Physical activity recall assessment for people with spinal cord injury: Thai translation and cross-cultural adaptation

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ABSTRACT

Purpose: This research sought to translate and culturally adapt the content of the original Physical Activity Recall Assessment for People with Spinal Cord Injury (PARA-SCI) into the Thai language and to assess its inter- and intra-rater reliability.

Methods: This study was divided into two parts; (i) translation and cross-cultural adaptation, using a six-step guideline-based translation-validation process and (ii) reliability assessment of the translated survey tool using intraclass correlation coefficients (ICCs), Bland–Altman plots and one-way ANOVA analyses.

Results: The Thai-PARA-SCI was successfully developed. The results revealed an excellent inter-rater reliability (ICC = 0.99, 95% CI range from 0.959–0.999) and the Bland-Altman plots showed little difference in times spent engaged physical activity. Intra-rater reliability results were affected inadvertently by testing across an unusual period, demonstrating poor to moderate scores (ICC ranged from 0.05–0.69, 95% CI ranged from −0.067–0.830) with the Bland-Altman plots showing very different ranges of time spent on physical activity.

Conclusion: This study achieved its aims of culturally and systematically translating the English PARA-SCI interview script into the Thai version with excellent scores for inter-rater reliability and was proven to be understandable by prospective users (Thai-PT) and participants (Thai-SCI).

IMPLICATIONS FOR REHABILITATION

- A robust cross-cultural translation and adaptation of the Physical Activity Recall Assessment for people with Spinal Cord Injury (PARA-SCI) into the Thai context has been undertaken, providing an effective exemplar for converting patient reported health outcome measures between languages of different root origins.
- When using the PARA-SCI as a pre- and post-intervention outcomes survey, clinicians should ensure that the timing of interview administration does not coincide with any unintended alterations in work-life balance, to ensure that the data are representative of the habitual physical activity levels performed by participants in their daily lives.
- Due to the possibility that physical activity levels could vary day-by-day or week-to-week, using the same day measurement findings may be a more reliable way to deploy the PARA-SCI than repeated assessments week(s) apart.

Introduction

People with spinal cord injuries (SCI) are at risk of developing secondary impairments and chronic diseases due to their low levels of post-traumatic physical activity [1,2]. Participation in regular physical activity and exercise is recommended to maintain general health and physical fitness [3,4]. Methods of quantifying physical activity in people with SCI [5] can include the use of an activity tracking device [6], self-reported measures [7] or questionnaire-based interviews [8]. Among the physical activity measurement tools, most were developed for the general population [9] or in people with disabilities with independent ambulation [10]. Therefore, these tools may be insensitive to very low-intensity physical activity levels [11] that are performed during activities of daily living (ADL) or during leisure-time activities (LTPA) in people with SCI [12]. To our knowledge, there is only one valid and reliable physical activity measurement tool that was specifically developed for people with SCI; the Physical Activity Recall Assessment for people with Spinal Cord Injury (PARA-SCI) [5, 13,14].
The PARA-SCI is a reliable (measures of total activity, ICC > 0.70) and valid (r = 0.63–0.88, p < 0.05) semi-structured interview that captures self-reported information on the type, frequency, duration and intensity of physical activity undertaken by people with SCI that use a wheelchair as their primary mode of mobility [13]. The normative data for the PARA-SCI test-retest (1-week interval) reliability scores were derived from a sample of 102 people with SCI (mean age = 39.0 y, SD = 11.3 y) recruited from three Canadian provinces and one American state. Validity was assessed in a sample of 14 people recruited from the same locations (mean age = 34.4 y, SD = 7.9 y), whose PARA-SCI scores were compared to indirect calorimetry [13]. The PARA-SCI assesses activities across three domains – leisure-time physical activities (LTPA), activities of daily living (ADL), and cumulative activity (T12 and T12v2) against the original English language version (O1). This was a 7-point Likert scale used for the identification of common problems and pitfalls that might have threatened the validity of the backward-translation of PARA-SCI (see Supplementary Appendix 1). The CIRS has two sections, comparability of language and similarity of interpretation, each ranging from 1 (extremely comparable and extremely similar, respectively) to 7 (not at all comparable and not at all similar, respectively). The CIRS assessment was performed independently by Assessor-1, Assessor-2a and 2b. All assessors were blinded from each other’s scores and comments.

The Accuracy and Interpretability Rating Scale (AIRS) was used to compare each statement of the forward-translated (Thai) PARA-SCI (T12 and T12v2) against the original English language version (O1). The AIRS is a modified (from the CIRS [18]) 7-point Likert scale used to identify problem statements that might have threatened the validity of the forward-translation of PARA-SCI (see Supplementary Appendix 2). It also has two sections, accuracy of translation and similarity of interpretation. The scale ranges from 1 (extremely accurate and extremely similar, respectively) to 7 (not at all accurate and not at all similar, respectively). This AIRS assessment was performed independently by the Assessor-3 group. AIRS scores and comments were blinded from each other.

Materials and methods
This study was divided into two parts; (i) translation and cross-cultural adaptation (following methodological guidelines related to “best practice” principles for the cross-cultural equivalence in translation for patient-reported outcomes in healthcare research) [17–24] of the PARA-SCI into the Thai context, and, (ii) reliability assessment of the Thai version of the PARA-SCI [25–27]. The lead author (ACE) was the overall translation Moderator and is linguistically fluent in English and Thai languages. ACE ethically managed each step throughout the research. The participants included assessors, translators, Thai physiotherapists (Thai-PT) and Thai people with SCI (Thai-SCI). The PARA-SCI’s developers granted permission to our research team to translate and deploy it in the current and a future study [13]. The study was conducted at the University of Sydney, and in a community of convenience in Bangkok, Thailand.

Part 1: translation and cross-cultural adaptation
Participants
The participants of the current study comprised “Translators” who performed forward- and backward-translations, “Assessors” who evaluated and graded the “quality” of the translations and cross-cultural adaptation and “Target Users” who represented the two likely user groups for the PARA-SCI in Thailand.

There were three different categories of Assessors: a senior researcher in the field of SCI, who was a native English-language speaker (Assessor-1); two early-career clinical researchers in the field of SCI, who spoke English as a second language (IELTS 7+) but did not speak Thai (Assessor-2a and 2b); and bilingual Thai-English speakers, who spoke fluent English in their everyday living and work environments (Assessor-3 group). All assessors participated in the test of content validity. There were two categories of Translators: professional commercial translators (Translator-1a and Translator-1b) and nominated non-professionally trained translators (Translator-2a, 2b and 2c). The additional roles of the nominated non-professionally trained translators were to participate in the comparison of the different translated versions of PARA-SCI, as well as discussions on the adjustments made to the translated version of PARA-SCI with the Moderator. There were two target user groups, comprising Thai physiotherapists with experience in treating people with SCI (Thai-PT) and Thai people with SCI (Thai-SCI). Both Thai-PT and Thai-SCI participated in the test of face validity. The recruitment criteria for each category of participants are presented in Table 1. Social media advertisements were posted on the internet to the Thai Community in Foreign Countries, the Thai Physical Therapy Association, and the Thai Spinal Cord Injury Society for recruitment of the Assessor-3 group, Thai-PT, and Thai-SCI, respectively. Those who responded and expressed their interest in participating were contacted and screened for eligibility based on fluency and disability-specific knowledge.

Measures
The following measures were used for the translation and cross-cultural adaptation to identify statements differing in content or context between the translated PARA-SCI and the English PARA-SCI.

The Comparability and Interpretability Rating Scale (CIRS) [18] was applied to each statement of the back-translated PARA-SCI (B1 and B2; Figure 1) compared to the original English language version (O1). This was a 7-point Likert scale used for the identification of common problems and pitfalls that might have threatened the validity of the backward-translation of PARA-SCI (see Supplementary Appendix 1). The CIRS has two sections, comparability of language and similarity of interpretation, each ranging from 1 (extremely comparable and extremely similar, respectively) to 7 (not at all comparable and not at all similar, respectively). The CIRS assessment was performed independently by Assessor-1, Assessor-2a and 2b. All assessors were blinded from each other’s scores and comments.

The Accuracy and Interpretability Rating Scale (AIRS) was used to compare each statement of the forward-translated (Thai) PARA-SCI (T12 and T12v2) against the original English language version (O1). The AIRS is a modified (from the CIRS [18]) 7-point Likert scale used to identify problem statements that might have threatened the validity of the forward-translation of PARA-SCI (see Supplementary Appendix 2). It also has two sections, accuracy of translation and similarity of interpretation. The scale ranges from 1 (extremely accurate and extremely similar, respectively) to 7 (not at all accurate and not at all similar, respectively). This AIRS assessment was performed independently by the Assessor-3 group. AIRS scores and comments were blinded from each other.

Translation procedures
A six-step translation and validation process [19] enabled the authors to identify any problematic linguistic content, assess, re-assess, and translate (both forward- and backward-translations) the interview script until we were confident that the translated questionnaire could be interpreted in the same manner as the original 43-statement English version. The processes of translation
| Participants | Definition |
|--------------|------------|
| **Assessors** | Individuals compared and scored the translated versions using a rating scale. There were three types of assessors as below: |
| - Assessor-1: SCI-expert and a native English speaker | (n = 1; They used CIRS to score B1 and B2) |
| - having an academic background related to healthcare, SCI, and cross-cultural research | |
| - Assessor-2: SCI-expert and a non-native English and non-Thai speaker | (n = 2; They used CIRS to score B1 and B2) |
| - speaking English as their second language | - able to communicate in Thai |
| - having a health professional background with experience of working with people with SCI in the non-English speaking country | |
| - Assessor-3: Thai people who speak English as their second language in everyday life | (n = 40; The first 20 used AIRS to score T12 and other 20 used AIRS to score T12v2) |
| - being a native Thai speaker | - not using English to communicate in their work environment or everyday life |
| - speaking English as their second language | |
| - having a medical background | |
| - originally born and live in Thailand for more than half of their lifetime | |
| **Translators** | Individuals who either performed forward or back-translation of the PARA-SCI. There were two types of the translator as below: |
| - Translator-1: Commercial translators | (n = 4; One with medical background (1a) performed English to Thai translation (T1) while another one with non-medical background (1b) performed Thai to English translations (B1). The bi-directional translations were cross-checked by commercial linguistic experts following ISO 17100:2015 standards) |
| - a native Thai speaker | - providing certified translation (ISO 17100:2015) |
| - born and resident in Thailand for more than half of their lifetime | - unable to participate in the revision, editing, proof reading of the Thai and English-back translation version of PARA-SCI and engaging in discussion with the authors |
| - speaking English as their second language | |
| - currently working or living in an English speaking country | |
| - Translator-2: Independent translators, with high fluency, but without professional translation certification | (n = 3; One with medical background (2a) performed English to Thai translation (T2) while other two with non-medical background (2b and 2c) performed Thai to English translations (B2 and B3) |
| - a native Thai speaker | - unable to participate in the revision, editing, proof reading of the Thai and English-back translation version of PARA-SCI and engaging in discussion with the authors |
| - born and resident in Thailand for more than half of their lifetime | |
| - currently working or living in an English speaking country | |
| - having a medical background | |
| **Thai physiotherapists** | Thai physiotherapists who had experience working in the field of SCI |
| (n = 6, They participated in the cognitive debriefing of T12v2) | |
| - being a native Thai speaker | - having no experience of working with people |
| - graduated from university that their course was carried out in the Thai language | with SCI |
| - holding an active license to practice as a healthcare professional in Thailand | |
| - currently practicing as a physiotherapist in hospital, clinic, home-visit services or community-based services | |
| **Thai people with SCI** | Thai people with SCI |
| (n = 43; 5 participated in the cognitive debriefing of T12v2 while the other 38 participated in the reliability test of the Thai PARA-SCI final version) | |
| - being a native Thai speaker | - having pre-existing medical conditions that affect the brain and cognitive function such as stroke and brain injury |
| - diagnosed as having SCI | - having unstable health conditions that require serious or intensive medical attention |
| - age 18 years old or older | - underwent spine surgery within the past 30 days |
| - having access to telecommunication tools | |

**PARA-SCI**: the physical activity recalls assessment for people with spinal cord injury; SCI: spinal cord injury; AIRS: Accuracy and interpretability rating scale; CIRS: Comparability and interpretability rating scale; T1: Forward translation or English to Thai translation of original PARA-SCI performed by Translator-1a; T2: Forward translation or English to Thai translation of original PARA-SCI performed by Translator-2a; T12: Thai PARA-SCI reconciled forward translation as a result of finalizing T1 and T2; T12v2: Thai PARA-SCI pre-final version as a result of adjusting the T12; B1: Back translation or Thai to English translation of T12 performed by Translator-1b; B2: Back translation or Thai to English translation of T12 performed by Translator-2b; B3: Back translation or Thai to English translation of T12v2 performed by second Translator-2c; n: number of assessors or participants.
and content validation of this PARA-SCI are described below (depicted in Figure 1):

Step 1 – forward translation. The original English language version of PARA-SCI (O1) was translated by two independent translators (Translator-1a and Translator-2a) into two initial Thai language PARA-SCI versions (T1 and T2, respectively).

Step 2 – reconciliation of the two forward translated versions (T1 and T2). The Moderator and forward Translator-2a identified linguistic errors and different contextual interpretations between T1 and T2 versions. At this step, the first consensus agreement was performed between the Moderator and forward Translator-2a. Any discrepancies were resolved by discussion to form a reconciled PARA-SCI Thai version (T12). The reason for choosing each statement was recorded.

Step 3 – backward-translation and evaluation of the translated version of the PARA-SCI. In this step, two parallel actions were performed. Firstly, the T12 was backward-translated by two independent translators (Translator-1b and Translator-2b) into two PARA-SCI English-translated versions (B1 and B2 respectively). Then Assessor-1 and Assessor-2 deployed CIRS assessment [18] to evaluate B1 and B2 against O1. Both Assessors were asked to provide comments on any statement that received a CIRS score of 3 or above (moderately comparable/similar to not at all comparable/similar). Secondly, the Assessor-3 group used AIRS to evaluate T12 against O1. The Assessor-3 group was asked to give suggestions and translation solutions on any statement of T12v2 that received AIRS score of 3 and above (moderately accurate/similar to not at all accurate/similar).

Step 4 – harmonization of the thai version of PARA-SCI. The Moderator and Translator-2b performed a consensus agreement and adjusted the T12 based on the CIRS and AIRS scores, comments, and suggestions from all assessors to create the Thai PARA-SCI pre-final version (T12v2). Any remaining differences between T12 and T12v2 were recorded. Then, a new Assessor-3 group used AIRS to evaluate T12v2 against O1. They were asked to give suggestions and translation solutions on any statement of T12v2 that received AIRS score of 3 and above (moderately accurate/similar to not at all accurate/similar).

Step 5 – back-translation of T12v2. Translator-2c backward-translated T12v2 from Thai into the PARA-SCI English-translated version (B3). At this step, the Moderator and Assessor-1 discussed and compared B3 against O1 to ensure their conceptual equivalence. Assessor-1 revised all declarations and explanations of word choices, changes, and translation solutions. A discussion about any remaining idiosyncrasies between B3 and O1 led to final consensus. Two official Thai government staff reviewed T12v2 against B3 and O1 for approval of T12v2 for later use in Thailand in a subsequent national physical activity survey.

Step 6 – cognitive debriefing with potential users and target population. Face-to-face semi-structured interviews (see Supplementary Appendix 3) were conducted in a community of convenience in Bangkok, Thailand with Thai-PT ($n = 6$) and Thai-SCI ($n = 5$) for their understanding of the content of the PARA-SCI (T12v2). These semi-structured interview questions allowed Thai-PT and Thai-SCI to reflect upon and discuss the interview script based on their understanding. Questions such as “Are there any words/texts/statements that seem confusing to you?” allowed participants to provide insightful responses. Drill-down prompting questions were asked if further clarifications were needed; for example, “How do you find the words/texts/statements confusing?” or “How would you respond to that question/statement”. Interviews lasted between 60 to 90 min and were digitally recorded and transcribed for later analysis. Based on these interviews, the Moderator and all Translator-2s revised and adjusted the T12v2 accordingly to ensure that the final version of the Thai PARA-SCI (Thai-PARA-SCI) was appropriate for the monolingual-targeted population. The original English language version of PARA-SCI (O1) is described in the PARA-SCI developers’ study [13] and the Thai-PARA-SCI is presented in Supplementary Appendix 4.

Data analysis
For the CIRS and AIRS assessments, any statement that was independently scored 3 or above was revised, analyzed, and discussed between the Moderator and Translator-2 for clarity and further amendments (Steps 3 and 4). All CIRS and AIRS scores (comparing B1, B2, T12 and T12v2 against O1) from all assessors were recorded in a spreadsheet. Results of CIRS (B1 and B2 against O1) and AIRS (T12 and T12v2 against O1) were presented as total number and percentage score ranges (Table 2).
Table 1. Potential participants who responded to the advertise
Thai-SCI. The recruitment criteria for Thai-SCI is described in
SCI individuals. Internet-based social media advertisements were
The participants involved in this component included only Thai-
ments were contacted and screened for eligibility.
Part 2: reliability testing
Participants
The participants involved in this component included only Thai-
 SCI individuals. Internet-based social media advertisements were
posted online to the Thai Spinal Cord Injury Society for recruiting
Thai-SCI. The recruitment criteria for Thai-SCI is described in
Table 1. Potential participants who responded to the advertise-
ments were contacted and screened for eligibility.

Measures
The final version of the Thai PARA-SCI (Thai-PARA-SCI) was
employed in three different assessment sessions – the second
interview being conducted one hour after the first interview, fol-
lowed by the third interview conducted one week later from the
day that the first and second interviews were conducted. In each
interview, all ADL and LTPA activities were recorded chronologi-
cally from the time the participant awakened until their bed time
along with the duration, intensity level and type of activity.
Operational definitions for the use of Thai-PARA-SCI based on
the advice received from Thai-PT and Thai-SCI were:
• Activities that took less than one minute of physical exertion
were rounded up and recorded as one minute in duration.
• The start and the finish time for each activity were recorded.
• The start and endpoint for the morning routine were
recorded from the time of awakening till transferring to a
wheelchair after completing self-care and getting dressed.
The start and endpoint for daytime activities were denoted
as being up in a wheelchair (after the morning routine) until
the time before getting ready for bed (changing dress for
bedtime as a “cut point”) or preparing to have a shower (if
taken in the evening prior to going to bed). The start and
endpoint for the evening routine was preparing for a shower
in the evening (or changing dress for bedtime) until sleep.
When a participant used a statement like “same as yester-
day”, they were asked to remember if they were forget-
ting something.

Table 2. CIRS and AIRS scores ranges by all assessors.

| Assessor’s scores | Comparability scores: n (%) | Interpretability scores: n (%) | Comparability scores: n (%) | Interpretability scores: n (%) |
|-------------------|-----------------------------|-------------------------------|-----------------------------|-------------------------------|
|                   | B1 (n = 3, N = 43)          |                               | B2 (n = 3, N = 43)          |                               |
|                   | Comparability scores: n (%) | Interpretability scores: n (%) | Comparability scores: n (%) | Interpretability scores: n (%) |
| <3                | 75 (58%)                    | 93 (72%)                      | 100 (100%)                  | 80 (80%)                      |
| 3-5               | 51 (40%)                    | 33 (26%)                      | 80 (80%)                    | 62 (62%)                      |
| >5                | 3 (2%)                      | 3 (2%)                        | 0 (0%)                      | 0 (0%)                        |

CIRS: Comparability and interpretability rating scale; AIRS: Accuracy and interpretability rating scale; B1: Back translation or Thai to English
translation of T12 performed by Translator-1b; B2: Back translation or Thai to English translation of T12 performed by Translator-2b; T12: Thai
PARA-SCI reconciled forward translation as a result of finalizing T1 and T2; T12v2: Thai PARA-SCI pre-final version as a result of adjusting the
T12; n: number of assessors; n: total number of sentences that were scored by assessors; N: number of sentences from PARA-SCI that were
divided for scoring purpose.

Qualitative content analysis [28] was performed on the
recorded interview transcriptions of Thai-PT and Thai-SCI. This
analysis allowed the Moderator to capture any problematic state-
dments, discuss those with all Translator-2, and adjust individual
statements accordingly.

Interview procedure
An HREC-approved Thai-language Participant Information
Statement was provided to the potential participants. Those who
met the recruitment criteria (Table 1) were asked to provide ver-
bal and written consent to participate in the study. Participants
were asked to revise the “intensity classification chart” to use on
the day of the interview. The interviews were conducted during
December 2018 and January 2019.

During the first interview, participants’ characteristics were col-
clected. These included the American Spinal Injury Association
Impairment Scale (AIS) and the neurological level of injury accord-
ging to the International Standards for Neurological Classification
of Spinal Cord Injury (ISNCSCI) [29]. Then, the Thai-PARA-SCI was
administered on three different occasions by two different
researchers to test inter- and intra-rater reliability of the survey.
The Moderator (ACE) performed the first and third interviews one
week apart, while a Thai research assistant performed the second
interview (one hour after the first interview).

Each Thai PARA-SCI interview lasted approximately 45 to
60 min. The Moderator and Thai research assistant were blinded
to each other’s interviews during the study. They were also
instructed not to disclose or discuss their assessments. The inter-
viewers were appropriately trained to use the Thai PARA-SCI. They
read the assessment items to the participants according to an uni-
form script.

Inter-rater reliability was assessed by comparing the assess-
ment results from the two researchers that performed the inter-
views one hour apart on the same day. Intra-rater reliability was
assessed by comparing the results of the Moderator that per-
formed the interviews one week apart.

Statistical analysis
The Statistical Package for the Social Sciences version 25 (IBM
Corporation, Armonk, NY, USA) was used to perform statistical
analyses. The inter- and intra-rater reliability of the Thai-PARA-SCI
was determined using intraclass correlation coefficients (ICCs),
Bland–Altman plots and one-way ANOVA analyses.
The reliability of repeated measures was calculated and their 95% confidence intervals based on mean variance, absolute agreement, two-way random-effect model. The intraclass correlation coefficients were interpreted according to a rating system suggested by Koo and Li [25]:

“Values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability and values greater than 0.90 indicate excellent reliability. page 161 [25].”

Bland-Altman plots were used to compare and measure the degree of association (correlations) of the total score of mild, moderate and heavy activity intensities of the Thai-PARA-SCI and these results are presented as scatterplots [26].

Two One-way ANOVA procedures were conducted. The first was applied to the inter-rater PARA-SCI measures, and compared the total score of mild, moderate and heavy activity intensities between the two interviewers conducted with each participant on the same day. The second ANOVA was applied to the intra-rater PARA-SCI measures, and compared the first assessment to the assessment one week later by the same interviewer. Alpha was set at 0.05. Confidence intervals were calculated to 95%. [27].

Results
Part 1: translation and cross-cultural adaptation

The purpose of this component was successfully completed. The Thai PARA-SCI was generalized and understandable by the mono-lingual-targeted population of Thai-PT and Thai-SCI. The results of each translation step and cross-cultural adaptation are presented in the following sections.

After T1 translation (refer to List of Abbreviations), critical misinterpretations and misconceptions were identified in numerous statements. For example, T1 translated “spinal cord injury” to "ไขสันหลังอักเสบ", "intensity" to "ระดับความรุนแรง", and "Did you have to take any trips to the bathroom during your day?” to “คุณมีไปใช้ห้องน้ำในระหว่างวันหรือไม?” Therefore, the Moderator and Translator-2a reached consensus that T1 was inaccurate and adjusted the content based on T2 to create T12.

The T12 was scored against O1 using AIRS by the twelve Assessor-3 group members (total statements n = 860). The back-translation of T12 (B1 and B2) was scored against O1 using CIRS by one Assessor-1 and two Assessor-2s (total statements n = 129). The total number and percentage of score ranges are presented in Table 2. Assessor-1 and Assessor-2 scored 1 or 2 (i.e., extremely comparable and extremely similar, respectively) on comparability (≈60%) and interpretability (≈70%) for the back-translations (B1 and B2) statements, while the Assessor-3 group mostly scored 1 or 2 (extremely accurate/similar) on accuracy and interpretability (both ≈90%) on T12 statements. All statements that obtained a score of 3 or higher (moderately accurate/similar to not at all accurate/similar) (≈30–40% for B1 and B2, ≈10% for T12) along with the comments and advice from all assessors were revised and adjusted in creating the T12v2. Most comments from Assessor-1 and Assessor-2 on the B1 and B2 were concerned about differences in interpretation, for example, the back-translations of “setting the stage” was “timing” (B1) and “setting the period” (B2). The majority of comments and advice from the Assessor-3 group on the T12 were about consistency in the formality of language, the flow of language, excessive use of Thai prepositions, inappropriate word choices, cultural inequivalence, wordiness and redundancy after translation.

Consensus agreement between the Moderator and Translator-2b was reached after adjustments of the T12 into T12v2 based on the comments and advice of all assessors. Major adjustments were made to the section “PARA-SCI script” and the “intensity classification chart”. The T12v2 was rated as 1 (extremely accurate/similar) in all 43 statements for both accuracy and interpretability by the Assessor-3 group. The B3 was revised and discussed between the Moderator and Assessor-1. All changes and adjustments in the T12v2 and B3 were declared and explained in detail until a consensus was reached.

Content analysis of the transcribed semi-structured interviews revealed that both Thai-PT and Thai-SCI interpreted the T12v2 as “understandable but needing minor adjustments”. Hence, minor changes in Thai prepositions, relative pronouns and spaces were made to the final version. Moreover, the statement “ไม่เคยสัมพันธ์กับประวัติ” (English context “not a history of what you usually do”) was removed as it caused confusion. These changes did not affect the main content of the PARA-SCI. After adjustments and revisions by the Moderator, Translators, Thai-PT and Thai-SCI, the Thai-PARA-SCI was created (Supplementary Appendix 5).

Part 2: reliability testing

The characteristics of Thai-SCI who participated in this study (n = 38) are presented in Table 3. Descriptive characteristics of all types of physical activity intensity classifications for each day, the One-way ANOVA, and the intra- and inter-rater reliability results are presented in Table 4. As shown in Table 4, the only significant changes in PARA-SCI mean score levels were in the week-apart intra-rater reliability measures, with a reduction in mean for moderate intensity LTPA (F (1,37) = 5.41, p = 0.03) over the week. Intra-rater reliability was poor (ICC score r < 0.5) for moderate intensity ADL, LTPA and cumulative physical activity as well as heavy intensity of LTPA and cumulative physical activity; and moderate reliability (ICC score between r = 0.5–0.75) for mild intensity ADL, LTPA, and cumulative physical activity as well as the heavy intensity ADL.

The Bland-Altman scatterplots of the intra- and inter-rater reliabilities are presented in Figure 2. The scatterplots broadly reflected the levels of agreement indicated by the ICCs. The three inter-rater graphs (upper panels) showed most points were clustered close to the zero-difference reference line, denoting small degree of bias. In contrast, the three intra-rater scatterplots (lower panels) revealed larger departures from the zero-difference reference line, denoting less agreement. In particular, differences between Time 1 and Time 3 measures, while centred around zero, revealed greater dispersion between independent raters for mild and moderate physical activity scores above 100 min per week.

Discussion

The current study translated and culturally adapted the PARA-SCI (English version) into the Thai language physical activity interview questionnaire using a multi-step translation and content validation process [17–24]. This novel study was undertaken in preparation for deploying the PARA-SCI and other survey tools in a Thai national survey of people with SCI in an economically developing Southeast Asian country. The benefits of using the PARA-SCI for

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The PARA-SCI has shown to be accurate for estimating energy expenditures in people with SCI when compared with the "gold standard" of physical activity assessment — highlighting in previous reports [30–32] and in clinical practice [30,33,34].

The PARA-SCI has shown to be accurate for estimating energy expenditures in people with SCI when compared with the "gold standard" of physical activity assessment — highlighting in previous reports [30–32] and in clinical practice [30,33,34]. Advantages of using the PARA-SCI over other physical activity assessments are its specificity to a population with SCI, the shorter duration for application and data collection, as well as the content-rich details about the type of physical activities and exercise-specific behaviours. We chose to deploy the PARA-SCI in this study and in the following Thai national survey of physical activity because of its superiority over the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) survey [35] for SCI population. PARA-SCI also demonstrates stronger relationship for Individuals with Physical Disabilities (PASIPD) survey [35] for SCI population. PARA-SCI also demonstrates stronger relationship with the doubly-labeled water [5]. Advantages of using the PARA-SCI over other physical activity assessments are its specificity to a population with SCI, the shorter duration for application and data collection, as well as the content-rich details about the type of physical activities and exercise-specific behaviours. We chose to deploy the PARA-SCI in this study and in the following Thai national survey of physical activity because of its superiority over the Physical Activity Scale (PASIPD) survey [35] for SCI population. PARA-SCI also demonstrates stronger relationship with the doubly-labeled water [5].

It is important to understand the physical activity patterns and exercise behaviours of Thai-SCI in order to improve public health policies, healthcare delivery and the implementation of key “Exercise is Medicine” interventions that are suitable within the Thai context. Furthermore, it is important to encourage greater uptake of physical activity for better health, thereby reducing the costs and healthcare burden to individuals with SCI and to the health system. Additionally, the methodology employed in this study can be viewed as a “benchmark” for translation of healthcare-related surveys into Southeast Asian contexts with different root languages for people with physical disabilities. To date, this information has not been available in Thailand, and so the development of the Thai-PARA-SCI was an important first step prior to surveying its national population of wheelchair users.

Our first aim was to translate and culturally adapt the content of the English version of the PARA-SCI into the Thai language. Thai spoken lexicon is rich in subtle distinctions and some of these cannot be easily placed within an English-language context. Some phrases are translatable, although only after careful consideration and content-validation. Also, there are many English words for which it is difficult to find accurate and culturally competent Thai translations [33,36]. Therefore, our use of bilingually fluent assessors to evaluate each step of the forward- and backward-translations was an important first step prior to surveying its national population of wheelchair users.

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backward-translation was deemed important to detect vague or imprecise statements. For example, the mismatch in comparability and interpretability scores between the first back-translation (version B1 and B2) with the preliminary version (T12) demonstrated that a word with multiple meanings in English might have only one corresponding expression in Thai or may require extensive explanation to become understandable [36].

The Thai PARA-SCI pre-final version (T12v2) obtained an absolute score of 1 (extremely accurate and extremely similar) in both accuracy and interpretability scores revealing that the English-Thai bilingual speakers could completely understand the context of the translated version. The suggestions for changes to the T12v2 by monolingual Thai speakers (Thai-PT and Thai-SCI) were regarding the nuanced tone, flow, and formality within the Thai spoken language. This generally happens when translating languages between different root origins, in this case from Indo-European (English) to Sino-Tibetan (Thai) [37]. The rigorous process of translation and cross-cultural adaptation employed in the current study confirms that the final version of the Thai PARA-SCI (Thai-PARA-SCI) (Supplementary Appendix 5) is contextually and linguistically valid to be used with the targeted population.

Our second aim was to assess the inter- and intra-rater reliability of the translated Thai PARA-SCI survey instrument. Our results revealed excellent inter-rater reliability of the Thai PARA-SCI (ICC = 0.99, 95% CI range from 0.95–0.99). However, these results must be interpreted with caution as our methodology of using one-hour reassessments (short retest time) could have led to recall bias or been influenced by practice effects. There was a noticeable reduction in the interview duration on the second interview conducted on the same day that could be related to the fact that some participants might have recalled the response they provided during the first interview rather than reflected from the prior 3 days as requested by the PARA-SCI script or had increased efficiency in responding to the answering pattern as they learned to estimate intensities and time duration with practice. This potential recall bias may lead to less accurate recollection of the actual activities performed in the past 3 days when compared to the previous interview performed one hour earlier [38]. Additionally, the standard operational definitions that the authors implemented based on the advice from Thai-PT and Thai-SCI to optimise data quality assurance might have affected our results in various ways. For example, it might have overestimated or underestimated the time participants spent performing physical activities of less than 1-min duration. Also, participants might have felt mentally taxed by being repetitively asked for the time, duration and type of intensity of their activities according to time of the day.

The wide range of poor to moderate intra-rater reliability scores in our study (ICC ranged from 0.05–0.69, 95% CI ranged from −0.06–0.83) was in contrast to the results of the original PARA-SCI development study (ICCs ranging from 0.45–0.91, 95% CI ranged from 0.27–0.94) [13]. The widespread deployment of the PARA-SCI [13–15,39,40] and its high “construct” validity to a “gold standard” ([2H]O doubly-labeled water; [5]) gave us confidence in the instrument for the purpose of this undertaking. However, the relatively poor intra-rater reliability scores in our study could be attributed to the period of data collection that inadvertently occurred during the customarily long Thai holiday period. Since the interview periods were seven days apart and across two different occasions, one interview could have possibly captured activities during personal vacation time while the subsequent one could have captured activities during their normal working week. Thus, the variation in the time spent on

Figure 2. Bland Altman plots showing the difference in times spent on mild, moderate and heavy physical activity.

| Figure 2. Bland Altman plots showing the difference in times spent on mild, moderate and heavy physical activity. | Figure 2. Bland Altman plots showing the difference in times spent on mild, moderate and heavy physical activity. |
|---|---|
| a. Intra-rater reliability on mild physical activity score | b. Intra-rater reliability on moderate physical activity score | c. Intra-rater reliability on heavy physical activity score |
| Mean bias (SD) = 2.23 (13.33) | Mean bias (SD) = 0.44 (10.46) | Mean bias (SD) = 0.30 (4.41) |
| 95% CI | 95% Limits of agreement | 95% CI | 95% Limits of agreement |
| Lower | Upper | Lower | Upper | Lower | Upper | Lower | Upper |
| -2.15 | 6.91 | -9.74 to 5.44 | -0.98 to 14.20 | -3.00 | 3.88 | -8.97 to 2.97 | -2.09 to 9.25 | -1.15 | 1.73 | -3.67 to 1.37 | -0.77 to 4.27 |
| All intra-rater reliability scores within these Bland Altman plots were exposed to small degree of bias (recall bias and practice effects). |

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|---|---|
| d. Intra-rater reliability on mild physical activity score | e. Intra-rater reliability on moderate physical activity score | f. Intra-rater reliability on heavy physical activity score |
| Mean bias (SD) = 12.28 (114.57) | Mean bias (SD) = 12.28 (114.57) | Mean bias (SD) = 8.10 (119.16) |
| Mean bias (SD) = 6.55 (54.77) | Mean bias (SD) = 6.55 (54.77) | Mean bias (SD) = 16.7 (119.16) |
| 95% CI | 95% Limits of agreement | 95% CI | 95% Limits of agreement |
| Lower | Upper | Lower | Upper | Lower | Upper | Lower | Upper |
| -25.37 | 49.94 | -90.72 to 39.98 | -13.41 to 115.29 | 8.93 | 87.26 | -59.03 to 78.86 | 19.30 to 155.22 | -11.43 | 24.53 | -42.69 to 19.79 | -6.69 to 55.79 |
| All intra-rater reliability scores within these Bland Altman plots were exposed to high degree of bias (bias from collecting the data across two different occasions). |
physical activity that was measured at the week-apart interval could have been due to genuine differences in activity patterns between holidays and work periods and might be expected as a natural behavioural variation [41,42], rather than any unreliability of the measuring instrument.

Although the degree of agreement among repeated administrations of a physical activity survey performed by a single rater depends on the construct being measured over time (to reduce the memory effects), the variability that exists in people’s physical activity patterns from one week to the next might also be altered by individual factors (e.g., personal preference and change in health status) [43], environmental causes (e.g., seasonal change and living condition) [44] or special circumstances (e.g., family gathering and holiday periods) [41,42]. Considering that the PARA-SCI was created to capture activity patterns in a “real-world” community life and the possibility that physical activity levels could vary over time, the authors assert that using the same day intra-rater findings (in our case, an hour-apart interval) may be a more trustworthy guide to the PARA-SCI reliability.

One limitation of the current study was that Translator-1, an out-sourced employee of a commercial translation company, who was used to ensure that our approach was ISO17100:2015 compliant was not available for discussions with the Moderator. Clarification regarding their translation or interpretation of certain Thai – English phrases could not be obtained. We viewed that the advantages of initially outsourced ISO-compliance during the forward- and backward-translation steps outweighed the disadvantages of the lack of a later consultation.

There are some recommendations for future research and clinical deployment of the Thai-PARA-SCI survey. The intra-rater reliability of the Thai-PARA-SCI should be retested at a different time of the year and during a non-holiday period for consistency of between-test conditions. When employing physical activity assessment tools in the community, clinicians should purposively choose the interview assessment time that best represents the participants’ “typical” activities during their normal daily routine. In addition, despite the fact that construct validity of the Thai-PARA-SCI was not tested due to the relatively small sample size of Thai SCI in this study (n = 38), further study should investigate its convergent or discriminant validity against another survey to confirm that the measures are related.

In conclusion, this study achieved its aims of culturally and systematically translate the English PARA-SCI interview survey script into Thai, with excellent inter-rater reliability being demonstrated. The Thai-PARA-SCI was shown to be culturally competent and understandable by prospective users (Thai-PT) and participants (Thai-SCI). Therefore, it is ready to be used in future research and clinical contexts. When employing the Thai-PARA-SCI, clinicians must ensure that the timing of interview administration is performed during a “stable” lifestyle period, and does not coincide with any unusual time points (e.g., festive holidays, local special events or illnesses) to ensure that the data are representative of the underlying physical activity levels of their participants.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethical approval

This research was approved by the Human Research Ethics Committee, The University of Sydney, Australia (Project numbers: 2017/1006 and 2018/588).

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