

Our investigation of the validity of LLFDI indicates that the dimension scores vary, as predicted, with a variety of subjective and objective measures. The differences between LLFDI frequency and LLFDI limitation emphasize the distinctiveness of these constructs and highlight the need to look beyond frequency when considering the multi-dimensional nature of participation. In this regard, it appears that participation frequency is only moderately related with perceived limitations, but the latter has stronger associations with measures of affect and self-confidence, which may be critical for quality of life.³⁶

Despite the promising metrics of the measure, the factor structure that was identified with the original sample was not replicated among power wheelchair users. For the LLFDI frequency, analysis indicated that item 3 (caring for others) and 11 (inviting others into the home) did not load well ($<.45$) onto either factor. This result shows that these items were not strongly related to the underlying factors for this sample; i.e., they explained less than 20% of the factor variance, which is considered poor.³³ Furthermore, in contrast to the original findings, item 10 (taking part in a regular fitness program) was considered part of the social role rather than the personal role dimension. The total variance explained by the two-factor LLFDI frequency was comparable (39.6% in the original vs. 40.4% in the current study). For the LLFDI limitation, a one-factor solution was recommended using parallel analysis. The total variance explained was lower with the current sample (32.1 vs. 45.9%). Given these results, the original LLFDI sub-scale scores may not be applicable to power wheelchair users. These findings are in keeping with Generalizability Theory, which indicates that measurement properties may vary for a variety of reasons (e.g., persons, raters, time and settings).³⁷

Study Limitations

The study had a number of strengths and limitations. First, it must be acknowledged that participants in the study were a volunteer sample of older adults, which may limit the generalizability of the findings to other power wheelchair users. The small amount of missing data was a strength of the study and the use of expectancy maximization was beneficial as a means of imputation to preserve the variability of the data.

CONCLUSIONS

This is the first study to examine the measurement properties of the disability component of LLFDI among individuals who use power wheelchairs as their primary means of mobility.

The reliability coefficients exceed those found for the original sample and the measure varies as hypothesized with related constructs. In this regard, the dimensions scores of the LLFDI seem appropriate for older adults who use power wheelchairs as their primary means of mobility. However, the original factor structure of the measure was not reproduced, which indicates that the use of the original sub-scale scores may not be appropriate for this population. If supported with additional research evidence, the use of the revised sub-scale scoring that was identified in this study, would be warranted.

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Abbreviations

LLDI	Late Life Disability Index
LLFDI	Late Life Functional Disability Index
ICC	intraclass correlation coefficients
WST-P	Wheelchair Skills Test 4.1 – power version
ATOP/M	Assistive Technology Outcomes Profile for Mobility
IRT	item response theory
HADS	Hospital Anxiety and Depression Scale
Wheelcon-P	Wheelchair Confidence Measure for Power Wheelchairs Users
LSA	Life Space Assessment
KMO	Kaiser-Meyer-Olkin

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Table 1

Descriptive Statistics for Participant Demographics and Measures *

Variable (range for measures)	Validity Sample		Reliability Sample	
	N	Mean(SD) or N,%	N	Mean(SD) or N,%
Female	105	55, 52.4%	81	41, 50.6%
Marital Status	105		81	
single		28, 26.7%		21, 25.9%
common-law/married		42, 40.0%		32, 39.9%
separated		28, 26.7%		23, 28.4%
widowed		7, 6.7%		5, 6.2%
Lives alone	105	50, 47.6%	81	42, 51.9%
Experienced User	105	91, 86.7%	81	81, 100%
Primary Diagnosis	105		81	
Spinal Cord Injury		19, 18.1%		15, 18.4%
Stroke		15, 14.3%		7, 8.7%
Amputation		3, 2.9%		2, 2.5%
Multiple Sclerosis		21, 20.0%		20, 24.7%
Muscular Dystrophy		6, 5.7%		6, 7.4%
Arthritis		6, 5.7%		4, 4.9%
Other		35, 33.3%		27, 33.3%
Age	105	61.080(7.924)	91	61.050(7.525)
Education	105	6.910(2.454)	91	7.050(2.330)
Income(\$15,000 increments)	99	3.170(2.272)	87	3.240(2.225)
ATOP Activity (0–100)	104	46.246(4.817)	90	46.164(4.920)
ATOP Participation (0–100)	104	53.154(9.050)	90	53.967(8.943)
Wheelcon-P Score(0–100)	78	77.224(16.940)	68	78.110(14.557)
HADS anxiety (0–21)	104	7.385(4.494)	91	7.022(4.328)
HADS depression (0–21)	103	5.515(3.651)	90	5.189(3.582)
LSA Composite Life Space (0–120)	105	41.310(15.557)	91	42.440(15.627)
WST (0–100)	104	80.733(13.675)	90	81.424(11.470)
Raw LLFDI Frequency Scores				
LLFDI Frequency Total Score (16–80)	100	49.24(8.698)	87	50.14(8.505)
LLFDI Social Role Domain (9–45)	100	24.46(5.407)	87	25.20(5.191)
LLFDI Personal Role Domain(7–35)	103	24.82(5.473)	90	24.98(5.230)
LLFDI Limitation Total Score (16–80)	99	51.03(11.333)	86	50.99(10.756)
LLFDI Instrumental Role (12–60)	100	35.00(9.039)	87	34.90(8.636)
LLFDI Management Role (4–20)	101	16.00(3.114)	88	16.06(2.961)
Scaled LLFDI Scores				
LLFDI Frequency Total (0–100)	100	45.918(5.821)	87	46.497(5.734)
LLFDI Social Role (0–100)	100	41.441(8.274)	87	42.410(8.156)
LLFDI Personal Role (0–100)	103	49.517(11.446)	90	49.668(11.059)
LLFDI Limitations Total (0–100)	99	55.700(7.698)	86	55.634(7.220)

Variable (range for measures)	Validity Sample		Reliability Sample	
	N	Mean(SD) or N,%	N	Mean(SD) or N,%
LLFDI Instrumental Role (0–100)	100	51.982(8.915)	87	51.872(8.475)
LLFDI Management Role (0–100)	101	76.620(14.386)	88	76.695(13.490)

*
French translation unavailable at baseline

Table 2

Intraclass Correlations Coefficients for Experienced Power Wheelchair Users for Raw and Standardized Late Life Disability Participation Scores.

95% Confidence Interval						
Dimension or domain	N	Intraclass Correlation	Lower Bound	Upper Bound	N	Cronbach's Alpha
Raw Late Life Disability Index Scores						
Frequency Dimension	78	.883	.822	.924	100	.723
Social	78	.832	.749	.890	100	.670
Personal	80	.842	.765	.896	103	.678
Limitations Dimension	77	.855	.781	.905	99	.858
Instrumental	78	.829	.744	.887	100	.820
Management	77	.763	.651	.843	101	.661
Scaled Late Life Disability Index Scores						
Frequency Dimension	78	.885	.826	.925	--	--
Social	78	.800	.703	.868	--	--
Personal	80	.766	.658	.844	--	--
Limitations Dimension	77	.836	.753	.892	--	--
Instrumental	78	.808	.714	.873	--	--
Management	77	.760	.647	.841	--	--

Table 3

Correlations among Raw LLFDI Dimension Scores and Other Variables

	LLFDI Frequency	Limitation	LLFDI	LSA	WST	HADS anxiety	HADS depression	ATOP activity	ATOP participation	WheelCon-P
LLFDI Frequency	Pearson	1	.396 [*]	.401 [*]	.307 [*]	-.239 [*]	-.301 [*]	.432 [*]	.415 [*]	.269 [†]
	Sig.		<.001	<.001	.002	.017	.002	<.001	<.001	.020
	N	100	99	100	99	100	100	99	99	75
LLFDI Limitation	Pearson	.396 [*]	1	.292 [*]	.268 [*]	-.508 [*]	-.523 [*]	.427 [*]	.524 [*]	.503 [*]
	Sig.	<.001		.003	.008	<.001	<.001	<.001	<.001	<.001
	N	99	99	99	98	99	99	98	98	74

*Correlation is significant at the 0.01 level (2 tailed)

†Correlation is significant at the 0.05 level (2 tailed)

Table 4

Pattern Matrix for LLFDI Frequency *

Item	Component	
	1	2
15. Local errands	.727	
8. Taking care of health	.708	
7. Household business or finances	.682	
4. Taking care of inside of home	.680	
16. Preparing dinner	.636	
13. Personal care needs	.529	
3. Caring for others	.255	.104
12. Going out with others	.198	.729
14. Partaking in organized social activities	-.185	.675
2. Visiting others in their homes		.652
9. Overnight travel		.569
6. Active recreation		.527
10. Regular Fitness Program		.508
1. Keeping in touch with others	.218	.476
5. Volunteer work	.256	.468
11. Inviting people into home	-.120	.337

*
Rotation converged in 6 iterations. Loadings <.1 omitted