Development and Validation of a Short Form of the Fugl-Meyer Motor Scale in Patients With Stroke

Yu-Wei Hsieh, MS; I-Ping Hsueh, MA; Yeh-Tai Chou, MS; Ching-Fan Sheu, PhD; Ching-Lin Hsieh, PhD; Gert Kwakkel, PhD

Background and Purpose—The 50-item Fugl-Meyer motor scale (FM) is commonly used in outcome studies. However, the lengthy administration time of the FM keeps it from being widely accepted for routine clinical use. We aimed to develop a short form of the FM (the S-FM) with sound psychometric properties for stroke patients.

Methods—The FM was administered to 279 patients. It was then simplified based on expert opinions and the results of Rasch analysis. The psychometric properties (including Rasch reliability, concurrent validity, predictive validity, and responsiveness) of the S-FM were examined and were compared with those of the FM. The concurrent validity and responsiveness of the S-FM were further validated in a sample from the Netherlands.

Results—We selected 6 items for each subscale to construct a 12-item S-FM. The S-FM demonstrated high Rasch reliability, high concurrent validity with the original scale, moderate responsiveness, and moderate predictive validity with the comprehensive activities of daily living function. The S-FM also showed sufficient concurrent validity and responsiveness on the Dutch sample.

Conclusions—Our results provide strong evidence that the psychometric properties of the S-FM are comparable with those of the FM. The S-FM contains only 12 items, making it a very efficient measure for assessing the motor function of stroke patients in both clinical and research settings. (Stroke. 2007;38:3052-3054.)

Key Words: cerebrovascular accident ■ motor function ■ Rasch analysis

A concise motor scale with sound psychometric properties is crucial for clinicians to monitor motor deficits after stroke. The Fugl-Meyer motor scale (FM) is widely used in clinical trials to quantify motor deficits after stroke. The FM consists of a 33-item upper extremity subscale and a 17-item lower extremity subscale. However, the 50-item FM has rarely been used in clinics because of its lengthy administration time, which places a burden on patients with endurance problems. Thus, there is a practical need to shorten the FM.

We aimed to develop a short form of the FM (S-FM) and to examine the psychometric properties (including Rasch reliability, concurrent validity, predictive validity, and responsiveness) of the S-FM using a Taiwanese sample. Furthermore, we examined the concurrent validity and responsiveness of the S-FM in a Dutch sample.

Materials and Methods

Participants
We recruited 279 patients at 14 days after stroke; 254, 207, and 198 of them completed the assessments at 30, 90, and 180 days after stroke, respectively. Table 1 shows the baseline characteristics of the patients. The characteristics of the patients from the Netherlands were reported previously.

Procedure
The FM was administered to patients of the Taiwanese sample at the 4 time points mentioned. The comprehensive activities of daily living function, used as an external criterion to examine predictive validity of the S-FM, was administered at 180 days after stroke. For the Dutch sample, the FM was administered at 14, 28, 84, and 182 days after stroke.

Measures
The upper extremity and lower extremity subscales of the FM are mainly scored on a 3-point scale from 0 to 2. The Barthel Index and the Frenchay Activities Index were combined to represent comprehensive activities of daily living function, representing the entire continuum of disability.

Data Analysis

Developing the S-FM With Expert Opinions and the Results of Rasch Analyses
We first examined the item fits of each subscale. Infit and outfit statistics were used to determine whether the item responses fit the
Table 1. Baseline Characteristics of the Participants (N=279)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, male/female</td>
<td>164/115</td>
</tr>
<tr>
<td>Age, mean year (SD)</td>
<td>66.5 (10.6)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
</tr>
<tr>
<td>Cerebral hemorrhage</td>
<td>78 (28%)</td>
</tr>
<tr>
<td>Cerebral infarction</td>
<td>201 (72%)</td>
</tr>
<tr>
<td>Hemiplegic side, right/left</td>
<td>131/148</td>
</tr>
<tr>
<td>Score at 14 days after stroke, median (quartiles 1 to 3)</td>
<td></td>
</tr>
<tr>
<td>FM-UE score</td>
<td>32.0 (6.0–60.0)</td>
</tr>
<tr>
<td>FM-LE score</td>
<td>23.0 (9.0–31.0)</td>
</tr>
<tr>
<td>S-FM-UE score*</td>
<td>57.0 (32.0–74.0)</td>
</tr>
<tr>
<td>S-FM-LE score*</td>
<td>58.0 (28.0–75.0)</td>
</tr>
</tbody>
</table>

*The Rasch scores of the S-FM were transformed to 0 to 100.
LE indicates lower extremity; UE, upper extremity.

experiences of the partial credit model. The analysis was performed using the ConQuest software.
A panel of clinical experts and Rasch experts selected items for the S-FM according to content representativeness on the basis of the 6 Brunnstrom stages and item difficulty (including overall and step difficulties). All the items selected for the S-FM had to fit the partial credit models’ expectations. To minimize ceiling and floor effects, the most difficult and easiest items of each subscale were generally retained. The panel aimed to select the S-FM items with difficulties scattered evenly over the range of difficulty continuum.

Examining Psychometric Properties of the S-FM
Four psychometric properties of the S-FM were examined. Rasch reliability was calculated by multidimensional Rasch analysis for upper extremity and lower extremity separately. The concurrent validity of the S-FM with the FM at each time point was examined by Pearson’s correlation coefficient (r). Pearson r was used to test the relationships between the S-FM and the FM at 14, 30, and 90 days after stroke, whereas predictive validity of the S-FM was examined for outcome of daily living function at 180 days after stroke. The standardized response mean was used to examine the responsiveness of both measures. In addition, the concurrent validity and the responsiveness of the S-FM were further validated in the Dutch sample of 101 first-ever, middle cerebral artery strokes.

Results
Results of Rasch Analyses and Developing the S-FM
Seven items in the upper extremity subscale and 6 items in the lower extremity subscale failed to meet the partial credit model’s expectations. A multidimensional Rasch analysis was performed on the remaining 37 items with satisfactory Rasch reliabilities (coefficients ≥0.95).

The most difficult and easiest items of each subscale were initially selected. The only exception was that the second easiest item of the lower extremity subscale was selected instead of the easiest item because the step difficulty of the second easiest item covered a wider range than that of the easiest one did. This item property could better differentiate patients’ motor performance, which is particularly important for a short measure. The panel found that 4 additional items of each subscale appropriately fit both the content representativeness and the results of Rasch analyses (eg, even distribution of item difficulty). Table 2 shows item difficulty for the 37-item FM and the S-FM.

Psychometric Properties of the S-FM
The Rasch reliabilities for both subscales of the S-FM were good (coefficients ≥0.92). Upper extremity and lower extremity of the S-FM had high concurrent validity with the corresponding subscale of the FM at each time point (r ≥0.93). Both subscales of the S-FM and FM at 3 time points had moderate predictive validity with the comprehensive
activities of daily living function ($r=0.49$ to $0.59$ for the S-FM, and $0.48$ to $0.53$ for the FM). The responsiveness of both subscales of the S-FM and FM was moderate from 14 to 30 days after stroke and from 30 to 90 days after stroke (standardized response mean: $0.62$ to $0.71$ for the S-FM, and $0.60$ to $0.67$ for the FM). Furthermore, the findings of concurrent validity and responsiveness of the S-FM from the Dutch sample were similar to those found in the Taiwanese sample (data may be retrieved by the corresponding author).

**Discussion**

The S-FM has 3 merits. First, it consists of only one-quarter of the original items, thereby offering clinicians an efficient way to monitor changes in motor function and, more importantly, to perform routine assessments on patients with low endurance. Second, the psychometric properties of the S-FM were satisfactory and comparable to those of the FM. Third, the Rasch scores of the S-FM are interval-level scores, and thus the change/difference scores on the S-FM within/between patients can be directly interpreted and compared by clinicians.

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**Disclosures**

None.

**References**

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