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Determination of the proportion of severe impairment of the upper extremity functions in patients with chronic stroke

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Abstract

The objective of this study was to assess the proportion of upper extremity (UE) motor impairment and activity limitation in Myanmar individuals with chronic stroke and to find out the correlation between motor impairment and activity limitation. The research was conducted at North Okkalapa General Hospital, Yangon, Myanmar. The motor portion of Fugl-Meyer Assessment-Upper Extremity (FMA-UE) and Streamlined Wolf Motor Function Test for chronic stroke (SWMFT-C) were applied to assess the UE motor impairment and activity limitation. The result showed that 38 patients with chronic stroke were impaired in their UE functions (FMA-UE score of 7.0-52.0). Among these, four levels of impairments were demonstrated with full impairment (31.6%), severe impairment (15.8%), moderate impairment (50%), and mild impairment (2.6%). For the UE activities, the mean score (SD) of SWMFT-C performance time (s) was 7.52 seconds (6.00). The mean score (SD) of SWMFT-C functional ability scale (SWMFT-C-FAS) was 2.70 (1.12). In conclusion, the majority of the patients with chronic stroke were with moderate and severe motor impairment and activity limitation in their UE. Therefore, UE rehabilitation is needed to improve the impairments and functional recovery.

Keywords: Upper extremity, chronic stoke, impairment, activity

1. Introduction

Stroke constitutes a major public health problem that affects millions of individuals globally and has significant socioeconomic and health-care consequences [1]. It is the second leading cause of death with an annual mortality rate of about 5.5 million [2]. Moreover, more than half of the patients with stroke need help with activities of daily living, such as showering, toileting, and dressing even 3 years post-stroke [3]. Therefore, stroke is a disease of immense public health importance with serious economic and social consequences [4].

Motor impairment of the upper extremity (UE) affects 73 to 88% of first-time stroke survivors and 55 to 75% of chronic stroke patients [5]. This problem becomes a major contributor to health issues and quality of life among persons after stroke [6]. Therefore, UE rehabilitation has been recognized as one of the top ten research priorities for healthcare professionals in stroke rehabilitation [7].

Nowadays, stroke rehabilitation emphasizes understanding the patients in functioning and the ability to participate in everyday life [8]. Therefore, in order to achieve adequate physiotherapeutic neurorehabilitation of UE, comprehensive assessments are important to assess the UE motor impairment and activity limitation in patients who have had a stroke. Accordingly, the assessments of UE should include impairments of body functions and structures as well as limitations in the activities of the stroke population to design more specific and effective intensive approaches to certain aspects of disability.

The neurological recovery after chronic stroke is different from the acute and sub-acute stroke [9]. Since the neurological recovery in chronic stroke is mainly dependent on intensive training without spontaneous plasticity, the experience-learning plasticity facilitates the brain's capacity to change in response to environmental stimuli that activate neural plastic changes and stroke recovery [10, 11]. Novel interventions for the improvement of UE motor functions require evidence-based measures of motor function assessments not only for the body and structure levels but also for the activity levels which are specific to the individuals with chronic stroke.

The impairments of UE in aspects of spasticity [12] and diminished handgrip strength by 39% [13] in patients with chronic stroke were assessed in previous studies. One study identified the personal impacts of UE disability following stroke, using internet-based accounts of stroke survivors rather than specific assessments [14]. Using the International Classification of Functioning, Disability and Health (ICF) framework, the participants responded to 80% of the body structure categories, over 40% of the body functions, activities, and participation categories, and 36% of the environmental factors. Another similar study evaluated the health status of UE using the Stroke Rehabilitation Assessment of Movement (STREAM), yielding a median score of 33.3/100 in both sub-acute and chronic phases of patients who have had a stroke [15]. The study found that over 80% of patients exhibited increased muscle tone, 45.7% experienced shoulder joint disorders, and there was a decrease in social participation, as indicated by a Stroke Impact Scale (SIS) score of 23.4/100. However, since their results could not represent the motor impairment and activity limitations of UE in patients with chronic stroke, more specific assessments are needed. One study demonstrated that impairments measured by the Short form Fugl-Meyer Assessment Scale ranged from 1.14 to 1.31 points, while activity limitations measured by the SWMFT-C ranged from 1.99 to 2.40 points. These impairments were associated with shoulder pain and shoulder subluxation, and were followed by wrist pain, muscle atrophy, and hand edema [16]. Another study assessed the activity limitations of UE in patients with chronic stroke, finding that 64.4% of patients exhibited poor functional capacity of the affected arm, as indicated by SWMFT-C-FAS scores lower than 3 [17]. There is also no study assessing the proportion of UE motor impairment and activity limitation for patients with chronic stroke.

Comprehensive measurements of UE functions with specific assessments should be established for people with chronic stroke to assess the proportion of UE motor impairment and activity limitations. Moreover, these clinical assessments of functional recovery remain essential tools to estimate the effectiveness of rehabilitation and to predict functional recovery. The results from these assessments may strengthen the applicability of contemporary techniques in rehabilitation for patients who have had a stroke to improve UE functions without long-term physical disabilities.

Report is lacking for the proportion of UE motor impairment and activity limitations in patients with chronic stroke. This is critical for tailoring rehabilitation programs according to the severity of each patient's condition. Therefore, the current study aimed to assess the proportion of UE motor impairment and activity limitations in patients with chronic stroke by specific measures. By categorizing motor impairments into different severity levels, the corresponding activity limitations can also be classified in this study.

2. Materials and methods

2.1 Study design and setting

This is an observational, cross-sectional study. This manuscript conforms to the STROBE Guidelines. The study was conducted at the Physical Medicine and Rehabilitation Department, North Okkalapa General Hospital (NOGH), Yangon, Myanmar from October 2022 to March 2023.

2.2 Participants

The demographic data and a history of stroke were recorded. As the incidence of stroke under 40 years of age is not common [19] and recovery from stroke is higher in those patients [20], patients with ages over 40 years, whose stroke occurred at least 6 months from the initial onset, able to communicate verbally, understand and follow command, able to sit for at least 30 minutes, able to understand the study and respond to questions (a score of more than 24 in the Mini Mental State Examination), and voluntarily participate in the study were included in the study. Patients with other neurological diseases such as Parkinson's disease, dementia, Alzheimer's disease, peripheral neuropathy, bilateral stroke, had been in a serious accident or had any disease limiting the function of UE before the stroke, shoulder pathology, or recent surgery to the neck, arm, or shoulder, and treatment of any surgical incision were excluded.

The sample size was defined based on the proportion of severe impairment of UE functions by FMA-UE that was reported in the previous study. Hijikata and colleagues reported that 52.5% of patients with chronic stroke in their study were severely impaired in their UE functions [18]. For the present study, according to 2021 hospital data, the total number of chronic stroke patients who could comprehend the instructions when attending NOGH were approximately 60, the standard normal deviation for 95% confidence interval = 1.96 and precision = 0.1, the

estimated sample size was calculated at least 38 patients with chronic stroke using the sample size calculation formula for the population proportion with a small finite population [21].

2.3 Outcome measurements

2.3.1 Measurement of UE impairments

UE impairments were assessed using the motor section of FMA-UE. The FMA is a performance-based measure. It has 5 subdivisions to test a specific construct (motor, balance, sensation, range of motion, and pain). The motor section of FMA is arranged to evaluate the extremity movement, reflexes, coordination, and speed. The motor section has a further 2 subsections: the upper extremities (upper arm and wrist and hand) and lower extremities. Out of the total scores of 66, a sub-score of 36 was for the upper arm (FMA-UA) and 30 for the wrist and hand (FMA-WH). Most of the items were scored on a 3-point ordinal scale from 0 = no function to 2 = full function [22]. UE impairments were classified using optimal FMA-UE cutoff scores from the previous study [23] and adjusted for appropriate categorization: no impairment (53 to 66 points), mild impairment (48 to 52 points), moderate impairment (32 to 47 points), severe impairment (23 to 31 points), and full impairment (0 to 22 points).

2.3.2 Measurement of UE activity limitations

Streamlined Wolf Motor Function test for chronic stroke performance time (s) and functional ability scale (SWMFT-C-FAS) were used to assess UE activity limitations, and the recovery of UE motor function after a stroke [24]. The SWMFT-C includes 6 tasks: extending the elbow 28 cm on a tabletop (one pound weight), moving hand to box (front), lifting a can, lifting a pencil, turning a key in lock, and folding a towel [24]. The FAS includes a 6-point scale ranging from 0 (no use) to 5 (normal). The patients were instructed firstly to perform the movement with their non-affected extremity, and then performed each of the tested movements with their affected extremity twice. The mean of the two measurements was calculated for each test item for both the median and the mean rate values [25]. For the performance time (s), the six items should be performed as quickly as possible, the maximum time allowed for each task is 120 seconds [25].

2.4 Procedure

Data collection was started with a screening procedure of the patients referred by physicians to determine the eligibility for study. Before assessing the patient's performance, the expert physical therapist who had experience in assessing the FMA-UE and SWMFT-C for 7 years trained the principal researcher on how to assess and score the outcome measurements accurately. The training period lasted 3 hours. The principal researcher collected the patients' data from their medical records and personal information by interviewing them or their caregivers. After getting the signed written informed consents from the eligible patients, they were assessed for the motor impairment of UE by using FMA-UE and activity limitation was assessed by using SWMFT-C.

2.5 Data analysis

Data analysis was performed using the International Business Machine Corporation Statistical Package for the Social Sciences (IBM SPSS) version 28 (copyright Khon Kaen University (KKU), Thailand). The demographic data and clinical characteristic data were analyzed and expressed with descriptive statistics such as mean and standard deviation as well as median and interquartile range. The data distribution was tested using the Shapiro-Wilk test statistics.

3. Results

3.1 Demographic data

Demographic data of the 38 patients are presented in Table 1. The flow diagram of patients is presented in Figure 1. The mean age (SD) of patients was 58.21 (9.40) years. Thirty-one patients (81.6%) were males and seven (18.4%) were females. Patients had different educational levels ranging from illiterate to above high school level. The majority of the patients were unemployed.

3.2 Disease and conditions of participants

Disease and conditions are presented in Table 2. The mean post-stroke duration (SD) of the patients was 45.95 (31.45) months. Among the 38 stroke patients, 20 patients (52.6%) were the left-sided stroke. All the patients

were right-sided dominant except one patient. The common type of stroke was ischemic type (76.3%) with 34 patients (89.5%) were first time of stroke. Out of 38 patients, 13 (34.2%) had no comorbid diseases and 22 (57.9%) had hypertension. Among them, 28 patients had no somatosensory loss. The value of MMSE ranged from 24 to 28 with a mean (SD) of 25.82 (1.20). Therefore, the patients in this study had no cognitive impairment.

Table 1 Demographic data of participants with chronic stroke participated in the study evaluated UE motor impairment and activity limitation (n = 38).

Demographic data	
Age (Years) (Mean± SD)	58.21±9.40
Gender, number (%)	
Male	31 (81.6%)
Female	7 (18.4%)
Education, number (%)	
Illiterate	9 (23.7%)
Primary school	21 (55.3%)
Secondary school	3 (7.9%)
High school	4 (10.5%)
Post high school	1 (2.6%)
Employment, number (%)	
Unemployed	33 (86.8%)
Employed	5 (13.2%)
Smoking and alcohol drinking, number (%)	
Ex-smoker	3 (7.9%)
Ex-alcohol drinking	4 (10.5%)
Ex both smoking and alcohol drinking	8 (21.1%)
Smoker	4 (10.5%)
Alcohol drinking	1 (2.6%)
Both smoking and alcohol drinking	2 (5.3%)
None	16 (42.1%)

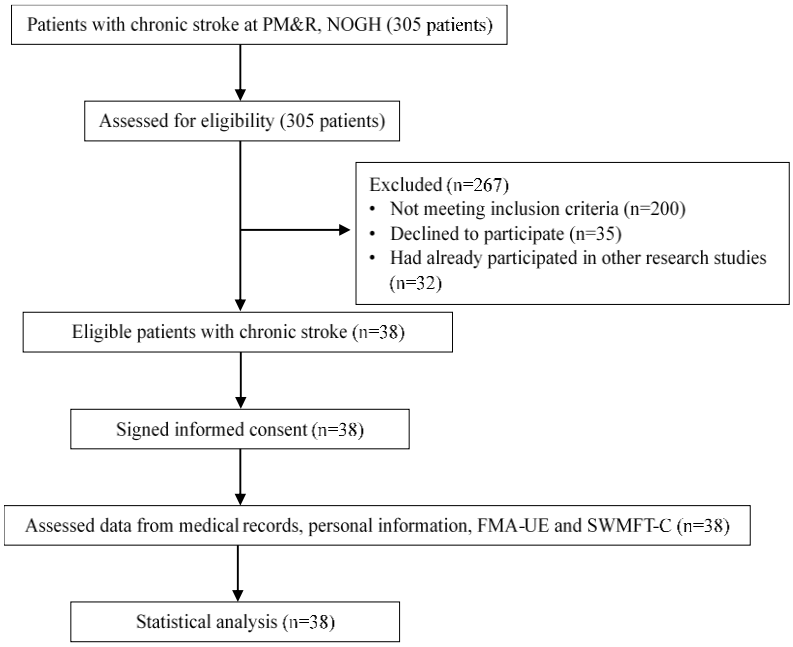

Figure 1 Flow diagram of participants.

Table 2 Disease and conditions of participants with chronic stroke participated in the study evaluated UE motor impairment and activity limitation (n = 38).

Disease and conditions	
Post stroke duration (months) (Mean± SD)	45.95±31.45
Side of stroke, number (%)	
Right	18 (47.4%)
Left	20 (52.6%)
Dominant hand, number (%)	
Right	37 (97.4%)
Left	1 (2.6%)
Stroke type, number (%)	
Ischemic	29 (76.3%)
Hemorrhagic	9 (23.7%)
Number of stroke (s), number (%)	
Once	34 (89.5%)
More than once	4 (10.5%)
Co-morbidities, number (%)	
None	13 (34.2%)
Hypertension	22 (57.9%)
IHD	1 (2.6%)
Diabetes mellitus	2 (5.3%)
Somatosensory loss, number (%)	
No	28 (73.7%)
Forearm	4 (10.5%)
DIP	3 (7.9%)
Fingers	3 (7.9%)
MMSE (Mean± SD)	25.82±1.20

Note: DIP: distal interphalangeal joint; IHD: ischemic heart disease; MMSE: Mini Mental State Examination.

3.3 Results of outcome measurements

3.3.1. Proportion of the motor impairment and activity limitation of upper extremity of patients

The proportion of the motor impairment of UE in the current sample according to the FMA-UE is described in Table 3. Motor impairment of UE was defined as FMA-UE score of 0-52 out of total 66 which was between full impairment, mild impairment and moderate impairment except no impairment [1]. The distribution of the FMA-UE score ranged from 7 to 51 with a mean of 29.29 (SD 13.62) in this study. According to this criterion, all 38 patients had motor impairment of UE. Among the 38 patients, 12 (31.6%) had full impairment, 6 (15.8%) had severe motor impairment, 19 (50%) patients had moderate impairment, and one (2.6%) had mild impairment.

The level of activity limitation of UE in patients according to SWMFT-C is described in Table 4. The distribution of performance time (s) represents with a mean of 7.52 (SD 6.00) seconds and 95% CI 1.73 to 24.24 seconds. The distribution of FAS represents with a mean of 2.63 (SD 1.07) and 95% CI 0.58 to 4.17.

Table 3 Proportion of the motor impairment in UE according to FMA-UE of participants with chronic stroke participated in the study evaluated UE motor impairment and activity limitation (n = 38).

	Number of participants (%)	FMA-UE Mean±SD	95% CI
Full impairment (0-22)	12 (31.6%)	12.25±5.01	7.00, 19.00
Severe impairment (23-31)	6 (15.8%)	26.17±2.79	23.00, 29.00
Moderate impairment (32-47)	19 (50%)	39.89±4.77	33.00, 47.00
Mild impairment (48-52)	1 (2.6%)	51±0.00	51.00
No impairment (53-66)	0 (0%)	-	-
Total	38 (100%)	29.29±13.63	29.29, 51.00

FMA-UE: Fugl-Meyer Assessment-Upper Extremity; SD: standard deviation; CI: confident interval.

Table 4 The level of activity limitation of UE according to SWMFT-C based on FMA-UE of participants with chronic stroke participated in the study evaluated UE motor impairment and activity limitation (n = 38).

Severity of activity limitation of UE (according to FMA-UE)	Number of participants (%)	Performance time (s)		Functional ability scale	
		Mean±SD	95% CI	Mean±SD	95% CI
Full impairment (0-22)	12 (31.6%)	14.92±4.69	8.43, 24.24	1.32±0.68	0.58, 2.33
Severe impairment (23-31)	6 (15.8%)	6.96±2.39	4.67, 11.44	2.67±0.21	2.33, 2.83
Moderate impairment (32-47)	19 (50%)	3.24±1.46	1.73, 8.10	3.36±0.46	2.67, 4.00
Mild impairment (48-52)	1 (2.6%)	3.21±0.00	3.21	4.17±0.00	4.17
No impairment (53-66)	0 (0%)	-	-	-	-
Total	38 (100%)	7.52±6.00	1.73, 24.24	2.63±1.07	0.58, 4.17

FMA-UE: Fugl-Meyer Assessment-Upper Extremity; SWMFT-C: Streamlined Wolf Motor Function Test for chronic stroke; SD: standard deviation; CI: confident interval.

3.3.2 Activity limitation of upper extremity according to SWMFT-C

Activity limitations of UE according to SWMFT-C of patients are described in Table 5. The mean performance time (s) were 7.52 (SD 6.00) seconds and the mean FAS was 2.70 (SD 1.12).

Table 5 Activity limitation of UE according to SWMFT-C of participants with chronic stroke participated in the study evaluated UE motor impairment and activity limitation (n = 38).

SWMFT-C items	Performance time (s)		Functional ability scale	
	Mean (SD)	95% CI	Mean (SD)	95% CI
Extend elbow	5.14 (4.20)	3.76, 6.52	2.77 (0.95)	2.46, 3.09
Hand to box (front)	3.01 (3.17)	1.97, 4.06	2.96 (1.07)	2.61, 3.31
Lift can	6.41 (6.82)	4.17, 8.66	2.51 (1.29)	2.09, 2.94
Lift pencil	4.89 (5.82)	2.98, 6.80	2.54 (1.32)	2.11, 2.97
Turn key	11.72 (13.24)	7.37, 16.07	2.65 (1.33)	2.21, 3.08
Fold towel	13.92 (9.82)	10.70, 17.15	2.34 (0.99)	2.02, 2.67
Average score	7.52 (6.00)	5.54, 9.49	2.70 (1.12)	2.28, 2.98

SWMFT-C: Streamlined Wolf Motor Function Test for chronic stroke; SD: standard deviation; CI: confident interval.

4. Discussions

The present study aimed to assess the proportion of the motor impairment and activity limitation of UE in patients with chronic stroke and to find out the correlation of the two outcomes. The patients were assessed for the motor impairment of UE by FMA-UE and their activity limitations by SWMFT-C. The result of the study showed that patients in this study who had a severe impairment of their UE functions constituted the third largest category and they could perform their functional activities with the assistance of the unaffected UE or their caregivers. The majority of patients had a moderate impairment of their UE functions performing their functional activities with some degrees of synergy. There were excellent correlations between FMA-UE and SWMFT-C.

The current study showed that the whole 38 patients are impaired in their UE motor functions that is FMA-UE score ranged from 7 to 51. Impairment of UE was defined as the motor recovery of FMA-UE score of 0 to 52 which were between full, and mild impairment [23]. There was no patient with no impairment in FMA-UE.

In this study, the majority of the patients (50%) had moderate impairment with a mean FMA-UE score of 39.89 (4.77). This is similar to the result of Hijikata and coworkers (2020). The second largest group included the patients with full impairment (31.6%) whose mean score was 12.25 (5.01). The third represented the patients with severe impairment (15.8%) whose mean score of 26.17 (2.79). The finding of a previous study stated the majority of the patients had severe impairment with a mean FMA-UE score of 27.9 [26]. The remaining category was one patient with mild impairment (2.6%) and the FMA-UE score was 51. This result is comparable to the

study which found that patients in the non-severe group were minor with a mean FMA-UE score of 54.6 [26]. The current study is different from the study of Faria-Fortini and colleagues, and they categorized with different ranging of FMA-UE scores. In their study, the majority of patients were those with mild impairment (60%) assessed by FMA-UE score between 50 and 65, followed by patients with moderate impairment (27%) with a score between 30 and 49, and the last group was patients with severe impairment (13%) whose FMA-UE score was below 30 [27]. This is because the chronicity and rehabilitation therapeutics are different between the previous studies and the current study.

The present findings suggested that the patients with chronic stroke had moderate to severe motor impairment. The two most difficult items of FMA-UE are hand movements using digits (e.g., lateral prehension grasp and palmar prehension grasp) rather than grasp using a whole hand such as cylindrical and spherical grasp and these results were in line with the previous study, regardless of stroke chronicity [18]. One reason is the reduced interhemispheric connectivity between the contra lesional primary motor cortex and the anterior intraparietal cortex affects grasping which requires higher visuospatial and sensorimotor demands. Additionally, the recovery of the more proximal shoulder/elbow movement components of the reach task is correlated with motor recovery and contra lesional activation [28].

Another difficulty was finger mass extension that occurred in cylindrical and spherical grasp in the present study. This was because the ability to extend fingers requires sufficient grip aperture for grasping an object. These movements are difficult for patients with moderate and severe impairments. Other items such as volitional movement within synergies, movement combining synergies, and movement out of synergies could be performed by patients with moderate impairment and mild impairment. The patients with full impairment had shoulder subluxation, severe spastic arm, and hand that were unable to perform the movements, UE extensor muscle wasting, and flexion contractures around elbow and wrist joints. These findings were comparable with previous studies that patients with chronic stroke may have increased muscle tone and shoulder joint disorder [12, 15].

The activity limitations of UE were assessed using SWMFT-C in this study. Among 6 items of the SWMFT-C performance time (s), folding the towel was the most difficult to perform because it took the longest time with the mean score of 13.92 seconds (SD 9.82 seconds) and it took the patients the longest time to reach the towel and fold it properly. Another item to take the second longest time was turning the key with a mean score of 11.72 seconds (SD 13.24 seconds) because the patients used more effort to hold the key and turn it in the correct direction. The finding of the current study is different from the previous studies, whereby the most difficult item was turning the key with a mean score of 55.98 seconds (SD 55.78 seconds) in one study [16] and 79.50 seconds (55.24 seconds) in another study [17]. The easiest task was placing hand to box (front) because the patients took the shortest time to complete the task with a mean score of 3.01 seconds (SD 3.17 seconds) and they could maintain their trunk in the upright position and their chronicity enabled them to complete the task. This study result was similar to the previous study; the easiest task was placing hand to box (front) with a mean score of 44.74 seconds (SD 56.88 seconds) [16]. However, the result is different from another study in which the easiest task was extending the elbow with a mean score of 54.07 seconds (SD 59.64 seconds) [17].

In FAS, only folding the towel with the mean score of 2.34 (SD 0.99) was the most difficult task for the patients to perform while the other items were the same difficulty for them to perform. Therefore, it can be proven that the patients were able to fold towel with the help of another person or their unaffected UE. And then, they could perform the remaining five tasks with some degree of synergy or slowly or with effort. The current study is different from the previous studies; the most difficult FAS item was to extend the elbow with a mean score of 1.99 (SD 1.58) in the previous study [16] and to turn the key with a mean score of 1.38 (SD 1.51) in another study [17]. The easiest FAS task in both studies was placing hand to box (front) with mean scores of 2.40 (SD 1.66) and 2.02 (SD 1.58) respectively [16, 17].

In this study, patients with full impairment spent the longest time to complete the SWMFT-C performance time tasks with a mean of 14.92 seconds (SD 4.69 seconds) and their mean FAS score was 1.32 (SD 0.68), indicating their affected UE movements were unable to participate functionally. Those with severe impairment took the mean of 6.96 seconds (SD 2.39 seconds) to establish performance time (s) and their mean FAS score was 2.67 (SD 0.21). It could be explained that those patients with severe impairment required assistance of the UE not being tested for minor readjustments or changed of position, or required more than 2 attempts to complete, or accomplished very slowly. In bilateral tasks, the UE being tested might serve only as a helper. Those patients with moderate impairment and mild impairment took the least time in performance time tasks (mean scores of 3.24 seconds and 3.21 seconds, respectively). And, the mean FAS score of those patients with moderate impairment was 3.36 indicating that they could perform their activities with some degrees of synergies or their activities were slow or required effort. The mean FAS score of the patient with mild impairment was 4.17 indicating that the activity performance became close to normal with slow movements, and fine

coordination or fluidity was needed during tasking. The current study is the first research that interprets the levels of activity limitation in relation to motor impairment.

This study had limitations. First, the cut-off values of severity for the FMA-UE and SWMFT-C were not established. Further work is needed to find out the optimal cut-off scores for the FMA-UE and SWMFT-C with regard to predicting different UE impairment categories for patients with acute and subacute stroke. Second, the participants were recruited in a single hospital and the clinical characteristics of patients according to the institution affect the generalization of the results. Therefore, multi-center assessments with more samples should be warranted to generalize large representations of patients with stroke. Third, in this study, patients with more severe cognitive impairment were excluded which prevents the generalization of these results. Further stu dies should be implemented across the stroke population representing different cognitive levels and a broader range of stroke severity, type and location. Finally, the researcher did not utilize any sampling method in recruiting the patients. In order to generate a representative sample that can be generalized to the population, more research is required and the patients will need to be recruited using appropriate sampling techniques.

The clinical implication of these standardized outcome measurements should be advised to national policymakers from rehabilitation fields. In stroke units, rehabilitation centers, hospitals, outpatient centers and private practices, clinicians should be provided with educational programs and assessment training. They can assess using these outcome measurements to patients with chronic poststroke and record the data for rehabilitation and research purposes as these outcomes had not been widely used in Myanmar.

5. Conclusions

The FMA-UE is commonly used in stroke rehabilitation to assess therapy-induced motor improvements and meaningful arm-hand capacity changes that involves investigating enhanced dexterity, strength, range of motion, and coordination, crucial for improved function. The SWMFT-C distinguishes post-stroke functional performance levels, reflecting motor ability progress in recovery. The patients with severe impairment of motor impairment and activity limitation in UE were the third largest group of patients in this study meanwhile the majority of the patients were at moderate impairment. The second largest group of patients were having full impairment. For the subsequent strategy, it is valuable to develop specific rehabilitation programs based on the different categories of the results from this study.

6. Ethical approvals

The study was approved by the Research Ethics Committee of the Center for Ethic in Human Research, Khon Kaen University with the approval number HE 652135 and the Institutional Review Board of the University of Medical Technology (IRB/UMTY/2-2022/002), Myanmar for human research and informed consent was obtained from all the patients recruited to the study.

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8. Conflicts of interest

The author declares that they have no conflict of interest.

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