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Research Article

Validity and Reliability of the Thai Version of the Gait Assessment and Intervention Tool (G.A.I.T.)

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Introduction. The Gait Assessment and Intervention Tool (G.A.I.T.) is well-accepted for determining changes in gait quality in neurological patients. This study is aimed at translating the G.A.I.T. to Thai and to examine its validity and reliability. *Methods*. The Thai translation and back-translation into English were done according to international guidelines. Sixty-eight patients with subacute to chronic stroke were recruited. Concurrent validity was determined by the correlation coefficient between the Thai G.A.I.T. scale and a comfortable vs. fast gait speed. The convergent validity was determined by the correlation coefficient between the Thai G.A.I.T. and the lower extremity Motricity Index, the Functional Ambulation Category (FAC), and the National Institutes of Health Stroke Scale (NIHSS). Interrater reliability was assessed using videos of 68 patients analysed by two independent raters. Each rater was randomly assigned to rescore the Thai G.A.I.T. for each patient over at least two weeks to assess intrarater reliability. *Results*. The concurrent validity of the Thai G.A.I.T. vs. the respective comfortable and fast gait speeds was excellent ($R_s = -0.79$ and $R_s = -0.68$, $p < 0.001$). The respective convergent validity with the lower extremity Motricity Index, NIHSS, and FAC was $R_s = -0.62$, 0.57, and -0.51, respectively. The respective inter- and intrarater reliabilities were excellent (ICC = 0.93, 95% CI 0.88-0.96 and 0.95, 95% CI 0.91-0.97). *Conclusion*. A Thai version of the G.A.I.T. was developed, and its validity and reliability for use among patients with subacute to chronic stroke were established. Further work regarding the responsiveness of the tool is needed.

1. Introduction

Stroke is a leading cause of death and disability globally [1] and a major health burden in Thailand. It is estimated that the prevalence of stroke in Thailand is 1.88% among adults over 45 years of age. Stroke incidence is projected to rise because of a growing aging demographic and changes in economics and health needs as the nation transitions from an agricultural to an industrialized society [2]. Stroke can result in muscle weakness and incoordination, as well as balance and sensory impairment that interfere with a normal gait [3–6]. Gait impairment is one of the most common problems in patients after stroke, lowering the quality of life and limiting community engagement [3]. More than one-third of patients who cannot walk by the first week cannot walk independently 12 weeks after stroke [7]. Thus, gait recovery is a primary objective in the rehabilitation of patients after stroke.

The characteristics of gait are used to assess recovery in walking after stroke [8]. Deviations in gait following stroke vary, so quantification of gait patterns may be useful as a guide to treatment planning [9, 10]. Computerized three-dimensional (3D) gait analysis allows objective, quantitative gait assessment, and it is considered the gold standard for analysing gait patterns [11]. Owing to the need for numerous resources—viz., equipment, time, and expertise in data analysis—the use of gait analysis is limited to general clinical practice.

Video gait analysis quantifies gait patterns according to observational gait analysis albeit less detailed than 3D gait analysis. In its favour, video analysis does not require expensive equipment, and it is practical for clinical use. Several tools are used in patients after stroke, including the Wisconsin Gait Scale (WGS) [12], the Ranchos Observational Gait Assessment (OGA) [13], the Gait Abnormality Rating Scale (GARS) [14], the Rivermead Visual Gait Analysis (RVGA) [15], and the Gait Assessment and Intervention Tool (G.A.I.T.) [16]. The Gait Assessment and Intervention Tool (G.A.I.T.) was developed by rehabilitation specialists in 2008 using the modified Delphi technique. It comprises 31 items and its intra- and interrater reliabilities are high [16]. The tool has proven to be more sensitive to changes in gait than the Tinetti Gait Scale (TGS) [14], and—according to a systematic review—G.A.I.T. is appropriate for assessing walking ability in patients after stroke. To this end, G.A.I.T. was found to be valid, reliable, sensitive, and comprehensive enough to evaluate the kinematics of gait pattern [11, 15]. Since there are no gait assessment tools in the Thai language, the aim of the current research was to translate the English version of G.A.I.T. into Thai, then to establish its validity and reliability.

2. Methods

A cross-sectional study was conducted in both the in- and out-patient rehabilitation units of Srinagarind Hospital, Thailand, between October 2017 and March 2019. The study was reviewed and approved by the Khon Kaen University Ethics Committee for Human Research (HE601085). All participants signed informed consent prior to participation.

2.1. Subjects. The eligible population comprised patients with subacute to chronic stroke whether from haemorrhagic or ischemic stroke (more than 3 months after stroke onset). The patient inclusion criteria were (1) ≥18 years of age, (2) able to walk at least 10 m, and (3) able to communicate without problems. The exclusion criteria were (1) severe perceptual or communication problems and/or (2) severe concurrent cardiac or pulmonary disease. In the recruitment process, the study nurse checked the electronic records of stroke patients eligible for the study to verify the dates of their future appointments. When the patients arrived for their routine clinical visit, the nurse described the study to them. For patients who were interested in participating, the nurse provided the study information sheet then later obtained written informed consent.

2.2. Sample Size Calculation. We calculated sample size based on the correlation coefficient for G.A.I.T. and a comfortable gait speed. Assuming an acceptable correlation of 0.6, an alpha value of 0.05, and a power of 80%, the sample size required was equal to $0.5 * \ln [(1+r)(1-r)]$ [16]. The resultant total sample size was 19 patients; however, for interrater reliability, we calculated the sample size based on an R_0 of 0.9, an R_1 of 0.95, an alpha of 0.05, and a power of 90%. The resulting sample size was 68 subjects [17].

2.3. The G.A.I.T. Questionnaire. The G.A.I.T. questionnaire was developed in 2008 using modified Delphi methods [16]. It comprises 3 parts: (1) upper extremity and trunk movement control during both stance and swing phases (4 items: items 1-4), (2) trunk and lower extremities in stance phase (14 items: items 5-18), and (3) trunk and lower extremities in swing phase (13 items: items 19-31). Each item uses a 2-4 scale and involves trunk, hip, knee, ankle, and toe movement during the stance and swing phases [16]. The final score of the questionnaire is the sum of scores for each question. The maximum score is 62, and the minimum score 0 (normal walking).

2.4. Translation of the Original Scale into Thai Language. We were granted permission by the authors of the study [16] to translate the original English G.A.I.T. questionnaire and to do test-retest reliability. Crosscultural adaptations for the health instruments are aimed at encompassing a process that considers both language and cultural adaptations in the process of preparing a tool for use in different contexts [17, 18]. In order to ensure that the language in the tool would be clear and easily understood for the target population and culture, in the translation process, we adhered to the Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcome (PRO) measures [19]. In the first step, the G.A.I.T. questionnaire was translated independently into Thai by two native Thai speakers with good command of the English language. Differences between these two Thai versions were discussed in four committees of physiatrists and physical therapists who work in stroke rehabilitation. In the second step, the final Thai version was back-translated into English by two native English speakers with a good command of the Thai language. Differences between these two English versions were discussed, and the committee group ensured that the Thai version of G.A.I.T. had satisfactory concordance between the Thai and the original English version. In the translation process, there were problems related to the use of Thai or English words for the specific word for the various gait phases; thus, the committee decided to retain the English word for clarity.

The questionnaire was then piloted in 5 videos and the ease of use and understandability of the questionnaire discussed. After pilot testing, there were comments related to the sequence of item scoring. The committee decided to adapt the order of the Thai G.A.I.T. to facilitate the rating process by arranging the items based on the scoring of the coronal and sagittal views. This approach yielded 5 parts: (1) upper extremities and trunk movement control during stance and swing phases (4 items), (2) stance—coronal view (5 items), (3) swing—coronal view (8 items), (4) stance—sagittal view (9 items), and (5) swing—sagittal view (5 items). The final version of the G.A.I.T questionnaire was used after the pilot.

2.5. Procedure. The National Institutes of Health Stroke Scale (NIHSS), Functional Ambulation Category (FAC), lower extremity Motricity Index, and the 10 m walk test were assessed. All clinical tests were done by two physiatrists with more than ten years' experience working with patients post stroke. All patients performed the 10 m walk test five times. One trial test was done to familiarize patients with the procedure. The recorded trials included two at a comfortable gait speed and two at a fast gait speed. During the comfortable gait speed, a video was recorded following the parameters as set out by Daly et al. [16].

2.6. Validation of the Thai Version of G.A.I.T.

2.6.1. Concurrent Validity. Concurrent validity tests were conducted to determine whether the Thai G.A.I.T. correlated with the standard measures of the same concept. Gait speed is considered a cardinal indicator of poststroke gait performance and is considered a standard measure of gait function [8, 20–22]. To date, there has been no validated Thai language gait observation analysis tool for concurrent validity, so comfortable and fast gait speeds were obtained from the 10 m walk test.

2.6.2. Convergent Validity. Convergent validity tests were used to determine whether the theoretical constructs relate to the Thai G.A.I.T. [23]. We hypothesized that the Thai G.A.I.T. would show a relationship with the FAC, the lower extremity Motricity Index, and the NIHSS.

2.6.3. Reliability of the Thai Version of G.A.I.T. Two raters (JS and PS) independently analysed the gait in the video for interrater reliability. As for intrarater reliability, two raters were randomly assigned to watch and score the video again after two weeks.

2.7. Statistical Analysis. Data obtained from the current study were analysed using SPSS version 23.0 (IBM Corp. released 2015; IBM SPSS Statistics for Windows, version 23.0, Armonk, NY: IBM Corp.). Descriptive statistical methods were used to analyse the demographic data. Concurrent and convergent validities of the questionnaire were determined using Spearman's rank test because the data were not normally distributed. A correlation coefficient of $R_s \geq 0.60$ is considered excellent, while a R_s of 0.31-0.59 is considered adequate, while a $R_s \leq 0.30$ is considered poor [24]. The expected concurrent validity for gait speed is a negative correlation. To determine test-retest reliability, the 2-way mixed, absolute agreement, intraclass correlation coefficient (ICC) was used [25]. A value of $0.40 \leq \text{ICC} < 0.75$ is considered fair to good while an $\text{ICC} \geq 0.75$ is considered excellent [24].

3. Results

Eighty-four subjects were eligible for the study, of whom 10 refused to participate and 6 were not recruited because of new onset joint pain and other documented neurological comorbidities that might interfere with gait (i.e., Parkinsonism). Sixty-eight patients with subacute to chronic stroke were enrolled and completed the study (43 males, 25 females). The mean age was 60.2 ± 14.1 (mean ± SD) years. Fifty-three patients (77.6%) had had an ischaemic stroke and 44 (64.7%) experienced left hemiparesis. Most patients were independent or modified independent in walking (66.2%) (Table 1). The mean G.A.I.T. score was 17.7 (range, 0-44). There were no ceiling or floor effects: the lowest and highest possible scores were not achieved by more than 20% of patients; 2.9% of patients had the lowest score, and none of the patients achieved the highest score.

Table 1: Patient demographic data ($n = 68$).

Variable	Value
Sex, male/female, *n* (%)	43 (63.2)/25 (36.8)
Age in y	60.2 (14.1)
Height in cm	161.6 (9.2)
Weight in kg	63.1 (12.3)
BMI in kg/m^2	24.3 (3.7)
Cerebral infarction/cerebral haemorrhage, *n* (%)	53 (77.9)/15 (22.1)
Side of hemiparesis, left/right, *n* (%)	44 (64.7)/24 (35.3)
Time since stroke in months, median (IQR)	90 (490)
Comorbidity, *n* (%)	
(i) Diabetes mellitus	21 (30.9)
(ii) Hypertension	39 (57.4)
(iii) Dyslipidemia	37 (54.4)
NIHSS, median (IQR)	5 (5.0)
Lower extremity Motricity Index	61.0 (26.3)
Gait aid used, *n* (%)	
(i) No gait aids	23 (33.8)
(ii) Single cane	5 (7.4)
(iii) Tripod cane	30 (44.1)
(iv) Personal assistance	10 (14.7)
FAC, *n* (%)	
(i) 2	3 (4.4)
(ii) 3	7 (10.3)
(iii) 4	35 (51.5)
(iv) 5	23 (33.8)
Comfortable gait speed (m/s), median (IQR)	0.28 (0.29)
Fast gait speed (m/s), median (IQR)	0.39 (0.45)
G.A.I.T. total score	17.7 (10.0)

Values are mean (SD) unless otherwise indicated. Abbreviations: *n*: number; SD: standard deviation; IQR: interquartile range; BMI: body mass index; NIHSS: National Institutes of Health Stroke Scale; FAC: Functional Ambulation Category.

3.1. Validity. Concurrent validity tests—including the new Thai G.A.I.T. scale questionnaire—correlated well with the established measures. We found that the G.A.I.T. score strongly correlated with a mean comfortable gait speed ($R_s = -0.79$, p value < 0.001) and a fast gait speed ($Rs = -0.68$, p value < 0.001).

Regarding convergent validity, there was good correlation between the G.A.I.T. score and measures of motor strength, using the lower extremity Motricity Index ($R_s = -0.62$, p value < 0.001), the FAC ($R_s = -0.51$), and the NIHSS ($R_s = 0.57$, p value < 0.001) (Table 2).

3.2. Reliability. The ICC for interrater reliability for the final G.A.I.T. score was 0.93 (0.86-0.95), while the ICC for intrarater reliability was 0.95 (0.91-0.97). Every subitem yielded an ICC above 0.75 (Table 3).

There was high interrater reliability for the upper extremities and trunk. By comparison, the interrater reliability for lower extremities was highest in the most distal segment (i.e., ankle, ICC = 0.87) and least for the more proximal segments (i.e., knee, hip, and pelvis). We found that the intrarater reliability was greater than the interrater reliability;

Table 2: Concurrent and convergent validity of Thai G.A.I.T. scale.

	R_s	p value
Comfortable gait speed	-0.79	<0.001
Fast gait speed	-0.68	<0.001
FAC	-0.51	<0.001
Lower extremity Motricity Index	-0.62	<0.001
NIHSS	0.57	<0.001

Abbreviations: FAC: Functional Ambulation Category; NIHSS: National Institutes of Health Stroke Scale.

Table 3: Reliability of Thai G.A.I.T. scale classified by 3 main items.

G.A.I.T. score	Interrater reliability ICC (95% CI)	Intrarater reliability ICC (95% CI)
Stance and swing (items 1-4)	0.90 (0.82-0.94)	0.90 (0.82-0.94)
Stance (items 5-18)	0.88 (0.80-0.92)	0.91 (0.84-0.95)
Swing (items 19-31)	0.91 (0.85-0.94)	0.92 (0.86-0.96)
Total score	0.93 (0.88-0.96)	0.95 (0.91-0.97)

Abbreviations: ICC: intraclass correlation coefficient; CI: confidence interval.

Table 4: Inter- and intrarater reliability of Thai G.A.I.T. scale classified by subcomponents.

G.A.I.T. score	Interrater reliability ICC (95% CI)	Intrarater reliability ICC (95% CI)
Upper extremities (items 1-3)	0.80 (0.68-0.89)	0.83 (0.70-0.90)
Trunk (items 4, 5, 6, 19, 20)	0.89 (0.83-0.93)	0.87 (0.77-0.93)
Pelvis (items 7, 8, 21, 22, 23)	0.72 (0.54-0.83)	0.90 (0.88-0.94)
Hip (items 9, 10, 24, 25)	0.80 (0.67-0.88)	0.87 (0.77-0.93)
Knee (items 11, 12, 13, 14, 26, 27, 28)	0.81 (0.70-0.89)	0.87 (0.77-0.93)
Ankle and toe (items 15, 16, 17, 18, 29, 30, 31)	0.87 (0.79-0.92)	0.83 (0.71-0.91)

Abbreviations: ICC: intraclass correlation coefficient; CI: confidence interval.

notwithstanding, the pelvis, hip, and knee had a higher intrarater reliability (ICC 0.87-0.90) than the lower segment (ankle, ICC 0.83) (Table 4).

4. Discussion

We developed the Thai version of G.A.I.T. by translating the original English version of G.A.I.T. to Thai, then tested its validity and reliability. The concurrent validity indicated a strong relationship between the G.A.I.T. and a comfortable gait speed ($R_s = -0.79$) and a fast gait speed ($R_s = -0.68$). The finding is comparable to a previous study using the G.A.I.T. by Zimbelman et al., who reported an r of -0.74 [26]. The Thai G.A.I.T. is also comparable to other gait scales, including the Gait Abnormality Rating Scale (GARS) ($r = -0.64$, $p < 0.001$) [27], the Tinetti Gait Scale (TGS) ($r = 0.74$, $p = 0.001$) [26], and the Wisconsin Gait Scale (WGS) ($r = -0.45$ to -0.81, $p < 0.001$) [12, 27, 28]. The correlation coefficient of the G.A.I.T. scale was more than 0.60, indicating that the scale has excellent concurrent validity with comfortable and fast gait speeds [29].

Regarding convergent validity, we found that the G.A.I.T. score has a strong correlation with the NIHSS ($R_s = -0.57$), the FAC ($R_s = -0.51$), and the lower extremity Motricity Index ($R_s = -0.62$). The degree of correlation was comparable to the WGS vs. the Motricity Index ($R_s = -0.68$), and the GARS vs. Motricity Index (-0.74) [27]. The correlation demonstrated between the G.A.I.T. and FAC is also consistent with a validity study using the WGS vs. FAC in acute, subacute, and chronic stages after stroke (-0.77 to -0.88) [12]. The correlation coefficient of 0.51 to 0.62 found in our study indicates that the G.A.I.T. scale has adequate to excellent validity, according to the interpretations proposed by Ferrarello et al. [29].

The respective inter- and intrarater reliability in our study was excellent (ICC = 0.93 and ICC = 0.95) and comparable to the original English version (ICC = 0.83 and ICC = 0.98 [26]. The higher interrater reliability of the distal segments in our study was comparable to del Pilar et al. who reported on the Edinburgh Visual Gait Score for cerebral palsy, noting that there was more variation in the reliability in proximal segments such as pelvic rotation [30].

The original G.A.I.T. is valid for measuring incremental changes in gait components. Zimbelman et al. found the original G.A.I.T. was more sensitive in identifying gains than the TGS. This sensitivity may be useful for rehabilitation in the clinic or in research as potential efficacious treatments may be misclassified as nonbeneficial as some gains might not be detected and measured [26].

The strength of the current study was its (1) standardized procedure in the translation and crosscultural adaptation processes and (2) adequate sample size. The limitations of the study were that (1) it is a single center; thus, the generalizability of the conclusions may be limited, and (2) we could not compare our methodology with gold standard methods of gait analysis. Notwithstanding, we used the most acceptable outcome measure (gait speed) which is generally chosen in other published studies [12, 26–28]. Further test-retest reliability of the Thai G.A.I.T. scale should be done to establish the minimal detectable changes and standard error of measurement for a full aspect of the psychometric properties of the scale.

5. Conclusion

We developed and tested the Thai version of the G.A.I.T. scale. The Thai version had excellent concurrent validity with gait speed. The Thai G.A.I.T. also demonstrated adequate to excellent convergent validity with the NIHSS, Motricity Index, and FAC. The tool also demonstrated excellent inter- and intrarater reliabilities. The use of the G.A.I.T. is recommended for providing information on walking quality and gait deviations. Future studies regarding responsiveness of the scale are needed.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author upon request.

Ethical Approval

The study was approved by the Khon Kaen University Ethics Committee for Human Research (HE601085).

Consent

All the patients gave informed written consent before participating in the study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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