Spinal Cord (2021) 59:1096–1103
https://doi.org/10.1038/s41393-021-00633-5

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ARTICLE

Adaptation and validation of the Japanese version of the Spinal Cord Independence Measure (SCIM III) self-report

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Received: 18 November 2020 / Revised: 8 April 2021 / Accepted: 8 April 2021 / Published online: 30 April 2021

Abstract

Study design Psychometric study, cross-sectional validation study.

Objectives To adapt and validate the Japanese version of the Spinal Cord Independence Measure self-report (SCIM-SR).

Setting A spinal cord injury (SCI) rehabilitation facility in Japan.

Methods We adapted the SCIM-SR for the Japanese population by translating and validating the questionnaire in accordance with the international guidelines. Following this, we analyzed 100 inpatients with SCI. We evaluated their independence using the Japanese SCIM-SR, and compared the data with those assessed using the SCIM III by trained ward nurses.

Results Spearman's rank correlation coefficients were 0.95 for the total score, 0.89 for self-care, 0.83 for respiration and sphincter management, and 0.89 for mobility subscores. The Bland–Altman analysis revealed no significant proportional bias (−0.02; 95% CI [−0.07, 0.06]), but a significant fixed bias (2; 95% CI [0.5, 3.5]). We did not identify any specific factor that affected the differences between SCIM III and SCIM-SR scores.

Conclusions Our study validated the Japanese version of SCIM-SR as a tool for the evaluation of the independence of persons with SCI, which could substitute SCIM III and help facilitate a deeper understanding of activities of daily living among patients with SCI.

Introduction

Among the many clinical measures of the activities of daily living (ADLs) of persons with spinal cord injury (SCI), the Spinal Cord Independence Measure III (SCIM III) [1, 2] is used most widely and internationally. The SCIM III itself has been developed to evaluate the ADLs solely on the basis of observation by trained medical professionals. Because of this characteristic, evaluation with the SCIM III is time-consuming. To overcome this drawback, Itzkovich et al. [3] examined and supported the reliability and validity of assessment using the SCIM III on the basis of interview; however, the individual SCIM III score obtained through interview should be used with caution for clinical purposes because the scores varied prominently between raters. For instance, the kappa coefficient value was 0.11 for item 9 (mobility bed). They also reported low to moderate agreement between the interview and observation scores (the lowest at 0.03 for item 8 (use of toilet)). Therefore, the SCIM III is entirely useful for evaluating the ADLs of outpatients. This indicates that observational assessment is more objective than evaluation with a questionnaire. However, a questionnaire is better for quick data collection [4]. For these reasons, Fekete et al. [4] developed a self-report version of Spinal Cord Independence Measure (SCIM-SR) in German and English. It has been translated into other languages: Spanish, Italian, Thai, and Chinese [5–8].

Both the SCIM III and SCIM-SR consist of three subscales, namely "self-care", "respiration and sphincter management", and "mobility". Both scales have 19 items that

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41393-021-00633-5.

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evaluate the same activities; however, the wording of the SCIM-SR has been adapted for non-medical professionals for easy understanding. For example, the seven measures in item 6 (bladder) of the SCIM III were deconstructed into three statements, and scoring algorithms were introduced for non-medical professionals to render the scores comparable to those assessed by medical professionals using the SCIM III.

The SCIM-SR is believed to be a valuable tool for outpatients. As the original authors intended, the SCIM-SR is now employed in several community-based surveys in Western countries [9–12]. Because of its widespread usage, owing to its convenience and comparability with the SCIM III, the SCIM-SR would soon become the standard measure worldwide for the screening of ADLs among community-dwelling individuals with SCI. It should be noted that the SCIM-SR in previously reported language versions demonstrated a high correlation with the SCIM III in total scores and subscale scores. However, no previous reports analyzed the correlation between each item score of the SCIM-SR with that of the SCIM III. Considering the cross-cultural comparison of the SCIM-SR worldwide, the validity confirmation of each item is necessary. Despite evaluating inpatients using the SCIM III to manage their rehabilitation programs, the recommendation for lifestyle changes after discharge is solely based on interviews at our clinic. This method, however, lacks objectivity and consistency. Hence, we decided to develop the SCIM-SR in Japanese to further evaluate outpatients as is done in other countries.

This study aimed to translate the SCIM-SR into Japanese and validate the Japanese version to make it accessible and standardized in assessing the ADLs of persons with SCI, particularly outpatients.

Methods

Translation of the SCIM-SR and its validation

We followed the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) checklist [13] and the international guidelines and proposals by Sperber [14] in the process of translation to ensure its validity. Initially, two medical experts familiar with the SCIM III independently translated the English version of SCIM-SR into Japanese. The third expert combined them to form a draft of the Japanese version of the SCIM-SR, called the "jSCIM-SR". The professional translator translated the draft jSCIM-SR back into English, hereafter referred to as the "back-translated jSCIM-SR". Then we recruited 30 medical students, who were proficient at English, to compare the original English version of the SCIM-SR and the back-translated jSCIM-SR, in terms of both comparability and interpretability. They were instructed to score each item on a scale of 1 to 7 points: 1 indicating extremely comparable or remarkably similar and 7 indicating not comparable at all or not similar at all. An average score of 3 for the comparability and the interpretability of each item was considered to be apt. If this standard was not met, we repeated the translation and back-translation until the average scores were 3 or less. After two rounds of corrections, we completed the translation of the SCIM-SR and formulated the jSCIM-SR (Supplementary material).

Data collection

The inclusion criteria were persons with SCI aged 18 or older. Those who were not able to answer questions because of the inability to read Japanese were excluded. Demographic data, such as age and sex, and the cause of the injury, vertebral level of the injury, severity of the injury, reason for hospitalization, time post-injury, and necessity of help to fill in were collected from medical records. After we recruited participants at Murayama Medical Center between June 2018 and June 2019, their ADLs were assessed using the Japanese version of SCIM III (jSCIM III) by trained nurses. The examiners asked the participants to answer the jSCIM-SR within 4 days of the assessment, and helped them fill the form if asked to do so due to any finger impairments or tiredness. The examiners were instructed not to answer any questions about the meaning of the questionnaire. They also measured the time in which the participants completed the jSCIM-SR.

Statistical analysis

The internal consistency and criterion validity of the jSCIM-SR were assessed according to the COSMIN checklist [13]. We calculated Cronbach's coefficient α to measure the internal consistency of the jSCIM-SR. The values of Cronbach's α exceeding 0.7 indicated a reasonable internal consistency. We also calculated Spearman's rank correlation coefficient to evaluate the relationship between the jSCIM-SR and the jSCIM III. We also performed a Bland–Altman analysis and assessed both unit differences and percentage differences between the jSCIM-SR and the jSCIM III. The unit difference was defined as the jSCIM-SR subtracted by the jSCIM III, while the percentage difference was the unit difference divided by the mean of the jSCIM-SR and the jSCIM III. Then, before plotting the data, we also performed Shapiro–Wilk tests to validate the normal distribution of these differences. In addition, we performed *t*-tests and Bonferroni corrections if necessary to detect factors that could have influenced the correlation between the jSCIM-SR and the jSCIM III. We

tested the following factors: age, sex, cause of the injury, vertebral level of the injury, severity of the injury, reason for hospitalization, time post-injury, and necessity of help to fill in. We classified age and time post-injury into tertiles—age: youngest (≤56 years), middle (57–68 years), and oldest (69≤ years) and time post-injury: shorter (≤3 months), middle (4–8 months), and longer (9≤ months). The statistical analyses were performed using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA).

Results

Translation of the SCIM-SR and its validation

In the process of translation repetition, we intended to retain the meaning of the wording from the English version of the SCIM-SR. Without the intention of modifying any item, two rounds of corrections resulted in the validation of the translation.

Patients' characteristics

We enrolled 113 participants. Six participants were excluded because the jSCIM III was not assessed within 4 days of the assessment of the jSCIM-SR. Four participants declined to participate. Three participants were excluded because of their inability to complete the questionnaires due to either decreased cognitive function or fatigue. In total, the data of 100 participants were collected. The characteristics of the participants are presented in Table 1.

Time to complete the jSCIM-SR

The participants' median time to complete the jSCIM-SR was 11 (IQR, 8.5–14.5) min.

Internal consistency of the jSCIM-SR

Cronbach's α is presented in Table 2. Cronbach's α of the total jSCIM-SR score was above 0.88, which decreased when any of the subscales was eliminated. Cronbach's α of the self-care jSCIM-SR score was above 0.92, which decreased when any of the items was eliminated. Cronbach's α of the respiration and sphincter management jSCIM-SR score was below 0.7. Removal of item 5 (breathing) increased the subscales' Cronbach's α, but removal of any of the other items decreased the subscales' Cronbach's α. Cronbach's α of the mobility jSCIM-SR score was above 0.89. Removal of item 9 (mobility bed) or 17 (transfer ground) increased the subscales' Cronbach's α, but removal of any of the other items decreased the subscales' Cronbach's α.

Table 1 Demographic and clinical characteristics of the study population.

	Total sample 100
Sex	
Male	76
Female	24
Cause of injury	
Trauma	57
Non-trauma	43
Vertebral level of injury	
Cervical	65
Thoracic	29
Lumbar and cauda equina	6
Severity of injury	
Complete	32
Incomplete	68
Reason for hospitalization	
First rehabilitation	85
Others	15
Necessity of help to fill in the questionnaire	
Yes	56
No	44
Age in years, median (IQR)	63 (52–70)
Time post-injury in months, median (IQR)	5 (3–9)

IQR interquartile range.

Correlation between the jSCIM III and the jSCIM-SR

We analyzed the correlation of total scores, each subscale score, and each item score between the jSCIM III and the jSCIM-SR (Table 3). The coefficients were above 0.7 for most of the items, indicating a strong correlation [15, 16], except for items 5 (breathing), 7 (bowel), 14 (mobility outdoor), 15 (stair), 16 (transfer car), and 17 (transfer ground) (Table 3). For these items, the coefficients were between 0.4 and 0.7 (Table 3), indicating a moderate correlation [16, 17].

Next, we examined whether the unit differences and the percentage differences between the jSCIM III and the jSCIM-SR were normally distributed. Only the unit and percentage differences of the total scores of jSCIM-SR and the jSCIM III were found to be normally distributed (Supplementary Table 1). The Bland–Altman analysis revealed there was no significant proportional bias (−0.02; 95% CI −0.07–0.06, $p = 0.88$), but a significant fixed bias (2; 95% CI 0.5–3.5, $p < 0.05$) between the difference and mean of the total jSCIM III and the jSCIM-SR (Fig. 1). Limits of agreement of the total score were −12.5 and 16.6 at the lower and the upper levels, respectively (Fig. 1).

Table 2 Internal consistency (Cronbach's coefficient α) within jSCIM-SR subscales.

Total	0.89
α if item was deleted	
Self-care	0.87
Respiration and sphincter management	0.87
Mobility	0.77
Self-care	0.93
α if item was deleted	
1	0.92
2A	0.91
2B	0.91
3A	0.90
3B	0.91
4	0.91
Respiration and sphincter management	0.62
α if item was deleted	
5	0.66
6	0.44
7	0.53
8	0.46
Mobility	0.89
α if item was deleted	
9	0.91
10	0.88
11	0.88
12	0.86
13	0.86
14	0.87
15	0.89
16	0.89
17	0.90

jSCIM-SR Japanese version of Spinal Cord Independence Measure Self-Report.

Table 3 Spearman correlation coefficient between the scores of jSCIM-SR and jSCIM III.

	Spearman correlation coefficient
Total	0.95
Self-care	0.89
1	0.79
2A	0.76
2B	0.74
3A	0.73
3B	0.73
4	0.72
Respiration and sphincter management	0.83
5	0.56
6	0.90
7	0.52
8	0.88
Mobility	0.89
9	0.76
10	0.86
11	0.82
12	0.77
13	0.77
14	0.54
15	0.64
16	0.47
17	0.44

jSCIM-SR Japanese version of Spinal Cord Independence Measure self-report, *jSCIM III* Japanese version of Spinal Cord Independence Measure.

We performed the statistical analysis to detect the factors that could influence the correlation between the jSCIM-SR and the jSCIM III (Supplementary Table 2). Although the largest difference among the tested factors was between shorter and longer time post-injury, which was 4.1, all of the 95% CIs of the tests we performed included zero, suggesting none were significant (Supplementary Table 2).

Discussion

We validated the jSCIM-SR to evaluate the ADLs of persons with SCI by employing an easy-to-use and standardized method. The jSCIM-SR showed a significant correlation with the jSCIM III. In addition, as shown in the present study, completion of the jSCIM-SR is not time-consuming, suggesting its feasibility in outpatient settings. We believe that the jSCIM-SR could substitute the jSCIM III in such settings.

The jSCIM-SR could unveil a variety of problems that individuals with SCI suffer from in every country. Comparing each item's difficulties in different cultural backgrounds will provide us important information on the factors influencing functional outcomes after SCI. Catz et al. [2] showed that each item of the SCIM III had a cross-cultural equivalence among 13 spinal units in six countries from North America, Europe, and the Middle-East. However, taking the lifestyle differences such as bathing tradition into account, relative item difficulties may vary across countries as found in cross-cultural comparisons using FIM in the stroke population [18]. The proportion of elderly individuals with SCI is increasing [19]. There is a high proportion of elderly individuals with incomplete cervical injury in Japan [20] because of falls on level surfaces as well as in other developed countries [21]. In those countries,

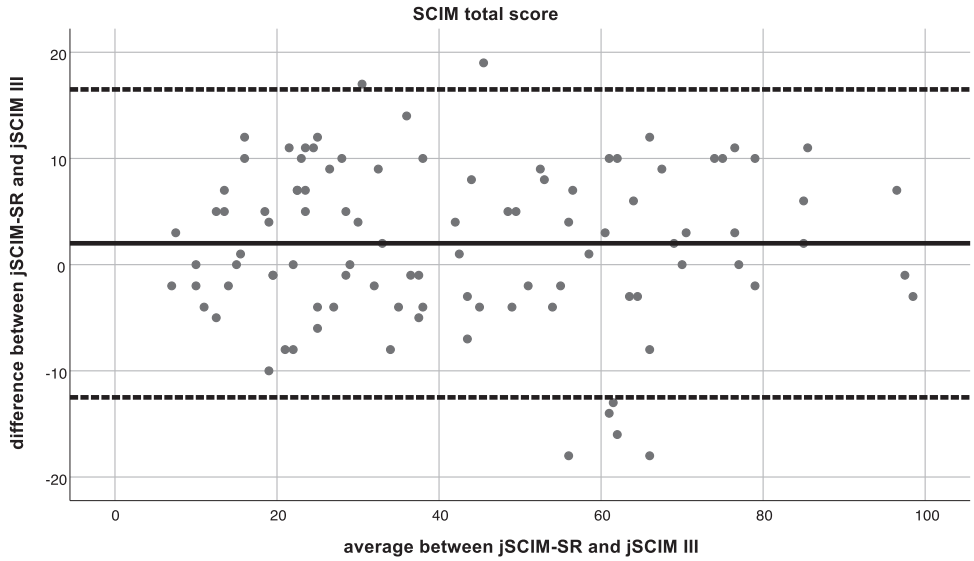

Fig. 1 Bland–Altman plot for the total scores of the jSCIM III and the jSCIM-SR. The solid line and dashed lines indicate mean difference and limits of agreement, respectively.

the functional outcome, i.e., total scores, and/or each item's difficulty might be similar. If there are any differences found, then a careful survey on epidemiology and demographics will be able to provide an explanation. Our study, and of course other reports, could mark the beginning of a worldwide cross-cultural comparison in the community settings.

We had previously reported an association between total SCIM III scores and individual item scores in the inpatients cohort, and we found that the total SCIM III score can provide information about the probability and degree of difficulty to attain independence level in each item [22]. Until now, it is not known whether the same association would be observed in community settings. Although the SCIM-SR has been reported to violate certain assumptions of the Rasch measurement model, Prodinger et al. [23] insisted the SCIM-SR revealed a good model fit in the sub-group of persons with tetraplegia and model fit in the group with complete paraplegia. It might be possible to do the same analysis in the community-dwelling cohort.

We had also demonstrated that ADLs could be predicted with a logarithmic model using the SCIM III [24]. To summarize, the logarithmic equation for the prediction of the SCIM III scores uses "days from onset" as an independent variable that encompasses actual SCIM III scores at two different time-points, and traces the actual SCIM III scores at arbitrary time-points quite well. Using this model, we would be able to estimate the ADLs using a patient's SCIM III measure after discharge, and highlight any prospective improvement by comparing the expected score of the SCIM III and the actual score of the SCIM-SR. This could serve as a helpful monitoring strategy for ADLs of community-dwellers with SCI. Not only is the jSCIM-SR beneficial in assessing patients in the individual level but it also helps discover similarities and differences among various countries from a global point of view.

This study showed a high correlation of the total scores and each subscale score between the jSCIM III and the jSCIM-SR, suggesting a strong positive linear relationship [15]. As shown in previous studies [4–8], this study also indicated that the correlations of the subscales of respiration and sphincter management were lower than those of other subscales between the two measures; Spearman's correlation coefficients were 0.56 and 0.52 for items 5 (breathing) and 7 (bowel), respectively (Table 3). These relatively low correlations in the items of the respiration and sphincter management subscales might be due to terminology and/or limited comparability between the jSCIM III and the jSCIM-SR. In item 5 (breathing), some participants were confused, because the term "respiratory tube" was unfamiliar to participants. In the process of translation and its validation, even minor changes in terminology resulted in inappropriate comparability. It would be helpful to use easily understandable wording by overlooking translational comparability or putting annotations with unfamiliar words so as not to distort the original meaning. In item 7 (bowel), the wordings "irregular or seldom (less than once in 3 days)" or "regular (once in 3 days or more)" might have puzzled the participants. It is not feasible to choose "irregular or seldom (less than once in 3 days)" or "regular (once in 3 days or more)" for those who have bowel movements regularly twice a week, or once in 3.5 days in a precise mathematical sense. It is important to schedule bowel care

at least once in 2 days to avoid colorectal overdistention [25]. At the same time, the defecation schedule should be established based on many factors, including care supplies. It might be clearer to use the wordings "scheduled" or "unscheduled" in item 7b of the questionnaire.

It was surprising that the Spearman correlation coefficients of items 14 (mobility outdoor), 15 (stair), 16 (transfer car), and 17 (transfer ground) were below 0.7 (Table 3), indicating moderate positive linear relationships [15], since the contents of these items are specific, and the sentences are straightforward. The scores of the jSCIM-SR of the previously mentioned items tended to be higher than those of the jSCIM III. These items ask about more advanced activities; thus, it is sometimes difficult for the ward nurses who scored the jSCIM III to evaluate these ADL parameters, which generally took place outside the ward. This suggests that ward nurses could underestimate the ADLs outside the ward with the jSCIM III. Nevertheless, the Spearman correlation coefficients were above 0.4. Considering no reports analyzed the correlation between each item level, the jSCIM-SR is useful and will serve as a reference for those forthcoming reports of SCIM-SR in other languages.

We chose the Bland–Altman unit difference analysis [26] because it has been widely used in such studies. Giavarina [27] indicated that percentage difference plots, as well as unit difference plots, perform a better evaluation, especially when the variability of the differences gets larger with the magnitude of the average. However, this was not the case in our study because the proportional bias was not significant; hence, we only exhibit the unit difference Bland–Altman plot in Fig. 1. In addition, we performed the Bland–Altman analysis only when the differences were normally distributed. Bland and Altman [28] had demonstrated that a nonparametric approach might be preferable, especially if there are one or more extreme discrepancies between the two methods. The differences between the 3 subscales and 19 items of the jSCIM-SR and the jSCIM III were neither normally distributed nor very high, so we used only Spearman correlation coefficients to analyze their correlations.

The Bland–Altman results showed both a significant fixed bias, indicating that the scores of the jSCIM-SR were statistically higher than those of the jSCIM III, and a non-significant proportional bias, demonstrating that the difference did not depend on the scores. However, a mean difference of 2 might not be clinically significant since the full range of the scores is 0–100. Despite the total scores' significant fixed bias, the difference between the jSCIM-SR and the jSCIM III was not significant in the sub-group analysis, in terms of reason for hospitalization (Supplementary Table 2). This was contrary to the previous study [4], which indicated that persons who were hospitalized for pressure ulcers were likely to answer with their habitual level of independence and, therefore, get a higher score of SCIM-SR than the one representative of their independence. This could be because of the effectiveness of the introductory sentence that Fekete et al. [4] added into the SCIM-SR: "Please refer your answers to the present situation". Thus, the jSCIM-SR is useful for all categories of persons with SCI, regardless of their background.

Not only do high validities of the SCIM-SR suggest its superiority over the SCIM III by interview but also the following: firstly, the SCIM III by interview is more time-consuming than directly giving the SCIM-SR to patients or helping them answer it. Secondly, the SCIM-SR could represent a more accurate ADL status because the SCIM III by interview showed low inter-rater reliability [3]. However, there has been no comparison research between the SCIM III by interview and SCIM-SR in any language, thereby requiring further study.

The limitations of this study, however, must not be overlooked. Firstly, we focused on the translation's validation; however, this made the sentences slightly more unnatural or difficult to understand. The comparability between the original English version of the SCIM-SR and the back-translated jSCIM-SR could be lower if the understandability of the jSCIM-SR was excessively emphasized. In addition, only the internal consistency was discussed in terms of the reliability of the jSCIM-SR. However, the reliability of the SCIM III is already proven [1], and thus, the process of proving the reliability of the Japanese version was skipped. Moreover, we did not obtain extremely high correlations in all 17 items. Nonetheless, the jSCIM-SR is reliable because the correlation between the total scores of the jSCIM-SR and the jSCIM III was high enough to allow evaluation of the ADLs of participants by themselves. Finally, we performed the Bland–Altman analysis only when the data were normally distributed, and the nonparametric approach of the Bland–Altman analysis is not shown in this article. Instead, we used the Spearman's rank correlation coefficients to discuss the 3 subscales and 17 questions' criterion validity.

We have confirmed the validity of the jSCIM-SR by performing correlations and Bland–Altman analysis. This study's scope is to evaluate the ADLs of persons who are not hospitalized but live in the community. Therefore, the jSCIM-SR will make it easier to determine how their ADLs change from hospital discharge to community life and whether their ADLs will improve or worsen after discharge. The jSCIM-SR will help us identify the challenges that persons with SCI face at home, and the issues we must address while they are hospitalized. The prospective findings of the jSCIM-SR will be applicable not only in Japan but also in other aging and developed communities worldwide.

Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgements We would like to acknowledge Dr. Christine Fekete (Swiss Paraplegic Research) for her permission to use the SCIM-SR in the current study. We thank Professor Timothy Minton (Keio University) for his arrangement in volunteer recruitment. Furthermore, we thank the participants and volunteers for their generous participation in the study.

Author contributions OU designed the study. ST, OU, and KU translated the SCIM-SR. ST and OU organized the validation of the translation. ST and OU performed data collection and analysis. ST, OU, and ML prepared the manuscript.

Funding This work was supported by the Japan Society for the Promotion of Science Grant-in-Aid for Early-Career Scientists (grant no. 18K17705 to ST).

Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

Ethical approval The protocol was reviewed and approved by our hospital's research ethics committee. The study number is 17-01. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

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