

Original Article

# Psychometric Properties of the Lower Extremity Subscale of the Fugl-Myer Assessment for Community-dwelling Hemiplegic Stroke Patients

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**Abstract.** [Purpose] The purpose of this study was to investigate the psychometric properties of the lower extremity subscale of the Fugl-Meyer Assessment lower extremity (FMA-LE) for community-dwelling hemiplegic stroke patients. [Subjects] The participants were 140 community-dwelling hemiplegic stroke patients. [Methods] To determine the psychometric properties of the FMA-LE, we examined construct validity, response characteristics, item discrimination, and internal consistency. [Results] Factor analysis of the FMA-LE revealed that the first factor explained 61.73% of the variance and provided evidence of unidimensionality. The FMA-LE did not show ceiling or floor effects; Cronbach's  $\alpha$  was 0.935 (95% CI: 0.919–0.950). [Conclusion] Because the FMA-LE seems to be both valid and reliable, we conclude that it is appropriate for the measurement of the lower extremity motor impairment of community-dwelling hemiplegic stroke patients.

**Key words:** Fugl-Meyer Assessment, Hemiplegic stroke, Lower extremity

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## INTRODUCTION

Motor impairment is one of the most common stroke symptoms<sup>1)</sup>. Evidence of relationships between motor impairment and disability, daily activities, and social participation following stroke has been reported. Motor impairment at the time of hospital admission has been reported to be a good predictor of physical disability after stroke rehabilitation. Chae et al.<sup>2)</sup> investigated motor impairment, assessed using the Fugl-Myer Assessment (FMA) Motor Impairment Scale, as a predictor of physical independence following inpatient stroke rehabilitation, and reported that dependency in physical activities of daily living was primarily determined by the degree of motor impairment. Independent walking has been correlated with lower extremity strength<sup>3)</sup>. Therefore, stroke rehabilitation focuses on the recovery of impaired movement and its associated function<sup>4)</sup>.

More attention has been paid to the evaluation of motor impairments in the upper extremities than in the lower extremities<sup>5, 6)</sup>, despite lower-extremity motor functions being frequently impaired following stroke and functional mobility deterioration<sup>7)</sup>. This tendency also appears in the FMA

assessment, and the FMA, which is considered to be one of the most comprehensive quantitative measures of post-stroke motor impairment, suffers from this drawback. The psychometric properties of the FMA with regard to the upper extremities have been verified through various analyses, and it is widely used to assess upper extremity function<sup>8–10)</sup>.

Although the FMA is commonly used in clinical trials to assess motor impairment and determine treatment efficacy, no study has yet verified the psychometric properties of the lower extremity subscales. Studies of FMA results for lower-extremities have not provided separate data for this subscale<sup>11, 12)</sup>. The psychometric properties of the upper extremity subscale, however, have been thoroughly established. Woodbury et al.<sup>6)</sup> reported on the dimensionality and construct validity of the FMA upper extremity scale; we note that as a result, 3 reflex items were removed, based on factor loadings and item infit statistics and a modified 30-item assessment was recommended.

The existing research on the psychometric properties of the FMA has another limitation. To date, most studies have employed heterogeneous samples, and the FMA's psychometric properties may differ among subjects. More sophisticated methodology is needed<sup>13)</sup>. Therefore, recent research has investigated whether hierarchical properties of the FMA scale are the same in acute and chronic stroke patients<sup>14)</sup>.

Choosing an appropriate measure is the foundation for planning an appropriate course of therapy and assessing the effects of an intervention. Lower extremity motor function of chronic stroke patients is important, and its improve-

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ment is a central aim of physical therapy. However, evidence supporting the use of the FMA for lower extremity motor impairment in chronic stroke patients is insufficient. Therefore, the purpose of this study was to investigate the psychometric properties of the FMA-LE subscale for community-dwelling hemiplegic stroke patients.

## SUBJECTS AND METHODS

This study followed a cross-sectional design. The sample was chosen from a group of community-dwelling stroke patients visiting convalescence or rehabilitation centers for disabled individuals in South Korea. Patients scoring 18 or below on the Korean version of the Mini Mental State Examination (MMSE-K) were excluded from the study. Approval was received from the ethics review board of our affiliated university. Informed written consent was received from all the participants prior to their participation in the study. Questionnaire responses and measurements of the 140 participants were analyzed; none had missing data. Participants' ages ranged from 42 to 86 years, with an average age of 57.07 years (SD = 9.88). Of the participants, 37.1% were female. The diagnoses included 66 hemorrhagic strokes and 74 ischemic strokes. The time since diagnosis of stroke ranged from 12 to 269 months, with an average of 50.48 months (SD = 47.06). The mean score on the MMSE-K was 26.63, and ranged from 18 to 30.

We administered the FMA-LE, which consists of 17 items, with a maximum possible score of 34 points. Each item was answered using a 3-point ordinal scale (0 = cannot perform, 1 = can partially perform, 2 = can fully perform). The assessment was completed by trained registered physical therapists.

Construct validity, response characteristics, item discrimination and internal consistency were assessed. We employed factor analysis to identify unidimensionality. The suitability of the collected data for factor analysis was examined using Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) test. The KMO value was 0.918 and the  $\chi^2$  of Bartlett's test was 2,841.56 ( $p < 0.001$ ). The criteria for determining unidimensionality through factor analysis were as follows: 1) the scree plot shows one clear factor, 2) the eigenvalue of this factor is significantly larger than those of other factors, and 3) this factor explains over 20% of the total variance<sup>15</sup>.

We found that the collected data were appropriate for factor analysis. Item discrimination was analyzed by calculating the correlations between items and total scores. We employed the SPSS 20 for the analysis.

## RESULTS

Factor analysis results are presented in Table 1 and Fig. 1.

The first factor explained 61.73% of the variance meeting the  $> 20\%$  criterion. The ratio between the eigenvalues of the first and second factors was 6.642 times the cutoff for unidimensionality reported previously<sup>16</sup>. The scree plot also showed the unidimensionality of the FMA-LE.

Response characteristics were examined through ceiling and floor effects. The lowest value (0) occurred in 2.9% of

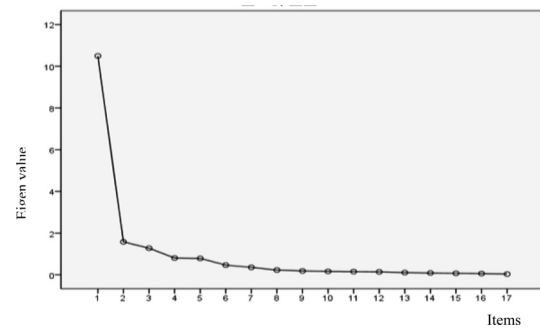


Fig. 1. Scree plot

Table 1. Results of factor analysis

Category	Factor 1	Factor 2	1:2 Ratio
Eigenvalue	10.494	1.580	6.642
Explained variance (%)	61.731	71.023	

the responses, and the highest value (34) occurred in 7.9%.

Table 2 shows item discrimination results.

Cronbach's  $\alpha$  of the FMA-LE was 0.935 (95% CI: 0.919–0.950).

## DISCUSSION

The purpose of the present study was to evaluate the reliability and validity of the FMA's lower extremity subscale. Although the FMA is widely used to measure motor impairment and recovery of stroke patients, the psychometric properties of the lower extremity subscale have not been separately examined until now.

The 50-item FMA motor scale is a widely used assessment of motor function of both the upper and lower extremities following stroke, and has been recommended as an outcome measure for stroke rehabilitation<sup>17</sup>. Nevertheless, although the construct validity of the FMA has been reported in previous studies, confirmation of unidimensionality of the FMA has only been reported for the upper extremity subscale<sup>6</sup>. Our results verified the unidimensionality of the FMA-LE, which suggests that the scale has a utility similar to that of the upper extremity subscale.

The acceptable level of ceiling and floor effects is below 30%<sup>18</sup>. We found no ceiling or floor effects, with the lowest score percentage being 2.9% and the highest score percentage being 7.9%. Concern about the FMA's ceiling effect was raised in a previous review<sup>13</sup>; however, this effect has not been examined objectively. In the present study, the FMA-LE showed no ceiling or floor effects in community-dwelling hemiplegic stroke patients.

Although there is no absolute standard for judging item discrimination, correlations above 0.40, between 0.30–0.40, and below 0.30 have been deemed to have high, moderate, and low discriminant ability, respectively<sup>19</sup>. If items scored below 0.20, they were considered for removal in a previous study<sup>20</sup>. We found that the FMA-LE item-total correlations were all above 0.40.

**Table 2.** Item discrimination

Items	Correlation	Items	Correlation
Hip flexion	0.784**	Ankle dorsiflexion (sitting)	0.850**
Hip extension	0.789**	Ankle dorsiflexion (standing)	0.784**
Hip adduction	0.818**	Ankle plantar flexion	0.806**
Knee flexion (supine)	0.846**	Heel-shine speed	0.746**
Knee flexion (sitting)	0.840**	Heel-shin tremor	0.800**
Knee flexion (standing)	0.835**	Heel-sheen dysmetria	0.679**
Knee extension	0.859**	Knee reflex	0.765**
Ankle dorsiflexion (supine)	0.489**	Hamstring reflex	0.703**
		Ankle reflex	0.850**

\*\*p < 0.01

The FMA-LE demonstrated high internal consistency. According to Nunnally and Bernstein<sup>21)</sup>, the classifications for the strength of Cronbach's  $\alpha$  coefficients are: poor = below 0.50, moderate from 0.50 to 0.75, good = 0.75 to 0.90, and high above 0.90. Our result for internal consistency was similar to the value of 0.96 found in the study by Duncan et al<sup>22)</sup>. Methodological shortcomings related to a small number of subjects being tested have been raised in previous research examining the reliability of the FMA<sup>13)</sup>. Our participants were 140 hemiplegic community-dwelling patients. The present results suggest that the FMA-LE is a reliable assessment tool for this group.

The FMA has been deemed to have appropriate validity and reliability; however, physical therapists should bear its limitations in mind. Our results suggest that the FMA-LE can be used as a separate assessment for measuring the motor impairment of community-dwelling stroke patients with hemiplegia. Further studies should explore the various psychometric properties among homogenous subjects.

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