

Original Article

Investigation of psychometric properties of the Falls Efficacy Scale using Rasch analysis in patients with hemiplegic stroke

EUN YOUNG PARK, PT, PhD¹⁾, YOO IM CHOI, OT, PhD^{2)*}

¹⁾ Department of Secondary Special Education, College of Education, Jeonju University, Republic of Korea

²⁾ Department of Occupational Therapy, School of Medicine & Institute for Health Improvement, Wonkwang University: 460 Iksandae-ro, Iksan, Jeollabuk-do 54538, Republic of Korea

Abstract. [Purpose] The purpose of this study was to investigate the psychometric properties of the Falls Efficacy Scale using Rasch analysis in patients with hemiplegic stroke. [Subjects] Fifty-five community-dwelling hemiplegic stroke patients were selected as participants. [Methods] Data were analyzed using the Winsteps program (version 3.62) with the Rasch model to confirm the unidimensionality through item fit, reliability, and appropriateness of the rating scale. [Results] There were no misfit persons or items. Furthermore, infit and outfit statistics appeared adjacent. The person separation value was 3.07, and the reliability coefficient was 0.90. The reliability of all items was at an acceptable level for patients with hemiplegic stroke. [Conclusion] This was the first study to investigate the psychometric properties of the Falls Efficacy Scale using Rasch analysis. The results of this study suggest that the 6-point Falls Efficacy Scale is an appropriate tool for measuring the self-perceived fear of falling in patients with hemiplegic stroke.

Key words: Falls Efficacy Scale, Hemiplegic stroke, Rasch analysis

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INTRODUCTION

Both prospective and retrospective studies have shown that hemiplegic stroke patients are at a high risk of fall throughout their post-stroke lifespan¹⁾. Although previous studies have reported varying fall rates among hemiplegic stroke patients, there is a general consensus regarding the higher fall rate in stroke patients compared to the general population of the same age^{2, 3)}. Falls are a common and serious complication after stroke⁴⁾, and approximately one-third of hospital-related falls lead to potentially serious injuries, such as a fracture⁵⁾. Given that falls in stroke patients are associated with lower rehabilitation potential and functional recovery⁶⁾, prevention of falls is a major rehabilitation goal.

Although the physical consequences of a fall receive the most attention, the psychosocial effects are also important. One of these psychosocial effects is the fear of falling. Falling and fear of falling form a vicious circle. The experience of falling increases the fear of falling, and the fear of falling decreases physical activity, resulting in deconditioning. Deconditioning leads to decreased physical activity, resulting

in lower functioning that increases the incidence of falls in stroke patients⁷⁻⁹⁾. The negative effect that the fear of falling has on rehabilitation emphasizes the need for physical therapists to be aware of this fear in hemiplegic stroke patients.

Assessment is the first step in developing a targeted rehabilitation intervention. Choosing an appropriate tool that measures the fear of falling is the foundation for planning an appropriate course of therapy for post-stroke intervention and assessing the effects of an intervention¹⁰⁾. Despite a shift that places emphasis on task-oriented evaluation and self-efficacy in rehabilitation assessment and management of chronic disease¹¹⁾, use of a self-reported scale is insufficient in most environmental contexts. The Falls Efficacy Scale (FES) developed by Tinetti et al.¹²⁾ is an instrument based on the theory of self-efficacy. The FES is designed to measure self-perceived fear of falling during the performance of 10 common activities, including dressing, toileting, and preparing meals. The authors investigated its reliability in ambulatory individuals aged over 65 years and reported a test-retest reliability of 0.71¹²⁾.

Understanding individual factors such as the level of confidence and the emotional responses of a patient working toward a particular post-stroke goal could help health professionals appreciate the different responses to rehabilitation¹³⁾; therefore the FES, which measures balance confidence, is useful for the physical therapist. Although the FES is used for measuring the fear of falling in hemiplegic stroke patients¹⁴⁾, its psychometric properties have not been fully investigated. Hellström et al.¹⁵⁾ reported the scaling properties

*Corresponding author. Yoo Im Choi (E-mail: tiffaniey@wku.ac.kr)

and the test-retest reliability of an extended version of the FES. Responsiveness of the FES was investigated through comparison with the Berg Balance Scale and the Fugl-Meyer Balance subscale. The results of a previous study suggested that the FES is responsive and useful for measurement of perceived confidence in task performance¹⁶).

After development of the FES, several studies have investigated its use in the general elderly population. Studies that examined the psychometric properties of the FES were conducted on the basis of the classical test theory. When investigating the psychometric properties of the FES in a clinical population, such as in patients with hemiplegic stroke, Rasch analysis, which is a specific application of the item response theory that is based on the application of a related mathematical model, is appropriate^{17, 18}). Rasch analysis is less sample-dependent and more broadly useful than the classical test theory because it provides a more comprehensive understanding of the latent structure of the test¹⁹).

The purpose of this study was to investigate the psychometric properties of the FES using Rasch analysis in patients with hemiplegic stroke. Through this investigation, the utility of the FES in stroke patients can be determined.

SUBJECTS AND METHODS

The study sample was chosen from a group of community-dwelling hemiplegic stroke patients visiting a convalescent or rehabilitation center for disabled individuals in South Korea. Inclusion criteria were as follows: (1) presence of hemiplegia, (2) score on the Korean version of the Mini-Mental State Examination (MMSE-K) >21, and (3) age > 65 years. Study approval was received from the Ethics Review Board of our affiliated university, and written informed consent was obtained from all participants. Participants' responses to the questionnaire and their measurements were analyzed; none had missing data. Participants' ages ranged from 65 to 89 years, with an average of 70.73 ± 3.06 years. Of the 55 participants, 30.9% were women. Diagnoses included hemorrhagic stroke in 23 and ischemic stroke in 22. Stroke duration since diagnosis ranged from 6 to 480 months, with an average of 103.87 ± 38.69 months. Participants' scores on the MMSE-K ranged from 21 to 30, with a mean of 27.71. The Korean FES was used for measuring fall self-efficacy²⁰). There were 10 items using a 10-point ordinal scale included in the FES, with a total possible score of 100 points. The Korean FES items were as follows: (1) take a bath or shower, (2) reach into the closet, (3) do "light" housekeeping (e.g., clean up your nightstand or dresser), (4) walk around the nursing home, (5) get in and out of bed, (6) get up at night to go to the bathroom, (7) get in and out of a chair, (8) get dressed and undressed, (9) do personal grooming (e.g., wash your face, comb your hair), and (10) get on and off the toilet. The assessments were completed by trained registered physical therapists.

Rasch analysis is used for examining the unidimensionality of a measurement. The Rasch model assumes that an item response is the result of an interaction between the scale item and the respondent's ability. The strength of Rasch analysis lies in its investigation of the construction and validation of health status questionnaires for various patient groups,

including stroke patients²¹⁻²³). In this study, data were analyzed with the Winsteps program (Version 3.62).

Infit and outfit mean square (MNSQ) statistics were used to confirm unidimensionality. Unidimensionality examines whether all items contribute adequately to the scale's domain and identifies any misfit items. In this study, if the item or subject was in the range of 0.60 to 1.40 or had a Z-value between -2.0 and 2.0 for the infit, it was considered to have an appropriate model fit²⁴). In Rasch analysis, each item is explained by a chain of threshold parameters that describe the difficulty or probability of the response categories. Rating scale analysis includes average measures, threshold estimates, and category fit. In this study, the item rating scale was considered to have an appropriate rating scale if the threshold increased by at least 1.4 logits between categories²⁵). Reliability was verified using the person separation reliability statistic; the separation index (SI) must exceed 2 to attain the desired level of separation reliability (i.e., a value of 0.80), and exceed 3 to achieve a value of 0.90²⁶).

RESULTS

There were no misfit persons or items (Table 1). A summary of the rating scale analysis is presented in Table 2. The average measures, which indicate the average of the modeled FES for all patients who chose that particular response category, followed the low-to-high expected order and increased with the category value. However, structure calibrations were disordered. The infit MNSQ values of categories 1 and 10 were greater than 1.4. Based on the structure calibration and fit statistics, ratings 1, 2, 5, 6, 7, 9, and 10 were combined in a new scale. A summary of the new 6-point rating scale analysis is presented in Table 3.

With this new scale, the threshold increased by more than 1.4 logits between categories. Furthermore, infit and outfit MNSQ values appeared to be adjacent. Thus, the rating scale from 1 to 6 was determined to be appropriate for stroke patients.

The person separation value was 3.07, and the reliability coefficient was 0.90. The reliability of all items was at an acceptable level for patients with hemiplegic stroke.

DISCUSSION

The purpose of this study was to use Rasch analysis to investigate the psychometric properties of the FES for measuring balance confidence in patients with hemiplegic stroke. We investigated its unidimensionality through item fit, reliability, and appropriateness of the rating scale. The FES was found to be reliable, there were no misfit persons or items, and it showed unidimensionality. However, the rating scale required modification for application in patients with hemiplegic stroke.

Item fit is a tool for determining unidimensionality of a psychometric measure, specifically for showing how each item fits in a single dimension²⁷). The fit statistics of the 10 items support the proposed unidimensionality of the FES. A high MNSQ value for an item indicates that the item is not homogenous with the other items, whereas a low MNSQ value indicates that the item is a duplicate of another. The

Table 1. Item fit statistics: entry order

Item	Measure	SE	Infit		Outfit	
			MNSQ	Z-value	MNSQ	Z-value
1	52.94	1.15	1.24	1.0	1.10	0.5
2	56.47	1.19	1.35	1.3	1.11	0.5
3	54.54	1.16	0.78	-0.09	0.73	-1.1
4	51.38	1.13	1.30	1.2	1.03	0.2
5	49.21	1.13	0.63	-1.7	0.64	-1.6
6	49.72	1.13	0.66	-1.5	0.52	-2.3
7	47.79	1.14	0.89	-0.4	1.09	0.4
8	47.39	1.15	0.80	-0.8	0.78	-0.8
9	44.93	1.20	1.09	0.4	0.92	-0.2
10	45.64	1.18	0.92	-0.2	0.85	-0.6

MNSQ: Mean Square Statistic, SE: Standard Error

Table 3. Rating scale analysis of the revised 6-point scale

Category Level	Observed Average	Infit MNSQ	Outfit MNSQ	Structure Calibration
1	-16.20	1.18	1.23	None
2	-10.73	0.75	0.87	-10.83
3	-2.99	1.00	1.19	-5.98
4	-3.12	0.76	0.65	-10.14
5	-11.87	1.30	1.24	10.12
6	24.80	0.89	0.93	16.83

MNSQ: Mean Square Statistic

ideal MNSQ value is 1^{24}). In this study, we selected a range of 0.60–1.40 for the infit MNSQ values and a Z-value of > 2.0 to determine whether the scale items were a misfit. Infit value is more sensitive to the pattern of responses to items targeted on the person, whereas outfit value is more sensitive to the responses to items with difficulty far from the person. The Infit MNSQ value is a residual that is sensitive to the estimated person's abilities, whereas the outfit MNSQ value is sensitive to unexpected outliers for either person or item parameters. Outfit MNSQ values are influenced by outliers and are easy to diagnose and remedy; therefore, they pose a lesser threat to measurement. However, infit MNSQ values are influenced by response patterns and are usually hard to diagnose and remedy, and therefore they are a greater threat to measurement²⁴).

Two items, namely, "reach into the closet" and "walk around the nursing home" were the closest to being misfits, having an inordinately high infit MNSQ value. The possibility of the different dimensions of "reach into a closet" and "walk around the nursing home" were reported in a previous study investigating the validity of the FES²⁰). These 2 items showed weaker item-total correlation than the other items. The value for "reach into a closet" in this study was reported to be 0.56, while that for "walk around the nursing home" was 0.62. Item-total correlation is one of the methods for assessing construct validity. A low item-total correlation value indicates the possibility of a different construct. "Get in and out of bed" and "get up at night to go to the bathroom"

Table 2. Rating scale analysis of the original 10-point scale

Category Level	Observed Average	Infit MNSQ	Outfit MNSQ	Structure Calibration
1	-27.71	3.64	1.21	None
2	-22.28	0.74	0.85	-36.70
3	-7.08	0.74	0.59	-3.40
4	-2.27	0.94	1.08	-5.37
5	-1.24	0.80	0.63	-0.80
6	2.77	0.94	0.82	-1.55
7	4.29	0.39	0.26	-0.19
8	8.24	1.34	1.29	-4.38
9	15.91	0.45	0.59	11.45
10	18.51	1.91	1.13	31.54

MNSQ: Mean Square Statistic

showed a low infit MNSQ value; a low infit MNSQ value indicates the possibility of duplication with other items. Although 4 items of the FES had a close misfit value, they did not exceed the border. In addition, although the fit indices of these 4 items were acceptable, further investigation is needed.

Psychometric properties of the FES in stroke patients have been examined using the classical test theory. Hellström et al.¹⁵) reported the reliability of the extended FES in 30 stroke patients. A 13-activity questionnaire was used, and the overall test-retest reliability was high (intraclass correlation coefficient [ICC] = 0.97). The ICCs for personal activities of daily living and instrumental activities of daily living were also high. The authors suggested that the FES was a useful instrument for assessing balance confidence in those patients with hemiplegic stroke who are at risk for falls.

The results of the rating scale analysis in this study showed the need for modifying the original 10-point scale. The adequacy of the rating scale was judged based on the order and the differences between the items. On the basis of the judgment criteria, ratings of 1, 2, 5, 6, 7, 9, and 10 were combined in a new scale. After rescaling, the fit statistics of the rating scale were improved and appropriate. The order was increased in structure calibration, and the threshold of the differences between items was at least 1.4 logits²⁵). Another guideline is Linaere's essential criteria²⁷). These criteria include at least 10 cases per category and monotonically increase the average measures across a category; a category outfit is indicated by a square value of $< 2^{28}$). The modified 6-point ordinal scale was appropriate based on the guidelines for scale adequacy. Person separation in the Rasch model is equivalent to Cronbach's α . In this study, the person separation value indicated how well the measure could differentiate patients in terms of their balance confidence. The recommended minimum acceptable person separation value is 0.80²⁹). The present study had a person separation value of 0.90.

Despite the clinical significance of falls in stroke patients, studies on falls and fall self-efficacy are insufficient¹). The psychosocial aspect of falls, in particular, should be emphasized because fear of falling is related to balance and gait deficits. New studies have been initiated to identify a

validated tool for assessing fall self-efficacy in stroke patients. Validation of this measure of balance confidence in stroke patients is needed to achieve the goals of reducing the fear of falling, developing an appropriate intervention, and assessing the effect of the intervention. This was the first study to investigate the psychometric properties of the FES using Rasch analysis. The results of this study suggest that the 6-point FES is an appropriate tool for measuring self-perceived fear of falling in patients with hemiplegic stroke.

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