ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95:1320-7

ORIGINAL ARTICLE

Computer-Adaptive Balance Testing Improves Discrimination Between Community-Dwelling Elderly Fallers and Nonfallers

Poonam K. Pardasaney, ScD,[a,b] Pengsheng Ni, MD,[b] Mary D. Slavin, PhD,[b] Nancy K. Latham, PhD,[b] Robert C. Wagenaar, PhD,[c,d,†] Jonathan Bean, MD,[e] Alan M. Jette, PhD[b]

From the [a]Department of Rehabilitation Sciences, Sargent College of Health and Rehabilitation Sciences, Boston University, Boston, MA; [b]Health and Disability Research Institute, School of Public Health, Boston University, Boston, MA; [c]Department of Physical Therapy and Athletic Training, Sargent College of Health and Rehabilitation Sciences, Boston University, Boston, MA; [d]Rudolf Magnus Institute of Neuroscience and Department of Rehabilitation, Nursing Sciences and Sports, University Medical Center Utrecht, Utrecht, The Netherlands; and [e]Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital Network, Harvard Medical School, Boston, MA. Current affiliation for Pardasaney, RTI International, Waltham, MA.

Abstract

Objectives: To build an item response theory–based computer adaptive test (CAT) for balance from 3 traditional, fixed-form balance measures: Berg Balance Scale (BBS), Performance-Oriented Mobility Assessment (POMA), and dynamic gait index (DGI); and to examine whether the CAT's psychometric performance exceeded that of individual measures.

Design: Secondary analysis combining 2 existing datasets.

Setting: Community based.

Participants: Community-dwelling older adults (N=187) who were aged ≥65 years (mean age, 75.2±6.8y, 69% women).

Interventions: Not applicable.

Main Outcome Measures: The BBS, POMA, and DGI items were compiled into an initial 38-item bank. The Rasch partial credit model was used for final item bank calibration. CAT simulations were conducted to identify the ideal CAT. CAT score accuracy, reliability, floor and ceiling effects, and validity were examined. Floor and ceiling effects and validity of the CAT and individual measures were compared.

Results: A 23-item bank met model expectations. A 10-item CAT was selected, showing a very strong association with full item bank scores ($r=.97$) and good overall reliability (.78). Reliability was better in low- to midbalance ranges as a result of better item targeting to balance ability when compared with the highest balance ranges. No floor effect was noted. The CAT ceiling effect (11.2%) was significantly lower than the POMA (40.1%) and DGI (40.3%) ceiling effects ($P<.001$ per comparison). The CAT outperformed individual measures, being the only test to discriminate between fallers and nonfallers ($P=.007$), and being the strongest predictor of self-reported function.

Conclusions: The balance CAT showed excellent accuracy, good overall reliability, and excellent validity compared with individual measures, being the only measure to discriminate between fallers and nonfallers. Prospective examination, particularly in low-functioning older adults and clinical populations with balance deficits, is recommended. Development of an improved CAT based on an expanded item bank containing higher difficulty items is also recommended.

Archives of Physical Medicine and Rehabilitation 2014;95:1320-7

© 2014 by the American Congress of Rehabilitation Medicine

Performance-based balance assessment is fundamental in geriatric rehabilitation given the negative impact of balance impairment on function and fall risk.[1] Although balance measures are used extensively to assess balance and monitor change, existing measures have important limitations in community-dwelling older

† Deceased.

Supported by the Dudley Allen Sargent Research Fund, Sargent College of Health and Rehabilitation Sciences, Boston University; National Institutes of Health–National Center for Medical Rehabilitation Research (award no. 1R24HD065688-02); and the National Institutes of Health (award nos. K23AG019663-01A2, K24HD070966-02).

Disclosures: none.

0003-9993/14/$36 - see front matter © 2014 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.03.013

adults, including limited comprehensiveness in content, ceiling effects, and limited sensitivity to change and responsiveness.[2-5] These limitations likely contribute to multiple test administration for assessment,[6,7] increasing burden. In clinical trials, measures with these limitations can lead to type II errors and falsely diminished effect sizes.[2] In clinical settings, these limitations render measures susceptible to reduced diagnostic sensitivity and reduced ability to capture improvement from intervention, particularly in individuals with mild deficits.

Most balance measures are traditional fixed-form measures requiring fixed item set administration to every person. Designing psychometrically strong fixed-form balance measures is challenging because of the large number of items needed to encompass the spectrum of balance ability and components.[8] Other authors acknowledge that the multifactorial nature of balance precludes development of all-encompassing measures,[9] and combinations of measures must be used for assessment.[10] Additionally, depending on an individual's balance ability and dysfunction, comprehensive assessment may not be needed. Computer adaptive testing (CAT), a contemporary method based on item response theory (IRT),[8] offers a promising approach for overcoming limitations of fixed-form balance measures and designing comprehensive, tailored, efficient, and responsive tests. IRT models describe the association between an individual's ability level and the probability of a particular item response, providing item-based scores rather than test-based scores, and allowing score comparison when individuals have not completed identical items.[8,11] CAT programs use simple artificial intelligence that selects the optimal items from a calibrated IRT item bank based on individual ability level, avoiding inappropriately easy or difficult items,[8] and adjusts the test length to achieve desired precision. In being tailored to individuals' ability level, CATs can provide precise scores while reducing administration time associated with fixed-form tests. Although CATs have been extensively applied to patient-reported outcomes assessment,[8,12-15] their application to performance-based assessments remains new.

A balance CAT developed for the stroke population showed promising psychometric properties and reduced testing time compared with the fixed-form Berg Balance Scale (BBS).[16] The item bank, however, excluded walking and stair climbing, limiting applicability to ambulatory, community-dwelling older adults. To our knowledge, a balance CAT for community-dwelling older adults has not been reported.

The purpose of this study was to develop and examine psychometric properties of a balance CAT for community-dwelling older adults based on 3 fixed-form measures: BBS,[17,18] Performance-Oriented Mobility Assessment (POMA),[4,19] and dynamic gait index (DGI).[20,21] The study had 3 aims: to create an IRT-based item bank combining BBS, POMA, and DGI items; to build a CAT from the item bank and examine its score accuracy, reliability, floor and ceiling effects, and known-groups and predictive validity; and to compare floor and ceiling effects and validity of the CAT against individual balance measures. We hypothesized that the CAT would provide superior validity over individual measures because of greater item bank comprehensiveness and testing tailored to individuals' balance ability.

List of abbreviations:

BBS	**Berg Balance Scale**
CAT	**computer adaptive test**
CFA	**confirmatory factor analysis**
CFI	**Comparative Fit Index**
DGI	**dynamic gait index**
DIF	**differential item functioning**
Infit MnSq	**information-weighted mean square**
IRT	**item response theory**
LLFDI	**Late-Life Function and Disability Instrument**
Outfit MnSq	**outlier-sensitive mean square**
POMA-B	**Performance-Oriented Mobility Assessment-balance subscale**
POMA	**Performance-Oriented Mobility Assessment**
RMSEA	**Root Mean Square Error of Approximation**
TLI	**Tucker-Lewis Index**

Methods

The study, involving secondary analysis, was approved by Institutional Review Boards of Boston University and Spaulding Rehabilitation Hospital, Boston, MA.

Participants

Data from 2 studies of ambulatory community-dwelling older adults (aged ≥65y) conducted in outpatient rehabilitation facilities in Greater Boston were combined. The first was a 16-week randomized controlled trial comparing 2 exercise interventions in 138 volunteer subjects[22]; baseline BBS, POMA, and DGI scores and 16-week Late-Life Function and Disability Instrument (LLFDI) function scale scores were used. The second was a cross-sectional study that examined the relation between balance and falls in 49 volunteer subjects[23]; BBS, POMA, and DGI scores were used. The first study required independence climbing a flight of stairs, whereas the second evenly recruited fallers and nonfallers. Exclusion criteria were neuromuscular impairment limiting participation[22]; unstable disease[22]; specific medical diagnoses or findings (eg, orthostatic hypotension) that could affect balance or fall status[23]; and cognitive impairment.[22,23] The first study defined fallers as persons reporting any mechanical fall within the past year, and the second study defined fallers as persons reporting two or more mechanical falls within the past year.

Balance measures

BBS, POMA, and DGI items were compiled into an initial 38-item bank; higher scores indicated better balance.[4,17-21] The 14-item BBS primarily assesses transfers and standing balance on a scale from 0 to 4.[17,18] POMA contains a 9-item balance subscale (Performance-Oriented Mobility Assessment-balance subscale [POMA-B]) assessing transfers and standing balance and a 7-item gait subscale comprising observational gait analysis, and both are rated on a scale from 0 to 1 or 0 to 2.[4,19] The 8-item DGI assesses balance during gait on a scale from 0 to 3.[20,21]

Self-reported function measure

The LLFDI function scale,[24] used for predictive validity testing, contains 32 items assessing upper and lower extremity function on a scale from 1 to 5.[24] Raw scores are converted to scaled summary scores from 0 to 100, where higher scores indicate better function. The LLFDI function scale has shown high test-retest reliability (intraclass correlation coefficient = .77−.98) in community-dwelling older adults and known-groups validity in distinguishing among persons with varying levels of functional limitation or cane use.[24,25] The LLFDI function scale scores show moderate to strong associations with balance[25,26] and were available from 115 subjects from the first subsample.

Download English Version:

https://daneshyari.com/en/article/3448723

Download Persian Version:

https://daneshyari.com/article/3448723

Daneshyari.com