



Construction of the Mobility to Participation Assessment Scale for Stroke (MPASS) and Testing Its Validity and Reliability in Persons With Stroke in Thailand

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Objectives: This study was conducted to develop the Mobility to Participation Assessment Scale for Stroke (MPASS) and assess its content validity, internal consistency, inter-rater and intra-rater reliability, and convergent validity in people with stroke living in the community.

Methods: The MPASS was developed using published data on mobility-related activity and participation timing in elderly individuals, and then reviewed by community physical therapists. Content validity was established by reaching a consensus of experienced physical therapists in a focus group. The MPASS was scored for 32 participants with stroke (mean age 61.75 ± 4.92 years) by 3 individual testers. Reliability was examined using the intraclass correlation coefficient (ICC), internal consistency using the Cronbach alpha coefficient (α), and convergent validity using the Pearson correlation coefficient (r) to compare the MPASS to the Modified Rivermead Mobility Index as a referent test of mobility.

Results: The MPASS consists of 8 items, and its scoring system provides information on the ability of people with stroke to reach a movement level enabling them to live in society, including interactions with other people and safe living in the community. The inter-rater and intra-rater reliability were excellent (ICC, 0.948; 95% confidence interval [CI], 0.893 to 0.982 and ICC, 0.967; 95% CI, 0.933 to 0.989, respectively). Internal consistency was good ($\alpha=0.877$). The convergent validity was moderate ($r=0.646$; $p<0.001$).

Conclusions: The newly developed MPASS showed acceptable construct validity and high reliability. The MPASS is suitable for use in people with stroke, especially those who have been discharged and live in the community with the ability to initiate sitting.

Key words: Stroke, Patient reported outcome measures, Movement, Locomotion, Motor activity

INTRODUCTION

Stroke is among the leading causes of death and disability in Thailand. The prevalence of stroke is estimated to be 1.88%

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among adults 45 years and older [1]. In Singapore, the stroke prevalence was 7.6%, (95% confidence interval [CI], 6.2 to 9.0) among older adult residents aged 60 years and above, which is relatively high when compared with other Asian countries [2]. After being discharged from the hospital, most stroke survivors return home and live with their families, but often have long-term difficulties with walking and other daily activities [3,4]. Several studies have shown that the mobility and functional dependence of stroke survivors worsened over time [5,6]. With developments in primary health and home care systems, most people with stroke are allowed to stay in the hospital for only a short period. Therefore, increasingly many

patients will directly return to their homes and communities faster. Regarding this shift in service delivery, the key role of community physical therapy (PT) in stroke rehabilitation will be increasingly emphasized. The goals of community PT for people after stroke are promoting self-care and functional independence, training disabled people to move around, and optimizing patients' participation in society [7,8]. Regaining community mobility is the primary goal for people with stroke during rehabilitation, since it is a key factor in becoming independent in daily functioning [9,10].

In assessing community mobility, different aspects of the environment need to be considered. Patla and Shumway-Cook [11] published a conceptual model outlining 8 dimensions of mobility. In a subsequent study, wherein the mobility in the community of people with disabilities was observed and compared to that of people without disabilities, 4 dimensions were indicated as being important, including terrain (such as stairs, slopes, uneven surfaces, and obstacles), temporal factors (walking speed), postural transitions, and physical loads [9]. Corrigan and McBurney [12] reviewed the assessment tools that are currently used by PTs and found that the most commonly measured dimensions were distance and terrain, while the impact of the environment in current assessment tools is limited in clinical usefulness.

The most common outcome measure for people with stroke utilized in community-based rehabilitation programs in Thailand is the Barthel Index (BI). The BI is designed to assess a patient's ability to perform simple self-care activities. It does not include items for measuring more complex activities related to mobility, which are necessary for an independent lifestyle after stroke in community settings. In addition, the dichotomous scale of the BI reduces outcome information and may limit the scale's ability to detect a significant shift in disability [13,14]. Other assessment scales such as the Motor Assessment Scale, the Rivermead Mobility Index (RMI), and the Functional Independence Measure are also commonly used to assess mobility following stroke [15]. These assessment tools have limitations for use in community settings, such as (1) not covering the environmental dimensions of mobility, (2) focusing on measures in hospital-based care rather than in home or community settings [12,16], and (3) being time-consuming for routine use. The RMI is a tool for assessing mobility in stroke patients in home settings. However, its dichotomous scoring system may limit its applicability in a community setting [17]. Therefore, RMI was modified to extend the scoring system; the

resultant modified Rivermead Mobility Index (MRMI) showed high reliability between raters, with high internal consistency [18]. However, the MRMI was recommended to measure mobility in the acute and sub-acute stroke phase [19], since the MRMI score did not show meaningful changes at 90 days to 180 days after stroke onset [20].

There is a need to develop a scale that is simple but specific and suitable for measuring mobility in the community setting for people with stroke. Furthermore, a new scale should be designed with a detailed scoring system covering a wide spectrum of patients' abilities, ranging from basic sitting to a level of mobility that would allow them to participate in society. Therefore, the aim of this study was to develop the Mobility to Participation Assessment Scale for Stroke (MPASS) and to examine the psychometric properties of the tool, including internal consistency of the items, inter-rater reliability, intra-rater reliability, and convergent validity.

METHODS

This study was performed in 2 phases: development of the MPASS and evaluation of its psychometric properties.

Phase I: Development of the MPASS

The development of the MPASS was partially based on the Consensus-based Standards for the selection of health status Measurement Instruments (COSMIN) guideline [21], because MPASS was intended to be a performance-based outcome measure (i.e., not solely as a patient-reported outcome measure [PROM]); therefore, only some of the COSMIN criteria were applied to develop the MPASS. Following the general design requirements of the COSMIN outcome measure guideline, the construction, target population, and context of use of MPASS were developed, as shown in Table 1.

After laying out the concept of creating the MPASS, we collected the data needed to generate its items. Initial items were chosen by searching for instruments used to assess the mobility of post-stroke patients in the literature, focusing on movement that progressed to participation in society and using a questionnaire to elicit opinions from community PTs on the mobility tasks that are necessary in community settings. The questionnaire was sent to 100 community PTs who were recruited from primary health care units and community hospitals covering all regions of Thailand. For qualitative data obtained through a survey questionnaire, a sample size ≥ 100 is

Table 1. The concept of the MPASS design

MPASS	Details
Constructs	The MPASS was developed to assess the necessary CM in people with stroke; The constructs of CM relate to movements used for various activities that encourage patients to participate socially and interact with other people in a community context
Conceptual framework	The MPASS was developed based on the International Classification of Functioning, Disability, and Health framework, especially for activity and participation, which includes 4 environmental factors related to mobility: terrain, postural transitions, time constraints, and external physical loads; Therefore, a detailed scoring system covered patients' abilities, ranging from basic sitting to a level of mobility that would enable them to participate in society; The score for each item ranges from 0 to 4; a score of 0 means moving with assistance or being dependent, while 4 means being able to move to participate in daily living in a community context with appropriate timing and/or external load
Target population	People with stroke who have been discharged from the hospital back to home and community and have the initial ability to sit; Participants could communicate and had no cognitive impairment, as confirmed using the Thai Mini-Mental State Examination (score ≥ 24)
Context of use	The MPASS was used by community health care personnel to assess people with stroke in a community setting

MPASS, Mobility to Participation Assessment Scale for Stroke; CM, community mobility.

considered very good for general design requirements according to the COSMIN recommendations [21]. The inclusion criteria for community PTs were a minimum of 2 years' experience in community stroke rehabilitation and currently practicing in the field. The data from the questionnaire and the literature review were integrated to develop the first draft of the MPASS.

Next, a focus group that consisted of 5 community PTs and 3 professional experienced PTs was arranged to discuss the content and constructs of the MPASS according to COSMIN. The results and the recommendations from the focus group were used to revise the drafted MPASS. After revision, this scale was sent to the participants in the previous focus group to confirm its relevancy, clarity, and applicability. The content validity of the revised version was determined by 3 PT experts who had at least 5 years of experience using the item-objective congruence (IOC) index. An IOC greater than 0.5 was accepted for the final version.

Phase II: Reliability Testing and Other Psychometric Properties of the MPASS

The main aim of this phase was to examine internal consistency, which is important in multiple-item scales because it indicates whether all items measure a similar construct. Moreover, the inter-rater reliability, intra-rater reliability, and convergent validity were used to study other psychometric properties. This phase was conducted among people with stroke who had been discharged from the hospital. People with stroke were included in the study if they met the following criteria: (1) diagnosis of stroke, (2) first onset of stroke and the absence of pre-existing disability, (3) a BI ≥ 40 , (4) ability to follow instructions as screened by a score ≥ 24 on the Thai Mini-Mental State Examination, (5) a medically stable condition, and (6) willingness to participate in this study.

The sample size calculation for this study was based on a power of 0.80 and alpha level of 0.05. This study aimed to develop a new scale; thus, the expected correlation coefficient (r) for the new scale was set at 0.80, which represented an acceptable correlation, whereas the r -value for the null hypothesis was set to be at least 0.5, representing an adequate correlation. The sample size for reliability and validity testing in this study was determined to be at least 29 participants. The drop-out rate was calculated at 10%. Therefore, a sample size of 32 was selected.

The procedure of evaluating inter-rater and intra-rater reliability [22,23] was determined by 3 PTs who were recruited from community settings. The raters were recruited based on the following inclusion criteria: (1) a minimum of 2 years' experience in community stroke rehabilitation and (2) currently practicing in the field. Prior to the study, all raters were provided with a copy of the criteria for scoring and general rules and given a period of 2 weeks to practice using the MPASS. After the practice period, the raters were asked to use the MPASS to score each patient's performance based on videotapes. During the rating session, the raters were unaware of each other's scores, and they were not allowed to discuss the patient's performance. The data were used to analyze inter-rater reliability by comparing the MPASS score assigned by all raters for each patient. One week later, the videotaped MPASS assessments were shown to the raters, who rated the patients again to determine intra-rater reliability.

Convergent validity was determined by the same 3 raters. All raters scored the patients with stroke performance using the MPASS and the MRMI. The MRMI, which uses the same constructs as the MPASS to measure disability related to mobility, showed acceptable levels of reliability, validity, and responsiveness in people with stroke. It consists of 8 items: turning

over, lying to sitting, sitting balance, sitting to standing, standing, transfers, walking indoors, and stairs. The scores of the MRMI range from 0 to 5, indicating functional ability on a spectrum from unable to perform to requiring assistance and independent [18]. The scores of the MPASS and MRMI were used to analyze convergent validity by examining the relationship between the total scores of both scales.

Statistical Analysis

Internal consistency was analyzed using the item-total correlation and the Cronbach alpha coefficient. The item-total correlation represents the correlation between each item and the entire score of MPASS. The corrected item-total correlation ranges from -1.00 to +1.00, and a value of +0.30 or more represents a good correlation [24]. The Cronbach alpha is generally considered acceptable if it is greater than 0.7 and good if it is greater than 0.8 [22].

The intraclass correlation coefficient (ICC) was used to analyze inter-rater and intra-rater reliability. The ICC model (2, 1) was used to compute the inter-rater reliability and the ICC model (3, 1) was used to compute the intra-rater reliability. ICC values of 0.8 and above indicate an excellent correlation (good reliability), values of 0.6-0.8 indicate an adequate correlation (moderate reliability), and values of 0.4-0.6 indicate a poor correlation (weak reliability). Finally, convergent validity was analyzed using the Spearman rank-order correlation coefficient, with values of 0.80 or greater indicating an excellent correlation, 0.50 to 0.79 indicating a moderate correlation, and 0.00 to 0.49 indicating a poor correlation [22].

Ethics Statement

The study was approved by the Ethics Committee of the Physical Therapy Faculty, Srinakharinwirot University, Thailand (HSPT2014-007), and the participants provided written informed consent.

RESULTS

Phase I: Development of the MPASS

Eighty-one out of 100 community PTs (81.0%) completed the questionnaire. They reported that sitting was the most frequently identified ability found in community-dwelling people with stroke at their first visit (46.9%). Therefore, the MPASS was designed to start from the sitting position. Consensus from the focus group of 8 participants together, with the results from questionnaires, reduced the number evaluated items from 14 to 8. The revised scale was sent to the participants in the focus group to confirm its relevancy, clarity, and applicability. The content validity of the revised version showed that the content of the MPASS was acceptable, as represented by an IOC for each item greater than 0.50 (range, 0.67-1.00). The 8 items of the final version and the maximal score description for each item are shown in Table 2. Each item is scored 0-4, and the total score of the MPASS is 32. The scoring descriptors of MPASS are as follows: 0 means moving with assistance or being dependent, 1 means being able to move independently, 2 means able to move independently in a suitable time, 3 means being able to move independently in a suitable time when changing posture, and 4 means being able to move independently to participate in daily living in a suitable time.

Table 2. Maximal score descriptions of MPASS items related to environmental factors

Item	Environmental factors related to community mobility	Maximal score descriptions
1. Sitting	Postural transition	Able to sit and reach forward to others
2. Moving up/down into or from a chair	Postural transition	Able to stand up and sit down 5 times within <12 sec
3. Standing	Postural transition	Able to stand and bend over to pick up / deliver things to others
4. Stepping over an obstacle	Terrain	Able to overcome an obstacle and stepping over it with one leg and continuing to walk
5. Walking speed on the ground	Terrain and time constraint	Able to walk at a speed >1.2 m/sec
6. Walking while talking	Attentional demand	Able to walk and talk at a speed >1.2 m/sec
7. Walking while carrying objects	External physical load and attentional demand	Able to walk and carry objects weighin 1 kg without stopping for at least 14 sec
8. Moving up/down stairs	Terrain	Able to walk up and down 4 steps for 3 rounds without holding onto a rail

MPASS, Mobility to Participation Assessment Scale for Stroke.

Table 3. Item-total statistics and Cronbach alpha of the MPASS

Items	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach alpha if item deleted
Item 1	15.3000	8.678	0.818	-	0.845
Item 2	16.2000	9.956	0.408	-	0.883
Item 3	16.1000	8.544	0.673	-	0.859
Item 4	16.7000	8.011	0.627	-	0.871
Item 5	16.9000	9.211	0.699	-	0.858
Item 6	17.0000	10.222	0.549	-	0.875
Item 7	16.8000	7.733	0.769	-	0.848
Item 8	17.3000	8.900	0.736	-	0.854
Cronbach's alpha					0.877

MPASS, Mobility to Participation Assessment Scale for Stroke.

Phase II: Reliability Testing and Other Psychometric Properties of the MPASS

Internal consistency

Each item of the MPASS showed a good correlation with the overall score of the MPASS (range, 0.408-0.818). The Cronbach alpha of the MPASS was 0.877, corresponding to good internal consistency, as shown in Table 3.

Reliability

The intra-rater ICC of the overall MPASS was 0.967 (95% CI, 0.933 to 0.989), and the item-level ICCs ranged from 0.962 to 1.000. The inter-rater ICC of the overall MPASS was 0.948 (95% CI, 0.893 to 0.982), and the item-level ICCs ranged from 0.948 to 1.000, as shown in Table 4.

Convergent validity

The convergent validity of the MPASS was analyzed using the correlation of the total score of MPASS with the MRMI, which was assessed in 32 people with stroke. The average score of the MPASS was 20.24 ± 3.09 out of a total score of 32, and the average score of the MRMI was 37.70 ± 1.51 out of a total score of 40. The correlation coefficient between the MPASS and MRMI was 0.646 ($p < 0.001$), indicating moderate convergent validity.

DISCUSSION

This study was conducted to develop the MPASS to assess mobility in people with stroke who are living in the community. The MPASS was partially developed based on the COSMIN Risk of Bias guideline for evaluating the methodological quali-

Table 4. Reliability of the MPASS

Items	Intra-rater reliability			Inter-rater reliability		
	ICC (3, 3)	95% CI		ICC (2, 3)	95% CI	
		UL	LL		UL	LL
Item 1	0.988	0.973	0.996	1.000	1.000	1.000
Item 2	0.962	0.914	0.987	1.000	1.000	1.000
Item 3	1.000	1.000	1.000	1.000	1.000	1.000
Item 4	0.963	0.918	0.988	0.915	0.774	0.973
Item 5	1.000	1.000	1.000	1.000	1.000	1.000
Item 6	1.000	1.000	1.000	1.000	1.000	1.000
Item 7	0.965	0.921	0.988	0.979	0.946	0.994
Item 8	0.962	0.914	0.987	1.000	1.000	1.000
Total	0.967	0.933	0.989	0.948	0.893	0.982

MPASS, Mobility to Participation Assessment Scale for Stroke; ICC, intra-class correlation coefficient; UL, upper limit; LL, lower limit.

ty of measurement properties [21]. The MPASS development followed the 3-step procedure of the COSMIN checklist: content validity, internal structure, and remaining measurement properties. The COSMIN checklist was developed to assess the methodological quality of PROMs. A PROM is a measurement of any aspect of a patient's health status that is directly assessed by the patient. Modes of data collection for PROM instruments include interviewer-administered, self-administered, and computer-administered instruments. However, the MPASS is a performance-based measure that assesses actual performance in a particular environment at a specific point in time; therefore, some COSMIN checklist items were not applied in the MPASS development process.

The MPASS was developed based on the concepts of activity and participation according to the World Health Organization International Classification of Functioning, Disability, and Health framework, corresponding to the environmental factors related to mobility concepts reported by Shumway-Cook et al. [9]. The 4 dimensions of environmental factors that affect a person with stroke include time constraints, as assessed in terms of walking speed (MPASS item 5); terrain characteristics with different geometric properties such as steps (MPASS items 4 and 8); external physical loads such as objects that are carried (MPASS item 7); and postural transitions such as changes in position or direction (MPASS items 1-3). Moreover, the attentional demand dimension of environmental factors, such as walking with distractions (MPASS item 6), was added to clinical usefulness as an indicator of fall risk in identifying the community-dwelling people with stroke who are most at risk of falls and in need of therapeutic intervention [25,26]. The MPASS

was designed to have a scoring system that covers a wide spectrum of patients' abilities, ranging from basic sitting to a level of mobility that enables them to participate in society. A high score indicates that a person with stroke is able to move sufficiently to participate in daily living in a community context with appropriate time and/or external loads. This scale differs from previous scales that only assess the ability to move (i.e., whether a person can or cannot perform a given movement).

The ability to integrate walking with other tasks in a complex environment (i.e., community ambulation) is an important goal for people with stroke [12,27]. The recovery of walking ability in the community has most often been studied among patients after stroke, and the inability to leave one's home and reduced levels of community walking have been linked to poorer quality of life in this population [27]. In 2005, Viosca et al. [28] showed that gait recovery mainly occurred in the majority of patients during the first 3 months after stroke, while the functional level improved in 37% of patients after 8 months. Therefore, the MPASS consists of 5 items (62.5%) that mainly assess walking activity consisting of stepping over obstacles, walking with one's preferred speed, walking while talking, walking with carrying objects, and moving up/down stairs. A previous study showed that mobility abilities influenced the physical health component of health-related quality of life (HRQoL), including physical function and general health (HRQoL) [29], and mobility problems were also dimension-specific factors influencing HRQoL in people with stroke, the importance of which increased with old age [30]. Higher levels of mobility and participation in society would lead to better HRQoL [31]. The MPASS could be used to assess patients' mobility and participation level, which may reflect their quality of life. Further research on the association of MPASS with HRQoL will clarify the importance of community mobility levels in people with stroke.

The MPASS showed satisfactory results in terms of intra-rater and inter-rater reliability ($ICC > 0.90$), according to Portney and Watkins [22]' recommendation that the ICC for a clinical measure should exceed 0.90 before the test can be deemed reliable. The moderate convergent validity of the MPASS as compared to the MRMI reflects the use of similar mobility construct outcome measures. Although the MRMI is a measure of the patient's ability to perform an activity independently [18], the MPASS also assesses the quality of the patient's performance related to community mobility. For example, a score of 4 of MPASS item 5 (walking speed on the ground) means walking

at a speed of 1.2 m/sec, which reflects the generally accepted speed of walking across a road [32]. Therefore, the moderate correlation may reflect the similarity of constructs, but not of the scoring system.

The MPASS was found to be suitable for assessing patients in the subacute stage following stroke who initially have the ability to sit. The present study confirmed that the MPASS is reliable, valid, and simple, and even more importantly, that the MPASS targets items that are relevant to the aims of therapists working in community stroke rehabilitation. The MPASS could be used as a specific assessment instrument for community mobility and assistance in rehabilitation management planning. Furthermore, since the MPASS requires no equipment, and the scoring items are relevant to community mobility, it is also simple enough to be used by community health-care personnel.

The main limitation of this study could be the comprehensibility of the MPASS. The MPASS was developed with the aim of being used by PTs or community healthcare workers, but in the initial process of development, community healthcare workers and people with stroke were not included. To further improve the applicability of the MPASS, more stakeholders should be considered. In addition, responsiveness, as well as floor and ceiling effects, should be established to evaluate the degree to which the MPASS can be used to detect changes in people with stroke's performance. Finally, the MPASS was developed in the Thai context. Therefore, cross-culturally appropriate translations of the MPASS would be important for its implementation in a global context.

CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

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AUTHOR CONTRIBUTIONS

Both authors contributed equally to conceiving the study, analyzing the data, and writing this paper.

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