ORIGINAL ARTICLE

The Symptom Inventory Disability-Specific Short Forms for Multiple Sclerosis: Reliability and Factor Structure

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ABSTRACT. Schwartz CE, Bode RK, Vollmer T. The Symptom Inventory disability-specific short forms for multiple sclerosis: reliability and factor structure. Arch Phys Med Rehabil 2012;93:1629-36.

Objective: To further the development of the 99-item Symptom Inventory (SI) for multiple sclerosis (MS) using modern test theory methods to create 3 disability-specific short forms for MS patient subgroups identified using Performance Scale (PS) items.

Design: A web-based cross-sectional study.

Setting: National MS Registry.

Participants: People with MS (N=1532) who participate in the North American Research Committee on Multiple Sclerosis Registry.

Interventions: None.

Main Outcome Measures: The SI; the disease-specific PS and the Patient-Determined Disease Steps; and the generic Short-Form 12.

Results: When the original SI subscales did not demonstrate unidimensionality, exploratory factor analysis was conducted yielding 14 factors that could be classified using the structure of the PS. Confirmatory factor analysis confirmed the unidimensionality of the hand function, vision, fatigue, cognitive, bowel/bladder, spasticity, and pain scales. The mobility scale was split into mobility and use of assistive devices; the sensory scale was split into sensory and vasomotor. Item response theory analyses revealed good model fit.

Conclusions: This study provides empirical support for a 10-scale symptom measure for use in MS clinical research, with short forms in 5 scales tailored to have good specificity for people with mild, moderate, and severe disability and single forms for the remaining 5 scales. The PS items can serve as a screener for these disability-specific short forms, which provide choice and flexibility that are similar to a computerized adaptive test but without the reliance on real-time computer infrastructure.

Key Words: Outcome Assessment, Patient; Psychometrics; Quality of life; Rehabilitation; Symptoms.

THE STUDY OF NEUROLOGIC impairment and disability in multiple sclerosis (MS) has been advanced by the development and integration of patient-reported outcome (PRO) measures into clinical research. While a number of PRO measures have been developed in the past 2 decades, the clinician-reported Expanded Disability Status Scale (EDSS)[1] remains the most widely used in MS research.[2] Although its widespread use ensures the comparability of results, the scale's lack of precision in defining mild, moderate, and severe impairment, as well as divergences in mean staying time at a particular scale level, leads to a substantial degree of interexaminer variability.[2] The scale also loses some of its objectivity in the areas of bowel and bladder function, as well as ambulation, because it relies on subjective assessment and is not responsive to clinical change, particularly with regard to upper limb and cognitive dysfunction.[2]

More than a decade ago, a PRO measure was validated that is of particular interest because it serves as a useful measure of symptoms. The 99-item Symptom Inventory (SI) measure of impairment[3] was validated in large samples in the 1990s and has been used by clinical researchers as an inexpensive and valid replacement or complement to the EDSS.

In the time since the original validation article[3] was published, there have been 2 major changes that serve as the foundation for the current work. First, in 2006, the Food and Drug Administration published its guidance on the use of PRO measures in medical product development to support labeling claims.[4] This guidance formalized the use of PRO measures in drug development and emphasized the use of symptom and function measures in such research.[4] The publication of this document has provided a clear path for MS clinical researchers to document the benefits of new disease-modifying treatments using PRO measures and, in particular, symptom and disability

List of Abbreviations

CFI	comparative fit index
EDSS	Expanded Disability Status Scale
ICF	*International Classification of Functioning, Disability and Health*
IRB	institutional review board
IRT	item response theory
MS	multiple sclerosis
NARCOMS	North American Research Committee on Multiple Sclerosis
PDDS	Patient-Determined Disease Steps
PRO	patient-reported outcome
PS	Performance Scales
RMSEA	root mean square error of approximation
SI	Symptom Inventory
SI-SF	Symptom Inventory short-form
2-PL	2-parameter logistic (model)

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Supported in part by a Metric Development and Validation Award (USAMRAA grant no. MS090018), and by a CMSC/Global MS Registry Visiting Scientist Fellowship, which was supported through a Foundation of the Consortium of Multiple Sclerosis Centers grant from EMD Serono, Inc. CMSC/Global MS Registry is supported by the Consortium of Multiple Sclerosis Centers and its Foundation.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

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In-press corrected proof published online on May 15, 2012, at www.archives-pmr.org.

0003-9993/12/9309-01285$36.00/0
http://dx.doi.org/10.1016/j.apmr.2012.03.006

measures. There is an acute need to hone the SI for use in clinical research so that it is shorter and provides short forms tailored to patient subgroups with specific levels of disability.

The second major change that motivates the current work is that psychometric methods have grown substantially. These methods have opened the door to a deeper and more nuanced approach to working with data and for characterizing clinically important change,[5] of relevance both for individual patient monitoring and for assessment of treatment value.[6]

Methodologic advances from educational testing using item response theory (IRT)[7] have been applied to health-related quality-of-life assessment, leading to a paradigm shift in PRO measures assessment. These methods allow the selection of items for short forms based on the range of the underlying trait (ie, θ) that is of most interest. Thus, short forms can be created for different disease groupings or levels of disabilities, rather than having 1 short form for all. This is particularly relevant for the SI given its 99-item length and the importance of developing abbreviated forms for clinical MS research.

The purpose of the present work is to use classic and modern test theory methods to reduce the number of items in the SI and generate item calibrations for the development of short forms. We aim to use the Performance Scales (PS) items as screener items to identify disability subgroups for each SI subscale, and to create 3 disability-specific short forms for specific subgroups of patients with MS.

METHODS

Sample and Design

This project involved cross-sectional data from 1532 people with MS who participate in the North American Research Committee on Multiple Sclerosis (NARCOMS) Registry. NARCOMS is a self-report registry of more than 36,000 individuals who have MS, with approximately 10,000 updating their data every 6 months using either paper or secure web-based survey forms capturing data on demographics, disease characteristics, disability, treatments, and access to health providers. Potential candidates for the study were selected among those NARCOMS Registry participants who completed the latest 2 semiannual update surveys online, reside in the United States, and are at least 18 years of age (n>5000). To ensure adequate cell sizes, we obtained a stratified sample with equal distribution by sex, age, course of disease (relapsing or not), and level of disability as measured by the most recent Patient-Determined Disease Steps (PDDS) score (0–2, mild; 3–4, moderate; 5–8, severe). These NARCOMS participants were sent an invitation to participate in this add-on survey after they completed the spring 2010 semiannual update.

Procedure

An e-mail notification describing the study was sent to a randomly selected cohort. Once our desired sample size was reached, no more e-mails were sent out. This e-mail included a unique identifier that was linkable to the NARCOMS database, and a link to a web-based set of questionnaires designed for this study. The survey engine is SurveyGizmo.com (www.surveygizmo.com), a user-friendly and Health Insurance Portability and Accountability Act–compliant interface for collecting data in a secure environment. The SurveyGizmo questionnaire began with an online (written) consent form and the measures described below. Data from the NARCOMS spring update and the SurveyGizmo data were then linked by the NARCOMS Coordinating Center using the NARCOMS unique identifier, and data were deidentified before data analysis. The project was reviewed and approved by the institutional review boards (IRBs) associated with NARCOMS (the Western IRB, Olympia, WA) and DeltaQuest Foundation (the New England IRB, Newton, MA).

Measures

In addition to demographic characteristics and MS-related treatment information, data from the following 2 PRO tools were used in the present psychometric development work:

1. *The 99-item SI*. Initial validation of the SI supported the reliability and validity of its 6 subscales designed to reflect localization of brain lesions (visual, left and right hemisphere, brainstem and cerebellum, spinal cord, and nonlocalized symptoms).[3,8,9] Item response options range from 0 ("not at all") to 4 ("a great deal") or, if the patient deems the item not applicable, the item is scored as missing or −99. SI scale scores were combined additively to produce an overall index of neurologic impairment.
2. *The PS*.[3] The PS is a measure of 8 domains of neurologic disability (mobility, hand function, vision, fatigue, cognition, bladder/bowel, sensory, spasticity). PS scores range from 0 ("normal") to 5 ("total [subscale name] disability") on all subscales except mobility, for which the highest score is 6, and are aggregated for an overall index of neurologic disability. The PS has been consistently used since the inception of NARCOMS as a brief, comprehensive measure of disability.

Two other PRO measures were included in the study for the purpose of sample description. These included the PDDS,[10] a self-report measure that was modeled after and correlates highly with the EDSS. The patient characterizes disability level into 1 of 9 steps (0, normal; 1, mild disability; 2, moderate disability; 3, gait disability; 4, early cane; 5, late cane; 6, bilateral support; 7, wheelchair or scooter; 8, bedridden). The Medical Outcomes Study Short-Form 12-Item Health Survey, version 2[11] generic measure of functional health was also included. This 12-item measure yields physical and mental health component scores that are reported in T scores, having a range of 0 to 100, a mean of 50, and an SD of 10.

Statistical Analysis

Descriptive analysis. Preliminary analyses were conducted on data for each existing SI scale to examine the distribution of responses within each item to identify categories with sparse data (potentially problematic in the IRT analysis) and to identify out-of-range responses and violations of monotonically increasing or decreasing sum score means across categories of the rating scale. Reliability analyses were conducted to assess the internal consistency of the items within the scales. The raw frequencies and sum score means for respondents choosing each response category were examined to identify categories with sparse data and inversions in category means. SPSS version 17.0[a] was used in these analyses.

Dimensionality. To evaluate the dimensionality of the scales, factor analysis was used. Before these analyses, the sample was randomly split in half: one sample for use in the exploratory factor analyses and the other for use in the confirmatory factor analyses. Since the factor structure of the SI was previously established,[3] confirmatory factor analysis was conducted on the item data for each SI scale by using Mplus version 5.2.[b] Because the SI responses were categorical, polychoric correlation matrices were used as input. Dimensionality was assessed using the weighted least-squares estimation method with adjustments for means and variances estimator; the criteria for acceptable unidimensionality used