

Determining the severity of upper-extremity motor impairment in chronic stroke survivors using Fugl-Meyer Score – A cluster analytical approach

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Introduction

- An estimated 8 million stroke survivors are living in the US, of which more than two-thirds suffer from upper extremity (UE) motor paresis.^{1,2,3}
- Even after intensive rehabilitation, chronic survivors experience difficulty in incorporating the weak upper limb into daily activities and self-care tasks.
- A generic approach is applied without consideration for the severity of stroke-related impairment, leading to mixed effects.
- Determining the severity of stroke-rated motor impairment and optimizing treatment with respect to the severity can enhance rehabilitation outcomes.
- The Upper Extremity Scale of the Fugl-Meyer (UEFM) is widely used to measure upper extremity motor impairment.⁴
- **Objective:- Determine the severity of motor impairment in chronic stroke survivors using UEFM**

Methods

- The UEFM is a quantitative assessment of post-stroke impairment consisting of 33 items, with each scored on a 0-2 point scale resulting in a maximum total score of 66 points
- Test items are designed to assess moving in and out of synergies at the shoulder, elbow, wrist, and hand
- The UEFM has been shown to have excellent reliability and validity in the chronic stroke population

Examples of UEFM Items

Reflexes			
Biceps or finger flexor reflex			
Biceps reflex		0 [no reflex]	2 [reflex excitable]
Synergistic: Flexor Synergy			
Voluntarily bring affected forearm fully supinated to ear of the affected side			
Shoulder abduction	0 [not done at all]	1 [partly done]	2 [faultless]
Wrist			
Perform the following tasks with shoulder in 0°, elbow 90°, forearm pronated			
Dorsiflex wrist	0 [can't dorsiflex wrist to 15°]	1 [can dorsiflex but not against resistance]	2 [can dorsiflex against resistance]
Hand			
Perform the following tasks with elbow at 90°			
Oppose thumb pad against pad of index finger with a pencil interposed	0 [cannot do this]	1 [pencil kept in place, but not against a slight tug]	2 [pencil held well against a tug]

Statistical Analysis

- The continuous variables were described using the sample mean and standard deviation, and the categorical variables were described using the number of counts.
- The clustering analysis was conducted using the **section scores from the UEFM score**.
- We applied **three popular clustering analysis methods** (K-means clustering, Partition Around Medoids (PAM) clustering with Euclidean distance metric, and PAM clustering with Gower distance metric) in order to identify the latent classes in our cohort.
- The stability of clustering results was evaluated through Silhouette analysis, and multidimensional scaling, a dimension reduction technique, was also performed for clustering result visualization.
- Finally, an analysis of variance (ANOVA) was conducted to compare the section scores and overall UEFM score among different cluster groups.
- All analyses were performed using the R software program (version 4.2.0; R Foundation for Statistical Computing, Vienna, Austria).
- All tests were 2-tailed, and the level of statistical significance was set at $p < 0.05$.

Preliminary Results

- The present study was a secondary analysis of data from three different stroke studies (**N=67**) investigating the effectiveness of UE repetitive task practice in chronic (>6 months) stroke

Demographics

Mean (SD) Age	Gender	Race	Paretic side	Months Since Stroke	Stroke Type
62.5 (10.9)	Male (37) Female (30)	Black (17) White (50)	Left (37) Right (30)	45.5 (48.0)	Ischemic(55) Hemorrhagic (8) Unknown (4)

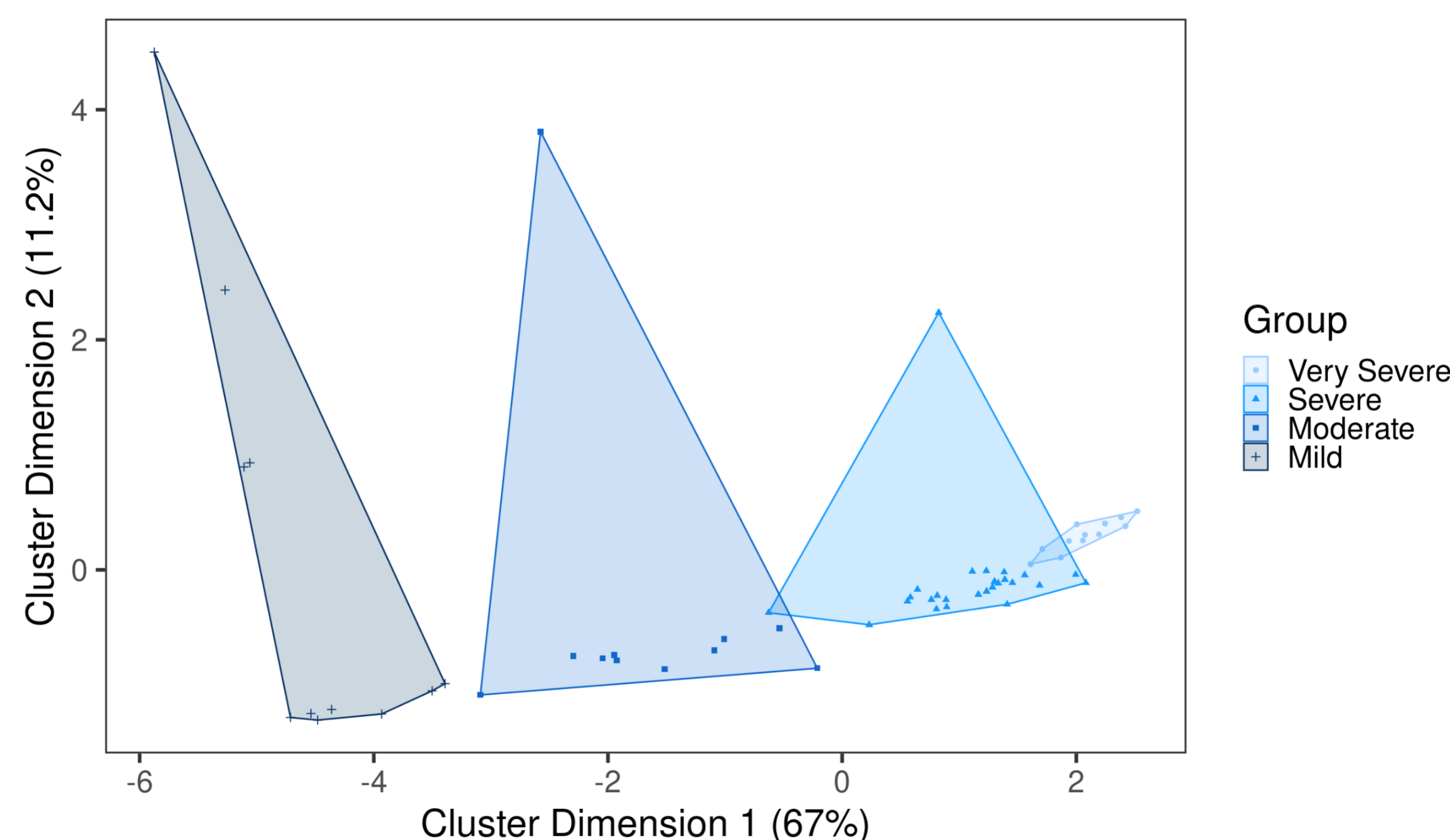


Figure 1. The multi-dimensional scaling representation of the clustering results.

Preliminary Results

Table 1. ANOVA comparison for the four cluster groups.

UEFM Scores	Cluster 1	Cluster 2	Cluster 3	Cluster 4	P_Value
	Very Severe	Severe	Moderate	Mild	
Section I	4.0 (0.0)	3.9 (0.4)	3.6 (1.2)	3.5 (0.9)	0.107
Section II	3.3 (0.9)	5.0 (0.9)	7.182 (1.00)	11.0 (0.6)	<.0001
Section III	0.9 (0.6)	3.0 (0.7)	4.7 (0.9)	5.7 (0.5)	<.0001
Section IV	0.1 (0.3)	1.1 (1.1)	4.2 (1.1)	5.8 (0.4)	<.0001
Section V	0.0 (0.0)	0.2 (0.5)	2.4 (1.1)	5.0 (0.8)	<.0001
Section VI	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.4 (0.8)	0.013
Section VII	0.2 (0.4)	1.2 (1.1)	4.7 (1.7)	8.8 (1.3)	<.0001
Section VIII	1.1 (0.5)	2.6 (1.9)	8.2 (3.3)	11.5 (1.6)	<.0001
Section IX	4.0 (0.0)	3.8 (0.8)	4.4 (1.0)	5.6 (0.5)	<.0001
Total score	13.5 (1.7)	20.9 (4.0)	39.4 (6.0)	57.3 (3.1)	<.0001

- Estimation of cutoff scores from FMA-UE total score
- **Very Severe:** ≤ 16
 - **Severe:** (16, 28]
 - **Moderate:** (28, 45]
 - **Mild:** > 45

My Training and Research Contribution

- Completed CITI training for good clinical practice, human research, and conflicts of interest
- Opportunity to observe and understand behavioral outcome measures for assessing motor impairment, activity limitation, and patient-reported disability after stroke.
- Compiled the motor impairment score and patient demographics and assessed the data integrity of the outcome measures
- Worked with Python/R to read and analyze data
- Learned advanced unsupervised machine learning and dimension reduction techniques

Discussion and Conclusion

- Our project aimed to the determine severity of the stroke-related upper extremity impairment using UEFM.
- **Results from our clustering-based analytical approach support a four-group motor impairment classification in chronic stroke survivors with upper extremity weakness.**
- Common residual motor functions were observed (mild and moderate having preserved distal movements – section VI and VIII) in our cohort.
- Future work: Combine Upper Extremity Scale of the Fugl-Meyer and Wolf motor function ability score for measuring motor function to classify the stroke survivors based on motor skill.

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