ORIGINAL ARTICLE

# Functionality among stroke survivors with upper limb impairment attending community-based rehabilitation

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**ABSTRACT**

**Introduction: There is scarcity of research information on upper limb (UL) functionality among Malaysian post-stroke population despite the increasing number of stroke survivors. This study intends to evaluate functionality among stroke survivors residing in the community, with a specific focus on the UL.**

**Methods: This cross-sectional study involved 65 stroke survivors with UL dysfunction (mean (SD) age = 64.83 (8.05) years, mean (SD) post-stroke duration 41.62 (35.24) months) who attended community-based rehabilitation program. Upper limb functionality was assessed using the UL items of Stroke Specific Quality of Life Scale (SSQOL), the Lawton Instrumental Activities of Daily Living (IADL) Scale and the Jebsen-Taylor Hand Function Test (JTHFT). The stroke survivors' performance in completing JTHFT using their affected dominant hand was compared with standard norms.**

**Results: The three most affected UL daily living tasks were writing (64.7%, n=42), opening a jar (63.1%, n=41) and putting on socks (58.5%, n=38). As for IADL, the mean (SD) score of Lawton scale was 3.26 (2.41), with more than 50% unable to handle finance, do the laundry and prepare meals for themselves. Performances of stroke survivors were much slower than normal population in all tasks of JTHFT ($p<0.05$), with largest speed difference demonstrated for 'stacking objects' task (mean difference 43.24 secs ($p=0.003$) and 24.57 ($p<0.001$) in males and females, respectively.**

**Conclusion: UL functions are significantly impaired among stroke survivors despite undergoing rehabilitation. Rehabilitation professionals should prioritize highly problematic tasks when retraining UL for greater post-stroke functionality.**

**KEY WORDS:**
*Functionality, upper limb, stroke, rehabilitation*

## INTRODUCTION

Stroke is a major health problem worldwide.[1] The disease currently ranks third as the largest contributors to disability-adjusted life years (DALYs) as highlighted in the Global Burden of Disease study in 2013.[2,3] In general, about three-quarter of stroke survivors remain disabled at many years post-onset.[4] Upper limb (UL) dysfunction is the most common disabling deficit following stroke.[5] About 55 to 75% of stroke survivors were unable to use their affected hand for many months post-stroke, and this residual arm dysfunction may cause dependency in performing functional daily living activities, which consequently lead to reduced quality of life among the survivors.[6,7]

Functional daily living activities can be divided into two types namely basic activities of daily living (BADL) and instrumental activities of daily living (IADL).[8] BADL includes basic self-care tasks, such as grooming, bathing, feeding and dressing, and other daily activities such as ambulating, transferring and communicating.[9] Reports documents that more than 50% of stroke survivors still require mild to moderate assistance in bathing, dressing and ascending/descending stairs for many months post-stroke.[10] It was also reported that at six years post-stroke, about 61% of survivors were dependent in some BADL skills notably dressing, transferring and outdoor walking which require mobility and dexterity.[11] A large study of 434 Canadian stroke survivors by Mayo and colleagues found significant limitation in recreational and occupational activities (53%), travel ability (50%) and household task performance (51%) at six months post-stroke.[12] Past studies focused on overall ADL activities which require both UL and lower limb function, and did not report on specific UL function in their assessment of post-stroke ADL activities.

Meanwhile, IADL involves more complex tasks which require a certain level of cognitive skills for the tasks completion.[13] Writing, cooking, managing finance, cleaning, shopping, doing laundry, using telephone, and using transportation services are some examples of IADL task.[9] Limitation in IADL skills indicates decrease in functional competency, and is likely to influence community participation and wellbeing.[14] Stroke survivors who have greater IADL skills are more likely to be active and have better quality of life.[10]

Past studies have shown that majority of stroke survivors require full assistance in a number of IADL tasks.[10,15,16] Doing laundry and shopping were reported as two most disabling activities affecting more than 80% of stroke survivors[10,15], while other problematic tasks include meal preparation and

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**Table I: Scores of the upper limb items of Stroke Specific Quality of Life Scale (N=65)**

| | Score 1 (Couldn't do it) n (%) | Score 2 (A lot of trouble) n (%) | Score 3 (Some trouble) n (%) | Score 4 (A little trouble) n (%) | Score 5 (No trouble at all) n (%) |
|---|---|---|---|---|---|
| Writing/ typing | 18 (27.7) | 12 (18.5) | 12 (18.5) | 14 (21.5) | 9 (13.8) |
| Putting on socks | 7 (10.8) | 14 (21.5) | 17 (26.2) | 18 (27.7) | 9 (13.8) |
| Buttoning | 5 (7.7) | 11 (16.9) | 19 (29.2) | 19 (29.2) | 11 (16.9) |
| Zipping | 3 (4.6) | 12 (18.5) | 13 (20.0) | 20 (30.8) | 17 (26.2) |
| Opening a jar | 1 (1.5) | 12 (18.5) | 29 (44.6) | 16 (24.6) | 7 (10.8) |

**Table II: Instrumental Activities of Daily Living skills performance among participants (N=65)**

| Skill | Description | Score | n(%) |
|---|---|---|---|
| Ability to use telephone | Operates telephone on own initiative; looks up and dials numbers | 1 | 45(69.2) |
| | Dials a few well-known numbers | 1 | 3(4.6) |
| | Answers telephone, but does not dial | 1 | 10(15.4) |
| | Does not use telephone at all | 0 | 7(10.8) |
| Shopping | Takes care of all shopping needs independently | 1 | 11(16.9) |
| | Shops independently for small purchases | 0 | 3(4.6) |
| | Needs to be accompanied on any shopping trip | 0 | 27(41.5) |
| | Completely unable to shop | 0 | 24(36.9) |
| Food preparation | Plans, prepares, and serves adequate meals independently | 1 | 14(21.5) |
| | Prepares adequate meals if supplied with ingredients | 0 | 8(12.3) |
| | Heats and serves prepared meals or prepares meals but does not maintain adequate diet | 0 | 10(15.4) |
| | Needs to have meals prepared and served | 0 | 33(50.8) |
| Housekeeping | Maintains house alone with occasional assistance (heavy work) | 1 | 8(12.3) |
| | Performs light daily tasks such as dishwashing, bed making | 1 | 3(4.6) |
| | Performs light daily tasks, but cannot maintain acceptable level of cleanliness | 1 | 11(16.9) |
| | Needs help with all home maintenance tasks | 1 | 11(16.9) |
| | Does not participate in any housekeeping tasks | 0 | 32(49.2) |
| Laundry | Does personal laundry completely | 1 | 16(24.6) |
| | Launders small items, rinses socks, etc., | 1 | 8(12.3) |
| | All laundry must be done by others | 0 | 41(63.1) |
| Mode of transportation | Travels independently on public transportation or drives own car | 1 | 14(21.5) |
| | Arranges own travel via taxi, but does not otherwise use public transportation | 1 | 3(4.6) |
| | Travels on public transportation when assisted or accompanied by another | 1 | 12(18.5) |
| | Travel limited to taxi or automobile with other's assistance | 0 | 23(35.4) |
| | Does not travel at all | 0 | 13(20.0) |
| Responsibility for own medications | Is responsible for taking medication in correct dosages at correct time | 1 | 30(46.2) |
| | Takes responsibility if medication is prepared in advance in separate dosages | 0 | 18(27.7) |
| | Is not capable of dispensing own medication | 0 | 17(26.2) |
| Ability to handle finances | Manages financial matters independently (budgets, pays rent and bills, goes to bank); collects and keeps track of income | 1 | 15(23.1) |
| | Manages day-to-day purchases, but needs help with banking, major purchases, etc | 1 | 8(12.3) |
| | Incapable of handling money | 0 | 42(64.6) |

**Table III: Comparison of time taken to complete JTHFT tasks between the participants with dominant hand affected and standard norm according to gender (N=37)**

| Task | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Time taken to complete (seconds) | | | Time taken to complete (seconds) | | |
| | Participants' Mean (SD) | Standard norm Mean (SD)* | Mean difference, (p) | Participants' Mean (SD) | Standard norm Mean (SD)* | Mean difference, (p) |
| Writing | 61.85 (37.36) | 19.50 (7.50) | 42.35 (0.039) | 33.39 (10.08) | 15.70 (4.70) | 17.69 (0.039) |
| Turning over cards | 23.84 (12.46) | 5.30 (1.60) | 18.54 (0.001) | 12.78 (5.99) | 4.90 (1.20) | 7.88 (0.004) |
| Picking up small objects | 36.74 (31.53) | 6.80 (1.20) | 29.94 (0.015) | 14.28 (6.30) | 6.60 (1.30) | 7.68 (0.006) |
| Feeding | 44.67 (25.34) | 6.90 (0.90) | 37.78 (0.001) | 19.11 (6.04) | 6.80 (1.10) | 12.31 (<0.001) |
| Stacking objects | 47.04 (24.36) | 3.80 (0.70) | 43.24 (0.003) | 28.17 (12.10) | 3.60 (0.60) | 24.57 (<0.001) |
| Picking up large light objects | 9.81 (3.09) | 3.60 (0.70) | 6.21 (<0.001) | 8.57 (3.30) | 3.50 (0.60) | 5.07 (0.002) |
| Picking up large heavy objects | 11.40 (4.76) | 3.50 (0.70) | 7.80 (0.001) | 9.91 (6.17) | 3.50 (0.60) | 6.41 (0.014) |

*data of age group '60 and above' (Jebsen et al.,1969)

housekeeping, which affect between 70 to 77 % of the survivors.[10] In another study, as much as 40.6% of stroke survivors were reported as having difficulties in managing medication, carrying out administrative tasks, and walking from room to room.[16]

In Malaysia, little is known about functionality level of stroke survivors despite the increasing number of survivors with post-stroke disability which also involve the UL.[17] A few past studies involving Malaysian stroke population reported functional limitations among the survivors following stroke onset. However, these studies did not include UL in their investigations.[18-23] Research data on UL functionality is important to enable rehabilitation professionals to design effective UL retraining program. Therefore, this study aims to determine functionality level among stroke survivors residing in the community, with a specific focus on the UL.

## MATERIALS AND METHODS

*Study design and setting*

This was a cross-sectional study which was conducted at three stroke rehabilitation centres in Kuala Lumpur, the states of Melaka and Perak in Malaysia. The three centres are among the main rehabilitation facilities dedicated for stroke in the Malaysian community and run on a five days per week basis. The study was approved by the Research and Ethics Committee of Universiti Kebangsaan Malaysia (study code: UKM 1.5.3.5/244/NN-043-2015).

*Participants*

Participants for the study were selected using a purposive sampling method. All stroke survivors attending rehabilitation sessions at the three rehabilitation centres were approached and screened for eligibility. Clinically diagnosed stroke survivors who were in sub-acute (3-6 months) or chronic phase (>6 months) post-stroke, age between 18-79 years, experiencing mild to moderately severe post-stroke disability score 2-4 as measured using modified Rankin scale (mRs) and having UL dysfunction following stroke as measured using Quick Disability of Arm, Shoulder and Hand (DASH) (score ≥2) were considered eligible for participation. Those excluded from the study were stroke survivors who have clinically recorded dementia or cognitive impairment as shown on mini mental state examination (MMSE, score ≤18); major illnesses or injury requiring hospital admission such as cardiac disease or fracture in the past six months; impaired UL function due to other conditions such as recent fracture, severe arthritis or other neurological disease such as polyneuropathy; 'flail arm' demonstrated by severe hypotonia and absence of muscle contraction ('grade 0') in the affected UL and post-stroke neuralgia or hyperesthesia affecting the UL.

*Measurements*

UL functionality was measured by using the UL function items of Stroke Specific Quality of life (SSQOL) scale, Lawton Instrumental Activities of Daily Living (IADL) Scale and Jebsen-Taylor hand function test (JTHFT).

UL function items in SSQOL questionnaire assess the level of difficulties in performing five common daily living activities namely writing, putting on socks, buttoning, zipping and opening jars.[24] Each item was ranked using a 5-point Likert scale ranging from 'unable to do at all (score 1)' to 'no difficulty at all (score 5)', with higher scores indicate better function.[24]

The Lawton IADL scale demonstrates level of independence in living skills involving the use of instruments.[9] The scale has eight items of function which mostly involve the UL, namely using the telephone, shopping, doing laundry, ability to travel, preparing food, doing household chores, handling own medication and handling finance. Each item was scored either 1 or 0 which the total score 0 indicates total dependence or poor skills and total score of eight indicates complete independence.[9] JTHFT provides an objective assessment of common hand functional tasks which involve manipulation and dexterity.[25] It is composed of seven items namely writing a sentence, turning over cards, picking up small objects and placing them in a can, picking up small objects with a teaspoon and placing them in a can (mimicking a feeding function), stacking objects, moving large light cans, and moving heavy cans.[25] Participants were asked to use their dominant hand and time taken to complete each item was recorded. The maximum allowed time to complete each task was 120 seconds and normative data by gender and five age groups (20-29, 30-39, 40-49, 50-59 and ≥60 years) is available for comparison of performance.[25,26]

All the measures are valid and reliable for the use in persons with post-stroke hemiparesis.[9,24-26] All measurements were carried out by a physiotherapist who was trained to use the measures. Participants were first guided to complete SSQOL questionnaire, following which IADL scale was administered. Participants with dominant hand affected were then further assessed for specific hand function tasks using JTHFT. The total time taken to complete all assessments on a participant ranged between 30 to 45 minutes; rests was given in between measures.

*Statistical Analysis*

Data were analysed using statistical package for social sciences (IBM-SPSS) version 22.0. Categorical data were presented as frequencies and percentages while scores for all quantitative variables were tabulated as mean (standard deviation) or median (interquartile range). One-samples t-test was used to compare the time taken for stroke survivors to complete JTHFT items with the standard norms according to gender and matched age group.[26]

## RESULTS

*Demography and clinical profile of participants*

A total of 131 stroke survivors were screened for eligibility from three stroke community-based rehabilitation centres. Of this, 66 participants were excluded due to cognitive issues, absence of arm disability (Quick DASH score <2) and did not provide consent to participate in this study. Hence the remaining 65 stroke survivors were selected as study participants.

The mean (SD) age of the participants was 64.83 (SD 8.046) years and the distribution of MRS score (n, %) were score 2 (23, 35.4%), score 3 (27, 41.5%) and Score 4 (15, 23.1%). More than half of the participants were males (53.8%, n=35), and of Chinese ethnicity (56.9%, n=37). The mean (SD) post-stroke duration was 41.62 (SD35.24) months, and nearly 45% had ischaemic stroke (n=29) affecting right side of the body (56.9%, n=37). Majority of the participants were right-handed (90.8%, n=59) and their mean (SD) score for Quick DASH was 47.03 (12.56) illustrating moderate disability.

*Score of SSQOL (UL function domains)*
Table I shows the results of SSQOL. Writing is the most problematic task, with a total of 27.7% (n=18) of the participants could not write at all, while another 37% (n=24) had apparent difficulty (some trouble or a lot of trouble) with the task. Other daily tasks that the participants have difficulty with are 'opening a jar' (63.1%, n=41) and 'putting on socks' (58.5%, n=38).

*Score of Lawton IADL*
Majority of the participants reported limitations in various IADL skills, with highest limitation (score 0, unable to perform) perceived in the ability to handle finances (n=42, 64.6%), do laundry (n=41, 63.1%) and prepare meals for own self (n=33, 50.8%) (Table II). The mean (SD) score for Lawton IADL of the participants was 3.25 (SD 2.41) out of 8.

*Score of JTHFT*
Of the 65 participants, 37 (n=57%), mean age 63.86 (8.01) years had their dominant hand affected and were further analysed for UL function using JTHFT. Table III shows the performance of the male and female participants in comparison to healthy population of matched age group (≥60 years) for JTHFT as generated by Jebsen et al.[26] Significant difference is found between the participants' mean score and the standard norm in the time taken to complete all tasks, with largest difference recorded for 'stacking objects' task; mean difference 43.24 secs, p=0.003 in male and mean difference 24.57, p<0.001 in female participants.

## DISCUSSION

The results of this study showed that stroke survivors experience UL functional difficulties in various basic and instrumental activities of daily living. In addition, a significant percentage of the stroke survivors were found to have complete inability to perform several ADL tasks.

Writing is a task which most stroke survivors have difficulty completing as shown by SSQOL and JTHFT results. This finding is comparable with the results of several past studies.[27-29] This result is not surprising given the fact that writing is a complex task which involves many processes such as language processing, spelling, visual perception, visual-spatial orientation for graphic symbols, motor planning, and specific motor control including fine motor movement and precision. A disturbance of any of these processes due to stroke can impair the ability to write.[28-30] Further, writing is influenced by an individual's level of education; individuals with lower education level take longer time to complete a sentence due to the tendency to re-read the phrases as they are writing them.[31]

Stroke survivors in this study face less difficulty with zipping and buttoning tasks; probably due to the increased use of non-affected hand as a compensatory strategy. Past studies have also found that these bimanual movement tasks do not substantially require contribution of the dominant hand compared to unilateral tasks.[32] It is also common for stroke survivors who experience strength reduction and lack of dexterity on the affected hand to use their non-affected limb to engage in daily living activities.33 In the later post-stroke stage, the lack of usage of the affected hand despite having an ability to use is due to learned non-use phenomenon.[33]

Previous studies by Rouillard et al., and Hartman-Maeir et al., have documented that most stroke survivors needed full assistance in some IADL following stroke.[10,15] In these two studies, shopping and doing laundry were IADL skills which perceived as most problematic following stroke, affecting more than 80% of stroke survivors. This was followed by meal preparation (77%) and performing housekeeping tasks (70%).[10,15] The results of this study is similar to these two past studies, and further strengthen the impact of stroke on IADL performance. A recent study which involved 237 stroke survivors reported that low IADL performance may persists for many years post-stroke onset.[34] In this recent study, measurements were done at seven years post-stroke using Frenchay Activities Index. The researchers found work and leisure being the activities with poorest performance and these were associated with cohabitation status and baseline score of mRS.[34]

When compared to the healthy population of similar age group and gender, the stroke survivors in the current study took twice as much time to complete most ADL tasks in the JTHFT, particularly 'stacking objects' task. This result is consistent with the results of a past study of Chinese stroke survivors[27] which showed slower hand function performance in both male and female stroke survivors compared to healthy subjects including the non-affected hand. Another study in the year 2015 also documented lower performance of stroke survivors' hand function when compared with healthy individuals.[35] This study focused on fine motor skills, which were measured using the nine-hole peg test and the box and block test. They found that the stroke patients needed more time to manipulate objects in both tests than the healthy individuals. In this current study, stacking objects is the slowest task to be completed by the stroke survivors in comparison to healthy population. This is due to the nature of the task which required greater hand-eye coordination and spatial accuracy than other tasks; these are commonly affected following stroke.[36]

The poor general performance of UL function among the stroke survivors can be associated with the presence of a set of impairment which normally persist over time. These include paresis, limitation in range of motion, spasticity and altered somato-sensation which usually exist in combination and have been reported to predict upper limb recovery.[37-39] In order to effectively perform ADL, one need a fair degree of effort and environmental interaction in addition to optimum

physical and psychosocial function according to the level of complexity of an ADL task.[13] These pre-requisites are often affected following stroke. As such, in training for ADL and IADL skills to restore upper limb functionality among stroke survivors, therapists need to consider thorough assessment of pre-requisites for each task other than prioritizing tasks to be trained.

This study has several limitations which may affect the applicability of its findings. Selection of participants was not by random sampling method, although this was intended. Together with the small sample size, the study participants could not represent all stroke survivors in Malaysia. About the measurements, there was minimal focus on qualitative description of hand function, such as prehension patterns as well as various grip and grasps ability. Therefore, the overall upper limb functionality could not be described.

## CONCLUSION

Functionality is significantly impaired among stroke survivors with upper limb dysfunction despite undergoing rehabilitation. This involves the basic and instrumental ADL skills performance and speed of movements. Rehabilitation professionals may use this study findings in planning effective therapy for greater post-stroke upper limb recovery. Further studies are needed to evaluate upper limb functionality of stroke survivors in a more detailed manner.

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## CONTRIBUTION BY AUTHORS

NHO conducted the study, analysed the data and drafted the manuscript. NAMN secured funding, advised on the design and data interpretation of the study, and revised the manuscript. CSC assisted in advising the study design and data interpretation. AFAA assisted in participants' selection and recruitment.

## CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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