

Validity and Reliability of the Thai Version of the Barthel Index Self-Report (BI-SR-TH) for People with Spinal Cord Injury

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ABSTRACT

OBJECTIVE This study aimed to cross-culturally translate and evaluate the psychometric properties of the Thai version of the Barthel Index Self-Report (BI-SR-TH) for Thai people with spinal cord injury (SCI).

METHODS A descriptive cross-sectional validation and reliability study was conducted at the Maharaj Nakorn Chiang Mai Hospital, involving 109 Thai people aged 18 or older with either traumatic or non-traumatic SCI. The English postal version of the Barthel Index was translated into Thai following standard cross-cultural procedures, including forward and backward translation. Participants completed both the BI-SR-TH and the Thai EuroQoL (EQ-5D-5L) questionnaires via self-report and clinician assessment using the Barthel Index. The BI-SR-TH was re-administered to the participants one week later. Psychometric evaluation included assessments of internal consistency (Cronbach's alpha), concurrent validity (Spearman's correlation with clinician-rated BI), construct validity (convergent and discriminant validity assessed by correlations with relevant and distinct EQ-5D-5L domains), and test-retest reliability (intraclass correlation coefficient, ICC). The agreement between the BI-SR-TH and BI scores was assessed using ICC and the Bland-Altman Altman analysis. Item-level agreement was assessed using the Kappa statistic.

RESULTS The BI-SR-TH demonstrated good internal consistency (Cronbach's alpha = 0.836) and excellent concurrent validity with a clinician-rated BI ($r = 0.884$). In terms of construct validity, the BI-SR-TH showed strong negative correlations with relevant EQ-5D-5L domains, e.g., mobility, self-care, and usual activities ($r = -0.67$ to -0.81 , $p < 0.01$), demonstrating convergent validity. In contrast, correlations with unrelated domains such as anxiety and pain were weak or nonsignificant, indicating discriminant validity. The total score agreement between BI-SR-TH and the clinician BI was high (ICC = 0.916), and Bland-Altman analysis indicated a small mean difference. Most BI-SR-TH items showed good agreement with clinician ratings (Kappa 0.61-0.72) with the exception of the bowels and bladder items which showed only fair agreement (Kappa = 0.34 and 0.35, respectively). Test-retest reliability was also high (ICC = 0.924).

CONCLUSIONS The BI-SR-TH is a valid and reliable tool for assessing functional independence in Thai people with SCI. However, the bowels and bladder items require further refinement for this population

KEYWORDS Barthel Index, self report, functional status, spinal cord injury, reliability and validity

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INTRODUCTION

Spinal cord injury (SCI) is a leading cause of major disability worldwide. Individuals with SCI usually lose the ability to perform some daily activities. As a result, tools to measure functional independence are essential for the rehabilitation process. There are several instruments for measuring this aspect, including the Barthel Index (BI) (1). The BI was initially developed for patients with stroke and neuromuscular diseases (1, 2). The assessment consists of a set of topics related to the ability to perform self-care activities, mobility, and bowel and bladder management across 10 domains, with scores ranging from 0 to 20. Healthcare providers conduct in-person interviews with patients or caregivers and evaluate patients by observing their functional abilities. The BI has been found to have good validity and reliability, and is widely used in clinical practice (2, 3). Psychometric properties of the BI have also been tested in persons with spinal cord injury (PwSCI). The BI has previously been translated and utilized to evaluate PwSCI in the Republic of Türkiye where it demonstrated good reliability and validity (4). In Thailand's intermediate care system, the BI is used in the evaluation of patients' level of independence during rehabilitation, including those with SCI, stroke, traumatic brain injury, and fractured hip (5). The simplicity and ease of use of the BI enables quick and efficient assessments, and its standardized scoring system allows for consistent comparisons of functional status across diverse patient populations. While the BI is less specific for SCI than instruments such as the Spinal Cord Independence Measure (SCIM) or the Spinal Cord Ability Ruler (SCAR), it offers a broad overview of functional independence. This makes the BI especially valuable when detailed assessment tools are unavailable or when a general measure of disability across various diagnoses is needed. In addition, the BI's widespread familiarity and acceptance in clinical practice supports its ongoing use for monitoring patient progress and guiding rehabilitation planning, particularly in resource-limited settings.

Gompertz and colleagues developed a postal version of the BI. It is a self-administered BI assessment consisting of a set of 10 questions, as

in the original version, but with multiple-choice answer formats that patients can complete by themselves. That version has been tested for psychometric properties in stroke patients and has demonstrated good reliability (6). Subsequent studies in Parkinson's disease and stroke patients have also demonstrated its good validity (7, 8). Self-reported assessment can be used to collect data from many patients simultaneously, particularly in circumstances where telemedicine is growing. It is convenient for long-term patient data collection, allowing continuous monitoring of changes and reducing the workload of health care providers. Previous studies have shown the development and psychometric properties testing of the self-reported BI, but it has not yet been translated into Thai. Furthermore, studies have focused only on stroke and Parkinson's disease patients, but no research has been published on PwSCI. The objectives of this study are to translate and cross-culturally adapt the postal version of the BI by Gompertz et al. (6) into a Thai version and to evaluate its psychometric properties in SCI individuals.

METHODS

This study protocol was approved by the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University, study code: REH-2564-08232. The study was conducted in two phases. The first phase involved translating the self-reported BI from English to Thai. The second phase evaluated the validity and reliability of the Thai version of the Barthel Index Self-Report (BI-SR-TH) in PwSCI.

Participants

Individuals with traumatic or non-traumatic SCI who visited the Department of Rehabilitation Medicine at Maharaj Nakorn Chiang Mai Hospital between August 2021 and March 2022 were recruited. The inclusion criteria comprised individuals aged 18 or older who were proficient in spoken Thai and could read Thai independently. Individuals with severe cognitive impairment or severe mental disorders who were unable to complete the assessment independently were excluded.

Research instruments

Thai version of the BI-SR-TH

Permission for translation of the BI-SR-TH was granted by Dr. Pandora Pound, a colleague of Dr. Patrick Gompertz, via electronic mail. The process of translation and cross-cultural adaptation into Thai was carried out for the self-reported BI. Initially, a forward translation was completed, resulting in two separate draft versions of the BI-SR-TH. These translations were independently conducted by two individuals, a physiatrist specializing in spinal cord medicine from the Department of Rehabilitation Medicine at Chiang Mai University, and a linguistic expert from the Humanities Academic Service Center at the same university. The researchers analyzed the items from the two draft versions and synthesized them into a single draft of the BI-SR-TH. Subsequently, back translation of that single draft was performed independently by two native English speakers who were proficient in Thai. Neither of the two translators was a health professional, and both were unaware of the original version of the self-reported BI. Once the translations were completed, they were submitted to Dr. Pandora Pound for review and feedback. Following her suggestions, the initial draft of the BI-SR-TH was revised into a pre-final version. Twenty-five Thai individuals with SCI tested the pre-final version of the BI-SR-TH to identify any areas of possible confusion or misunderstanding (9). Internal consistency was assessed using Cronbach's alpha, which yielded a value of 0.646, indicating questionable reliability. The Kappa statistic, used to evaluate the agreement between the pre-final version of the BI-SR-TH and the original BI, showed moderate to substantial agreement for most items; however, the bladder item exhibited poor agreement ($K = 0.02$). In response to this feedback, the bladder item was modified in the final version. It was changed from "need urinary catheterization" (0 point) to "need assistance with urinary catheterization" (0 point). The final version of the BI-SR-TH is included in the supplementary appendix.

The Barthel Index

The BI is a clinician-rated ordinal scale developed by Collin et al. (2) to assess a person's ability to perform ten common self-care and basic mobility activities. These activities include feeding,

bathing, grooming, dressing, bowel and bladder management, toileting, transfers (from bed to chair and back), mobility on level surfaces, and stair negotiation. Administered through observation and/or structured interview by healthcare professionals, the total score range is from 0 to 20, with higher scores indicating greater functional independence. The BI has been widely used to evaluate functional independence in patients with various conditions, including SCI (4, 5).

The Thai Version of the EQ-5D-5L Health Questionnaire

The EQ-5D-5L questionnaire is used to evaluate health-related quality of life. This questionnaire has been translated into more than 160 languages globally, including Thai (10). It is used to assess health-related quality of life, particularly for monitoring treatment results in hospitals, clinical research, health technology assessment, and monitoring the quality of life of the general population and of patients, including PwSCI (11). The EQ-5D-5L consists of two parts. The first part includes five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each question has five possible answers based on severity, ranging from no problems to unable/extreme problems. The second part evaluates health status via a Visual Analog Scale (VAS).

Data collection

After obtaining informed consent, demographic information and lesion characteristics of the participants were collected through interviews and reviews of medical records using the International SCI Core Data Set (version 3.0) (12). Participants then independently completed two self-administered questionnaires: the BI-SR-TH and the Thai version of the EQ-5D-5L (10). For participants unable to write due to hand or arm limitations, caregivers were permitted to assist with writing, but were not allowed to help interpret or explain any items. On the same day, a clinician-administered BI assessment was performed by one of five rehabilitation medicine residents, all of whom had received standardized training including a one-hour clinical demonstration and a review of the modified BI, as recommended by Shah et al., to ensure competency. The evaluators demonstrated high interrater reliability ($r > 0.9$) (13). To prevent bias, raters were blinded to the

BI-SR-TH responses, and both physicians and participants remained unaware of each other's scores. For inpatients, all assessments were conducted the day before discharge. To evaluate test-retest reliability, participants were provided with a copy of the BI-SR-TH in a sealed envelope and instructed to complete it again one week later, returning the questionnaire either by mail or electronically. The flow of the study is presented in the CONSORT flow diagram (Figure 1).

Statistical analysis

Sample size calculations

The sample size was calculated by the Bland-Altman method (14) using Medcalc version 19.7. Based on the research by Sutton et al. (8), the expected mean of difference was set at -1.0, and the expected standard deviation of differences at 0.9, with a maximum allowed difference between methods of 3.2. This resulted in a calculated sample size of at least 106 participants. For assessing test-retest reliability using the formula from Green et al. (15), the expected mean of difference was set at 0.4, and the expected standard deviation of differences at 1.0, which yielded an estimated sample size of 51 individuals. Ultimately,

the final sample size consisted of a minimum of 106 participants.

$$n = \frac{(t_{n-1, \alpha/2} + t_{n-1, \beta})^2}{d^2}$$

All statistical data analyses were conducted using IBM SPSS version 22. The demographic data are presented using descriptive statistics, including frequency, percentage, mean, and standard deviation. Additionally, the total scores of the BI and the Thai version of the BI-SR-TH are shown. The floor and ceiling effects were considered significant if they exceeded 15% (16).

Reliability and validity analysis

- Reliability: Internal consistency was assessed using Cronbach's alpha, with a threshold of 0.7 or above considered acceptable (15). Test-retest reliability was evaluated with the intraclass correlation coefficient (ICC), where a value of at least 0.7 was deemed adequate (16).

- Concurrent validity: Criterion validity between BI and BI-SR-TH was determined using Spearman's ICC (r), which ranges from -1.00 to 1.00. Negative values indicate an inverse relationship. The levels of correlation were categorized as follows: $r \geq 0.75$ was very strong; $0.50 < r < 0.75$ was

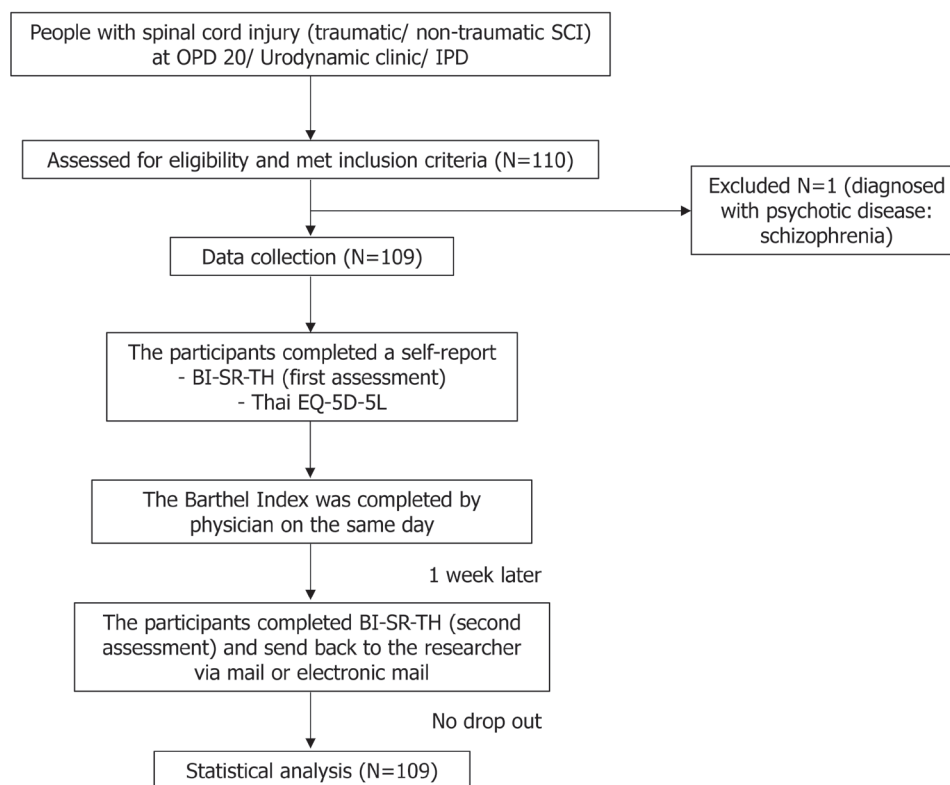


Figure 1. CONSORT flow diagram

strong; $0.25 < r < 0.50$ was moderate; $r < 0.25$ was weak (16).

- Construct validity was examined through convergent and discriminant validity using the Thai EQ-5D-5L. The Spearman's ICC (r) was used to evaluate this correlation.

- Agreement: Agreement between the totals of BI and BI-SR-TH were analyzed using the Bland-Altman plot, with the limit of agreement (LOA) set at a mean difference ± 1.96 SD (16). An Intraclass ICC greater than 0.7 was considered acceptable (16). Kappa values were used to assess agreement for each item, with interpretations as follows: $K < 0.2$ was considered poor, 0.21-0.40 was considered fair, 0.41-0.60 was considered moderate, 0.61-0.80 was considered good, and 0.81-1.00 was considered very good/fairly complete (17).

RESULTS

Characteristics of the study population

A total of 109 individuals with either traumatic or non-traumatic spinal cord injuries participated in the study. Most participants were male (79 out of 109, or 72.5%), and the average age was 49 years. Most had T1-S3 paraplegia with ASIA (American Spinal Injury Association) Impairment Scale categories A, B, or C (60 out of 109, or 55.0%). Most participants had completed a secondary education. The characteristics of the study population are detailed in Table 1.

Psychometric properties of the BI-SR-TH

Each of the 109 participants answered all 10 BI questions and completed the BI-SR-TH questionnaire, a response rate of 100%. The average

total scores for BI and BI-SR-TH are displayed in Table 2, which indicate comparable total scores and a floor and ceiling effect of 0.0-5.5%.

Internal consistency: Cronbach's alpha was 0.836, and the Cronbach's alpha of each item deleted from the BI-SR-TH are shown in Table 3.

Table 1. Demographic and clinical characteristics of the study population

	N (%) or mean $\pm$ SD
Age (year)	48.9 $\pm$ 16.0
20-29 years	16 (14.7)
30-59 years	62 (56.9)
≥ 60 years	31 (28.4)
Gender	
Male	79 (72.5)
Female	30 (27.5)
Education	
No education	1 (0.9)
Primary school education	37 (33.9)
Secondary school	48 (44.0)
Bachelor's degree	23 (21.1)
Etiology of SCI	
Traumatic	86 (78.9)
Non-traumatic	23 (21.1)
Time since injury (year)	
< 1 year	26 (23.9)
1-4 years	16 (14.7)
5-9 years	22 (20.2)
10-14 years	20 (18.3)
> 15 years	25 (22.9)
Severity of SCI	
C1-4 AIS A, B, C	10 (9.2)
C5-8 AIS A, B, C	16 (14.7)
T1-S3 AIS A, B, C	60 (55.0)
AIS D at any level	23 (21.1)

N, number; SD, standard deviation; SCI, spinal cord injury; AIS, ASIA impairment scale

Table 2. Total scores of the Barthel Index and the Thai version of the Barthel Index Self-Report

	Barthel Index Total scores (score 0-20)	BI-SR-TH Total scores	
		First assessment (score 0-20)	Second assessment (score 0-20)
Mean $\pm$ SD	11.88 $\pm$ 5.78	12.42 $\pm$ 4.80	12.64 $\pm$ 4.99
Median (IQR)	14 (8)	14 (6)	14 (6)
Min	0	1	0
Max	20	20	20
Floor effect, n (%)	4 (3.7)	0 (0.0)	1 (0.9)
Ceiling effect, n (%)	6 (5.5)	6 (5.5)	5 (4.6)

BI-SR-TH, Thai version of the Barthel Index Self-Report; SD, standard deviation; IQR, interquartile range

Table 3. Internal consistency (Cronbach's alpha and Cronbach's alpha if item deleted) within BI-SR-TH

	Cronbach's alpha
Total	0.836
Cronbach's alpha if item deleted	
BI-SR-TH-bowel	0.842
BI-SR-TH-bladder	0.858
BI-SR-TH-grooming	0.816
BI-SR-TH-toilet	0.789
BI-SR-TH-feeding	0.810
BI-SR-TH-transfer	0.782
BI-SR-TH-mobility	0.823
BI-SR-TH-dressing	0.793
BI-SR-TH-stair	0.833
BI-SR-TH-bathing	0.811

BI-SR-TH, Thai version of the Barthel Index Self-Report

Test and retest reliability: The test-retest reliability was excellent, with an ICC of 0.924 (95%CI: 0.890-0.947).

Concurrent validity: There was a very strong correlation between the total scores of BI and BI-SR-TH, with a Spearman's ICC of 0.884.

Construct validity:

- **Convergent validity:** The relationship between the BI-SR-TH and the Thai EQ-5D-5L was assessed by correlating similar measures. The Spearman's ICC for the BI-SR-TH mobility item and the Thai EQ-5D-5L mobility item was -0.665

($p < 0.05$). For the BI-SR-TH dressing item and the Thai EQ-5D-5L self-care item, the coefficient was -0.810 ($p < 0.05$). These results indicate significant inverse correlations at strong and very strong levels.

- **Discriminant or divergent validity:** Correlations were examined between dissimilar measures, e.g., the BI-SR-TH mobility item and the Thai EQ-5D-5L pain item, both of which yielded a Spearman's ICC of -0.011 ($p = 0.912$). The correlation between the BI-SR-TH dressing item and the Thai EQ-5D-5L anxiety item was -0.125 ($p = 0.196$), indicating weak or no correlation (Table 4).

Agreement:

- The agreement of total scores between the BI and BI-SR-TH was within an acceptable range, with an ICC of 0.916. The Bland-Altman analysis showed a mean score difference of -0.541 between the two measurements, with limits of agreement ranging from -4.797 to 3.714 (Table 5). Most data points from both assessments fell within this acceptable range, as shown in Figure 2.

- Agreement between each item of the BI and BI-SR-TH was good (Kappa values between 0.61 and 0.72) for all items except the bowels and bladder items, which had fair agreement with Kappa coefficients of 0.34 and 0.35, respectively (Table 6).

Table 4. Spearman's Correlation Coefficient between the Thai EQ-5D-5L and the Thai version of the Barthel Index Self-Report

Spearman's Correlation Coefficient		BI-SR-TH									
Thai EQ-5D-5L		Bowel	Bladder	Grooming	Toileting	Feeding	Transfer	Mobility	Dressing	Stair	Bathing
Mobility		-0.064	-0.085	-0.212*	-0.264**	-0.218*	-0.303**	-0.665**	-0.173	-0.532**	-0.208*
Self-care		-0.136	-0.124	-0.573**	-0.769**	-0.612**	-0.786**	-0.372**	-0.810**	-0.198*	-0.659**
Activities		-0.113	-0.002	-0.359**	-0.689**	-0.366**	-0.640**	-0.270**	-0.544**	-0.216*	-0.628**
Pain		-0.082	-0.082	-0.110	-0.289**	-0.033	-0.251**	-0.011	-0.218*	-0.019	-0.238*
Anxiety		-0.123	-0.069	-0.167	-0.269**	-0.148	-0.275**	-0.114	-0.125	-0.036	-0.154

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

BI-SR-TH, Thai version of the Barthel Index Self-Report; Thai EQ-5D-5L, Thai version of EuroQoL Group 5 dimensions 5 levels

Table 5. Intraclass correlation coefficients, differences in the mean, and concurrent validity analysis between the total scores of the Barthel Index and the Thai version of the Barthel Index Self-Report

	Intraclass correlation (95%CI)	Mean difference		Concurrent validity	
		Mean diff (95%CI)	95% limit of agreement	Spearman's correlation coefficient	95%CI
Total scores	0.916 (0.880 to 0.942)	-0.541 (-0.954 to -0.129)	-4.797 to 3.714	0.884	0.835 to 0.920

CI, confidence interval

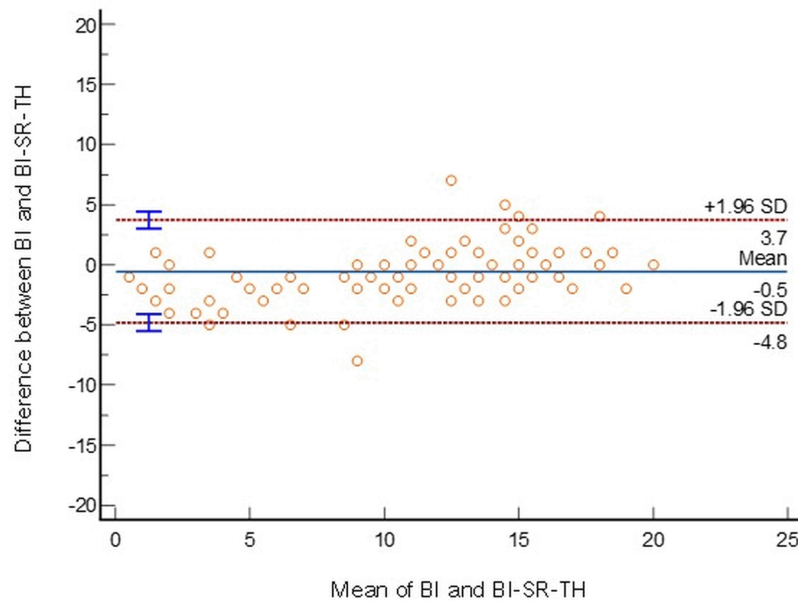


Figure 2. The Bland-Altman plot illustrates the mean differences between BI and BI-SR-TH measurements, showing a few outliers in the total scores. The error bars indicate variability at lower mean values.

Table 6. K value for each item of the Barthel Index and the BI-SR-TH

Item	K (SE)
Bowels	0.34 (0.07)
Bladder	0.35 (0.07)
Grooming	0.72 (0.09)
Toilet	0.68 (0.06)
Feeding	0.72 (0.09)
Transfer	0.61 (0.06)
Mobility	0.70 (0.06)
Dressing	0.71 (0.06)
Stairs	0.64 (0.11)
Bathing	0.71 (0.07)

K, Kappa coefficients; SE, standard error; BI-SR-TH, Thai version of the Barthel Index Self-Report

DISCUSSION

This study developed and validated a Thai version of the BI-SR-TH which demonstrated good validity and reliability for use with individuals having SCI. The BI-SR-TH showed acceptable internal consistency (Cronbach's alpha = 0.836) and very good concurrent validity, with a clinician-rated BI ($r = 0.884$). These results are higher than those reported by Morley and colleagues, who found a Cronbach's alpha of 0.69 and a correlation of $r = 0.64$ in Parkinson's disease patients using the postal version of the BI (7). Construct validity was supported through correlations with the Thai EQ-5D-5L. Strong negative correlations between BI-SR-TH and EQ-5D-5L domains such

as mobility, self-care, and usual activities confirmed convergent validity, as these domains conceptually overlap with the BI. In contrast, weak or nonsignificant correlations between BI-SR-TH and EQ-5D-5L domains such as anxiety and pain supported discriminant validity, indicating that the instrument does not strongly associate with unrelated constructs. The validated Thai EQ-5D-5L was chosen for these assessments based on its reliability in chronic and neurological conditions (18) and its inclusion of both overlapping and distinct domains. While SCIM is a valuable tool for assessing the functional abilities of individuals with SCI, we chose not to focus on it for this study because SCIM does not include items for assessing discriminant validity. Test-retest reliability of the questionnaire was also high and was in line with previous studies, e.g., Gompertz and colleagues (6). The floor and ceiling effects were within acceptable limits ($< 15.0\%$) (16).

Agreement between BI and BI-SR-TH total scores were strong (ICC = 0.916), comparable to results by Sutton et al. in stroke patients (ICC = 0.90) (8). Mean differences between BI-SR-TH and clinician-rated BI were negligible, with most Bland-Altman plot points within acceptable limits, supporting equivalence between the two formats. Consistent with previous research (8), the BI-SR-TH tended to yield slightly higher scores. However, the agreement between the BI and BI-SR-TH was lower for bowel and bladder items, as

was observed by Sutton et al. ($K = 0.24$). Sutton et al. speculated that this might be due to patients feeling uncomfortable answering questions about incontinence (8).

The most inconsistent response in the bladder item was that the physician assessed the BI as “incontinence or catheterized and unable to manage alone (0),” while some participants’ responses to the BI-SR-TH were “never incontinent” (2 points). Two points (continent) in the BI was intended to include participants who could manage their urinary catheters themselves; however, if a participant required assistance even without leakage, they would be assessed as “(0).” In the BI-SR-TH version, based on discussions with participants, it was found that there was an issue in cases where participants could not manage their urinary catheters themselves but did not have urine leakage sometimes misunderstanding the question and electing “never incontinent” (2 points) instead of “need assistance with urinary catheterization” (0 points). This likely resulted in only a fair agreement when the BI and the BI-SR-TH were compared.

A similar issue was observed for the bowels items. Participants who could not manage bowel care themselves but did not experience incontinence chose to respond with “never experienced incontinence” (2 points) instead of answering “incontinence all the time or need someone to give an enema” (0 points). Another point of difference was that the physician assessed “continence (2 points)” but the participants responded with 1 “occasional accident” (1 point). This might be due to the BI specifying a time frame for the bladder and bowel evaluations (over the past week). Those who did not experience incontinence during that week would be evaluated as “continence (2).” However, in the postal version by Gompertz et al. (6), there was no specified time frame in the description, allowing patients who experienced incontinence more than a week ago to choose “occasional accident” (1 point).

Due to the aforementioned issues, the authors believe that additional changes in the bowels and bladder items in the BI-SR-TH would enhance understanding and validity. This could potentially be achieved by adding phrases such as “completely managed alone” in the response option “never incontinent/never an accident” (2 points) and including the phrase “in the past week” in the descriptions of both the bladder

and bowels items (the BI-SR-TH with additional suggestions is provided in the supplementary appendix). Since items other than the bowel and bladder aspects in BI-SR-TH were consistent with BI, we did not find it necessary to conduct further investigations or make changes in those items. Considering the inconsistencies observed between the BI and the BI-SR-TH, it is also possible that the BI-SR-TH, by being self-administered and sensitive to SCI-related issues, may ultimately provide a more accurate reflection of patients’ true functional abilities. Future research should compare these formats against real-world outcomes and quality of life.

There were several limitations to this study. While the overall score agreement was strong, the agreement for bowel and bladder items was only fair. Factor analysis was not performed, and the study did not collect data on questionnaire completion time. The sample included only individuals with SCI; therefore, validation in other populations, such as stroke or other neurological conditions, is warranted. Further research should also explore how cultural differences affect self-reporting behaviors to ensure broader applicability and cross-cultural validity.

CONCLUSIONS

The BI-SR-TH demonstrated good internal consistency, good validity, excellent test-retest reliability, as well as good overall agreement with the clinician-rated version. However, agreement for the bowels and bladder items was only fair. Given the importance of these functions for people with SCI, further refinement of these items is recommended to enhance the tool’s suitability for this population before widespread implementation.

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CONFLICTS OF INTEREST

The authors have no conflict of interest to report.

AUTHOR CONTRIBUTIONS

S.T.: designed the research questions and methodology, analyzed the data, and wrote the preliminary version of the manuscript; S.M.: designed the research questions and methodology, collected the data, analyzed the data, and wrote the preliminary version of the manuscript; P.K.: designed the research questions and methodology, analyzed the data, wrote the preliminary version, and revised the final version of the manuscript; T.W.: designed the research questions and methodology, analyzed the data, and wrote the preliminary version of the manuscript.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University (study code: REH-2564-08232, approved on 12 July 2021).

INFORMED CONSENT STATEMENT

Informed consent was obtained from all participants involved in the study.

SUPPLEMENTARY MATERIALS

The following supporting information can be downloaded at: Supplementary appendix

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Supplementary Appendix

Barthel Questionnaire (English Version)

These are some questions about your ability to look after yourself.

They may not seem to apply to you. Please answer them all.

Tick one box in each section like this: ☒

Bathing In the bath or shower, do you: <i>Remember - tick one box only</i>	manage on your own?	☐	1
	need help getting in and out?	☐	0
	need other help?	☐	
	never have a bath or shower?	☐	
	need to be washed in bed?	☐	
Stairs Do you climb stairs at home: <i>Remember - tick one box only</i>	without any help?	☐	2
	with someone carrying your frame?	☐	1
	with someone encouraging you?	☐	
	with physical help?	☐	
	not at all?	☐	0
Dressing Do you get dressed: <i>Remember - tick one box only</i>	don't have stairs?	☐	
	without any help?	☐	2
	just with help with buttons?	☐	1
Mobility Do you walk indoors: <i>Remember - tick one box only</i>	with someone helping you most of the time?	☐	0
	without any help apart from a frame?	☐	3
	with one person watching over you?	☐	2
	with one person helping you?	☐	
	with more than one person helping?	☐	0
	not at all?	☐	
Transfer Do you move from bed to chair: <i>Remember - tick one box only</i>	or do you use a wheelchair independently (e.g. to go around corners)?	☐	1
	on your own?	☐	3
	with a little help from one person?	☐	2
	with a lot of help from one or more people?	☐	1
Feeding Do you eat food: <i>Remember - tick one box only</i>	not at all?	☐	0
	without any help?	☐	2
	with help cutting food or spreading butter	☐	1
	with more help?	☐	0

Toilet use Do you use the toilet or commode: <i>Remember - tick one box only</i>	without any help?	☐	2
	with some help but can do some thing?	☐	1
	with quite a lot of help?	☐	0
Grooming Do you brush your hair and teeth, wash your face and shave: <i>Remember - tick one box only</i>	without help?	☐	1
	with help?	☐	0
Bladder (during the past week) Are you incontinent of urine? <i>Remember - tick one box only</i>	never (<u>manage on your own</u>)	☐	2
	less than once a week	☐	
	less than once a day	☐	1
	more often	☐	0
	have a catheter managed for you?	☐	
Bowels (during the past week) Do you soil yourself? <i>Remember - tick one box only</i>	never (<u>manage on your own</u>)	☐	2
	Occasional accident	☐	1
	all the time	☐	0
	need someone to give you an enema?	☐	

Note: The recommendations made by the researcher for further improvements have been underlined

Barthel Questionnaire (Thai Version; BI-SR-TH)

แบบสอบถามบาร์เธล

แบบประเมินชุดนี้มีไว้เพื่อให้ท่านประเมินความสามารถในการประกอบกิจวัตรประจำวัน

กรุณาตอบคำถามทั้งหมด แม้บางข้ออาจดูเหมือนไม่เกี่ยวข้องกับคุณ

ทำเครื่องหมาย ☒ เพียง 1 ช่องในแต่ละหัวข้อ

การอาบน้ำ คุณอาบน้ำได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	อาบน้ำได้ด้วยตนเอง	1
	ต้องช่วยเหลือในการเข้าและออกบริเวณอาบน้ำ	0
	ต้องการความช่วยเหลือด้านอื่นๆ	
	ไม่เคยอาบน้ำเลย	
	ต้องเช็ดตัว/อาบน้ำบนเตียง	
การขึ้นลงบันได คุณขึ้นลงบันไดที่บ้านได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ไม่ต้องการความช่วยเหลือใด ๆ	2
	โดยต้องมีคนช่วยถืออุปกรณ์ช่วยเดิน	1
	โดยต้องมีคนช่วยให้กำลังใจ	
	โดยต้องช่วยเหลือทางกาย	
	ไม่ได้ขึ้นลงบันไดเลย	0
การแต่งตัว คุณแต่งตัวได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	แต่งตัวได้ด้วยตนเอง	2
	โดยต้องมีคนช่วยติดกระดุม	1
	โดยต้องมีคนช่วยเหลือเกือบตลอดเวลา	0
	เดินได้เอง หรือใช้เพียงอุปกรณ์ช่วยเดิน	3
	โดยต้องมีคนเฝ้าระวัง 1 คน	2
การเคลื่อนที่ คุณเดินในบ้านโดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	โดยต้องมีคนช่วยเหลือ 1 คน	
	โดยต้องมีคนช่วยเหลือ 2 คนขึ้นไป	0
	ไม่สามารถเดินหรือใช้วีลแชร์ด้วยตนเองได้	
	หรือคุณใช้วีลแชร์ได้ด้วยตนเอง (เข้าออกมุมต่างๆได้)	1
การเคลื่อนย้ายตัว คุณย้ายตัวเองจากเตียงไปที่เก้าอี้ได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ย้ายได้ด้วยตนเอง	3
	โดยการคน 1 คนช่วยเหลือเล็กน้อย	2
	โดยการคน 1 คนขึ้นไป ช่วยเหลืออย่างมาก	1
	ไม่สามารถย้ายตัวได้เลย	0

การรับประทานอาหาร คุณรับประทานอาหารได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ทานอาหารได้ด้วยตนเอง		2
	โดยต้องช่วยเหลือในการตัดอาหารหรือทาน		1
	โดยต้องช่วยเหลือมากกว่าข้อด้านบน		0
การใช้ห้องน้ำ คุณสามารถใช้ห้องน้ำ หรือเก้าอี้นั่งถ่ายเพื่อ ขับถ่ายได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ไม่ต้องการความช่วยเหลือใด ๆ		2
	โดยทำบางอย่างได้เอง แต่ต้องช่วยเหลืออยู่บ้าง		1
	ทำได้โดยต้องการความช่วยเหลืออย่างมาก		0
การดูแลความสะอาดใบหน้า คุณหวีผม แปรงฟัน ล้างหน้า และ โกนหนวดได้โดย..... หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ดูแลได้โดยไม่ต้องความช่วยเหลือ		1
	โดยต้องการความช่วยเหลือ		0
การถ่ายปัสสาวะ (ช่วง 1 สัปดาห์ที่ผ่านมา) คุณปัสสาวะเล็ดราดหรือไม่ หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ไม่เคยปัสสาวะเล็ดราดและจัดการได้ด้วยตนเอง		2
	เล็ดราดบ้าง 1 ครั้งใน 2-3 สัปดาห์		
	เล็ดราดบ้าง 1 ครั้งใน 2-3 วัน		1
	ปัสสาวะเล็ดราดบ่อยๆ		0
	คุณต้องมีผู้ช่วยในการใช้สายสวนหรือคาสายสวนปัสสาวะ		
การถ่ายอุจจาระ (ช่วง 1 สัปดาห์ที่ผ่านมา) คุณอุจจาระเล็ดราดหรือไม่ หมายเหตุ – เลือกเพียง 1 ตัวเลือกเท่านั้น	ไม่เคยอุจจาระเล็ดราดและจัดการได้ด้วยตนเอง		2
	เล็ดราดเป็นบางครั้ง		1
	เล็ดราดตลอดเวลา		0
	หรือคุณต้องมีผู้ช่วยในการสวนถ่ายอุจจาระ		

หมายเหตุ: ข้อเสนอที่ผู้วิจัยแนะนำให้มีการปรับปรุงเพิ่มเติม ได้ทำการขีดเส้นใต้ไว้