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ARTICLE

Translation and validation of the Chinese version of the Spinal Cord Independence Measure (SCIM III) Self-Report

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Abstract

Study design A cross-sectional psychometric study.

Objective To translate, culturally adapt and validate the Chinese version of the Spinal Cord Independence Measure III-Self Report (SCIM-SR).

Setting Four rehabilitation centers in Guangzhou, Chengdu, and Shiyan, China.

Methods Translation and cultural adaptation of the Chinese version of the SCIM-SR was conducted according to Brislin guidelines. A total of 147 spinal cord injury patients self-rated their functional independence using translated instrument. The psychometric properties of content validity, criterion-related validity, internal consistency reliability, and test–retest reliability were examined.

Results The content validity index of the new scale was 0.99. The intraclass correlation coefficient between the total SCIM-SR and SCIM III scores was 0.935, and the coefficients for its three subscales were 0.899, 0.760, and 0.942. Bland–Altman analysis showed that the mean difference between the total SCIM-SR and SCIM III scores was 2.35 (95% confidence interval −0.58 to 5.28), and differences for the three subscales were 0.75 (−0.51–2.01), 1.30 (−0.63–3.23), and 0.30 (−0.80–1.40). The Cronbach's α coefficients for the total scale, the self-care subscale, and the mobility subscale were 0.908, 0.913, and 0.895, respectively. The α for the respiration and sphincter management subscale was 0.581. Test–retest reliability after 2 weeks yielded a Spearman coefficient for the total scale of and subscale values all above 0.73.

Conclusions Our results indicate acceptable validity and reliability of the Chinese version of SCIM-SR. It may facilitate long-term evaluations of independence in Chinese spinal cord injury patients in the community and at home.

Introduction

Spinal cord injury (SCI) is usually accompanied by some degree of disability and dysfunction, as well as various acute and chronic complications that seriously affect the patient's daily activities [1]. One of the most important objectives of SCI rehabilitation is to improve the patient's functional independence and in the activities of daily life (ADL) to the greatest extent possible. Sensitive and accurate outcome measurements could quantify changes in functional independence and provide evidence for developing personalized treatment plans [2].

At present, there are many tools to evaluate ADL ability and functional independence, such as the Functional Independence Measure (FIM), the Barthel Index, the Modified Barthel Index, and others [3]. Most of the evaluation tools are universal and administered by medical staff. Due to the severity and complexity of dysfunction in patients with SCI, it is necessary to develop an

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assessment tool specific for the functional independence of the SCI population. The spinal cord independence measurement (SCIM) was therefore developed in 1997 for the functional assessment of patients with SCI [4]. It was revised in 2002 [5]. The latest version is the SCIM III, updated and published in 2007 [6]. The SCIM-III has shown satisfactory reliability and validity in many studies, and it is a reliable tool for evaluating functional independence [7–9]. There are many other ADL assessment tools not specific to SCI patients, and they cannot fully reflect the functional status of SCI patients.

The SCIM-III is a measurement tool specifically for SCI patients, but it is mainly used in medical institutions and administered by medical staff. After acute and early recovery, most SCI patients return home [10]. But due to various dysfunction and complications they usually need long-term follow-up to monitor their health status. In China, SCI patients are often scattered widely. They need long-term care, but the limited local resources cannot meet their long-term care needs. At the same time, some traditional follow-up methods such as by telephone cannot properly evaluate the patients' functional status from a distance. So it is difficult and inconvenient for professional medical staff to use the SCIM-III to evaluate SCI patients at home [11]. A self-report instrument for SCI patients would be particularly convenient and important.

A German group led by Fekete has developed a self-reported version of the SCIM-III (the SCIM-SR) in 2013 [11]. Unlike other tools, it evaluates the functional independence of patients through their own reports, rather than relying on medical staff. It has been translated into English, Spanish, Italian and other languages and has shown good reliability and validity in many studies. It has been shown to validly assess the functional independence of SCI patients in family and community environments [1, 12].

In China, the functional independence of SCI patients is mainly assessed using the Barthel Index, the Modified Barthel Index, and version III of the SCIM [13]. The SCIM-SR seems suitable for providing long-term follow-up and assessment in family and community settings, but there is no Chinese version at present. Apart from translation, it is important to have cross-cultural adaptation of the SCIM-SR if it is to be widely accepted in China. The cultural adaptation must of course maintain the instrument's content validity on the conceptual level despite the cultural differences [14]. The purpose of this study was to translate the SCIM-SR into Mandarin Chinese and to generate a cross-cultural adaptation of it, then to test the reliability and validity of that version in a Chinese SCI population.

Methods

Design and settings

This was a cross-sectional psychometric study performed in four rehabilitation centers in Guangzhou, Chengdu, and Shiyan in China.

Translation of the SCIM-SR

After obtaining permission from the original author of the SCIM-SR, translation into Chinese was conducted according to the Brislin guidelines [15]. It involved four steps. (i) The English version was first translated into Chinese by two nursing graduates with bilingual literacy in Chinese and English and SCI research backgrounds, working independently. (ii) The two translated versions were then compared by the two nursing graduates. Differences were discussed and resolved. If disagreements still remained, an expert on SCI with bilingual literacy was consulted. After that, the forward translation was completed, and an initial Chinese version was formed. (iii) The initial Chinese version was then translated back into English by two bilingual graduates from Hong Kong who had been educated in English, working independently. They had no experience in SCI nursing or rehabilitation. (iv) The two back-translated versions were then compared with the original English version by the two nursing graduates who performed the forward translation. Any differences were analyzed and modified, calling on the SCI expert if necessary. After the agreement was attained, the final Chinese version of the scale was complete.

Participants

The Chinese version of the instrument was tested with SCI patients admitted to the hospital between June 2018 and December 2019. The inclusion criteria were (i) aged 18–70 years; (ii) complete or incomplete SCI, either traumatic or non-traumatic; and (iii) conscious and able to answer questions independently and communicate verbally. The exclusion criteria were (i) congenital spinal cord disease; (ii) severe cardiovascular, brain, pulmonary, liver or kidney complications; or (iii) any cognitive disorder.

Instruments

Demographic-disease inquiry

The following information was collected from the patients' medical records: age, gender, course of disease, etiology, level of lesion (paraplegia/tetraplegia), and injury severity.

SCIM III

The SCIM III includes 19 items divided into three subscales: self-care (six items, range 0–20), respiration and sphincter management (four items, range 0–40), and mobility (nine items, range 0–40). The scale's total score is thus 100 points, with a higher score reflecting greater functional independence. A group led by Ye translated the SCIM III into Chinese in 2007. The Cronbach's α coefficient of the Chinese version among SCI patients was 0.82, and the test–retest reliability coefficient was 0.90 [16].

Chinese version of the SCIM-SR

The SCIM-SR consists of 17 items (see Supplementary Appendix 1 for the Chinese version of SCIM-SR, Appendix 2 and 3 for scoring of item 6 and 7 in SCIM-SR). Like the SCIM-III, it has three subscales, and each item has between 2 and 9 grades. The total possible scores of the SCIM III and SCIM-SR are equivalent, with higher scores reflecting greater independence.

Validation of the Chinese SCIM-SR

Procedure

A pilot study was performed with 20 hospitalized SCI patients to confirm the suitability of the scale. After the formal study began, patients who fulfilled the criteria were invited to participate. After obtaining their consent, demographic and disease-related data were collected from the patients' medical records. Then the patients were required to complete the Chinese version of the SCIM-SR by themselves. For patients with hand dysfunction it could be finished with the help of a caregiver as long as the caregiver did not explain items or help choose any answers.

Language equivalence and cultural relevance

Seven experts on SCI nursing and rehabilitation with bilingual literacy in Chinese and English were invited to rate the initial Chinese version of the SCIM-SR from the perspectives of language equivalence and cultural relevance using a 4-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). They were also free to express their opinions and make suggestions on the scale's wording compared with the original English version. The language equivalence indicated how comparable the scale was between the two versions, and cultural relevance evaluations indicated whether or not the expressions conformed to Chinese cultural norms. The percentages of experts who provided ratings of 3 and 4 were calculated, and their comments were considered in revising the initial Chinese version of the SCIM-SR.

Content validity

The revised version was evaluated by eight clinical experts (very experienced in clinical practice with SCI patients) to assess its content validity. Each item was rated using a 4-point Likert scale (1 = uncorrelated, 2 = slightly correlated, 3 = very correlated, 4 = highly correlated) indicating how well the experts felt it was related to the functional independence of SCI patients. An item's content validity index (I-CVI) was calculated as the percentage of experts who gave a rating of 3 or 4, and the scale's CVI (S-CVI) was the mean of I-CVI of all the items in the scale. I-CVI values ≥0.78 and S-CVI values ≥0.9 were considered acceptable [17], and items with unsatisfactory CVI required modification.

Criterion-related validity

To examine criterion-related validity, 40 patients in one research center (a rehabilitation hospital in Guangzhou) were required to complete the SCIM-SR by themselves. Their functional independence was also independently rated by the nurses using the SCIM III at the same time. The nurses were not the same nurses involved in previous studies or in the forward-back translation activity.

Internal consistency

To examine internal consistency, 147 inpatients with SCI in 4 rehabilitation centers completed the SCIM-SR by themselves or with the help of caregivers as described above.

Test–retest reliability

The 40 patients who were rated by nurses completed the SCIM-SR twice, 2 weeks apart, to assess the scale's test–retest reliability. The 40 patients included in the test–retest study were the same patients who were involved in the criterion validity study.

Data analysis

The data were analyzed using version 25.0 of the SPSS software suite (IBM Corp., Armonk, NY, USA). The patients' demographics and disease-related data were described using mean, standard deviation (SD), median, interquartile range (IQR), frequencies, and percentages. The language equivalence, culture relevance and I-CVIs were calculated as percentages. The S-CVI was represented by the mean of I-CVI of all the items in the scale. The SCIM-

III and SCIM-SR scores were not normally distributed, so differences in the medians were analyzed with Wilcoxon's test [18]. The mean differences between the SCIM-III and SCIM-SR total and subscale scores were depicted using Bland–Altman plots [19]. The criterion-related validity was also represented by the intraclass correlation coefficient (ICC) between the SCIM-III and SCIM-SR [20]. The internal consistency was tested using Cronbach's α [21]. The test–retest reliability was assessed using Spearman correlation coefficients [22].

Results

Patient characteristics

A total of 147 SCI patients were recruited. The mean age was 40.3 ± 12.9 years. Most patients (92.5%, 136/147) were <60, and nearly half (44.9%, 66/147) were under 40. Male patients (81.6%, 120/147) made up the majority. Trauma (88.4%, 130/147) was the main cause of their SCIs, and the most common traumas were falls and motor vehicle accidents. The median course of the disease was 7 months (IQR, 1–43). Half of the patients (51.8%, 72/147) had complete SCI. Tetraplegic and paraplegic patients accounted for 30.6% (45/147) and 69.4% (102/147), respectively. The other characteristics are shown in Table 1.

Table 1 Patient characteristics ($N = 147$).

Items	Frequency	Percent (%)
Sex		
Male	120	81.6
Female	27	18.4
Age (years)		
18–29	43	29.3
30–39	23	15.6
40–49	44	29.9
50–59	26	17.7
60–65	11	7.5
Course of disease (months)		
0–2.9	13	8.8
3.0–5.9	43	29.3
6.0–11.9	59	40.1
12.0–23.9	27	18.4
24.0–67.0	5	3.4
SCI level		
Tetraplegia	45	30.6
Paraplegia	102	69.4
Etiology		
Fall	66	44.9
Motor vehicle accident	41	27.9
Injured by falling objects	23	15.6
Infection	7	4.8
Tumor	5	3.4
Degeneration	5	3.4
AIS grade ($n = 139$)		
A	72	51.8
B	17	12.2
C	30	21.6
D	20	14.4

SCI spinal cord injury, *AIS* American Spinal Injury Association Impairment Scale.

Language equivalence, cultural relevance, and CVIs

Regarding language equivalence and cultural relevance, the seven experts agreed 100% for all items. The S-CVI was 0.99, and the I-CVIs of the Chinese version of the SCIM-SR ranged from 0.88 to 1.0. Those results suggest that the content of the SCIM-SR accurately reflected the patients' state of functional independence.

Criterion-related validity

The frequency distributions of the total SCIM III and SCIM-SR scores showed that they were not normally distributed (Fig. 1). Thus the median values using the Wilcoxon's test instead of the means. No significant differences were detected (p values >0.05), although the SCIM III scores ran slightly higher than those of the SCIM-SR (Table 2).

The mean differences of the scores on the total scale and on the three subscales were close to 0 between the SCIM III and the SCIM-SR, and their 95% confidence intervals (CI) contained 0 (Table 3). The limits of the agreement included 95% of the differences in the total scale and all subscales, and the Bland–Altman plots (Fig. 2) displayed a few outliers, indicating agreement between the two scales.

The ICC for the total score between the two scales was 0.935 (95% CI, 0.876–0.966). The values were 0.899 (0.808–0.946) for the self-care subscale, 0.760 (0.546–0.873) for the respiration and sphincter management subscale, and 0.942 (0.890–0.969) for the mobility subscale, indicating high consistency between the two scales (Table 3).

Internal consistency

The Cronbach's α of the SCIM-SR was 0.920 in the pilot study. The Cronbach's α of the total scale was satisfactory (0.908). The internal consistencies of the three subscales were different, with Cronbach's α values of 0.913 for the self-care subscale and 0.895 for the mobility subscale, but a

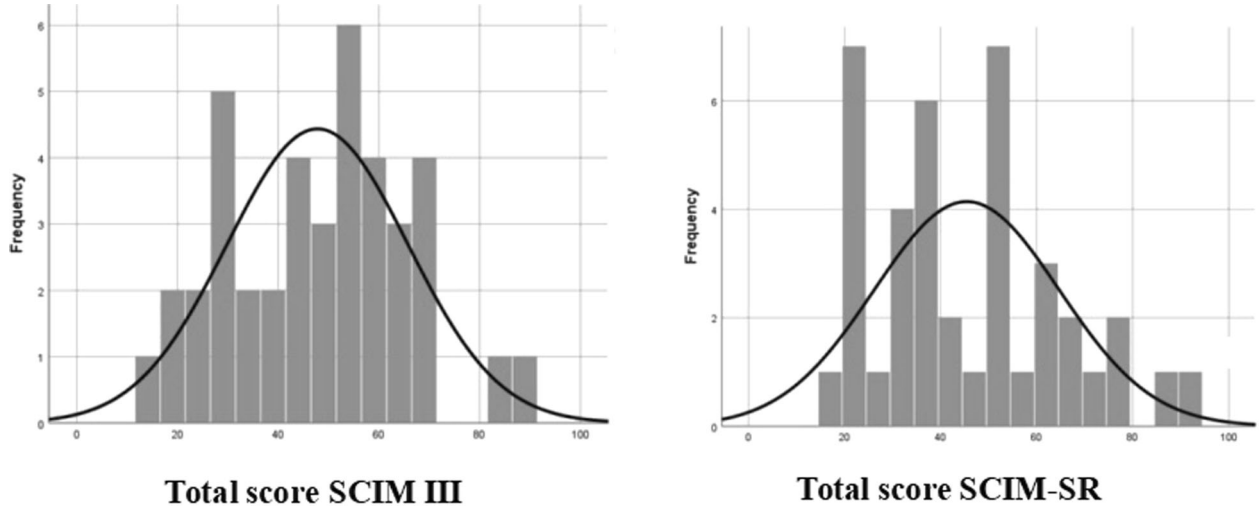

Fig. 1 Frequency distributions of the total SCIM III and SCIM-SR scores. The graph shows the distribution of the total scores of the two scales. The scores were not normally distributed.

Table 2 Comparison between the scores of SCIM III and SCIM-SR ($n = 40$).

	Total score		Self-care		Respiration and sphincter management		Mobility	
	SCIM III	SCIM-SR	SCIM III	SCIM-SR	SCIM III	SCIM-SR	SCIM III	SCIM-SR
Mean (Standard deviation)	47.8 (18.0)	45.4 (19.3)	11.3 (6.0)	10.5 (6.9)	24.4 (6.7)	23.1 (7.0)	12.1 (7.1)	11.8 (7.6)
Median (Interquartile range)	50 (14–88)	42 (17–90)	13 (0–19)	11 (1–21)	25 (14–39)	21 (15–40)	13 (0–32)	12 (0–33)
Z	−0.741		−0.376		−0.820		−0.208	
p	0.459		0.707		0.412		0.836	

SCIM spinal cord independence measure, *SCIM-SR* self-report version of SCIM III.

Table 3 Correlations and mean differences between SCIM-SR and SCIM III ($n = 40$).

	Intraclass correlation (95% CI)	Bland–Altman analysis			
		Mean difference (SCIM III-SCIM-SR)	Point estimate 95% CI	LOA	% Observed differences included in LOA
Self-care	0.899[a] (0.808–0.946)	0.75	−0.51–2.01	−7.0–8.5	95%
Respiration and sphincter management	0.760[a] (0.546–0.873)	1.30	−0.63–3.23	−10.5–13.1	95%
Mobility	0.942[a] (0.890–0.969)	0.30	−0.80–1.40	−6.5–7.1	95%
Total	0.935[a] (0.876–0.966)	2.35	−0.58–5.28	−15.6–20.4	95%

CI confidence interval, *LOA* limit of agreement, *SCIM* spinal cord independence measure, *SCIM-SR* self-report version of SCIM III.

[a]At 0.05 level (double tail), the correlation was significant.

relatively lower value (0.581) for the respiration and sphincter management subscale (Table 4).

Test–retest reliability

Regarding test–retest reliability, the Spearman coefficient for the total scale administered 2 weeks apart was 0.876. For the self-care subscale it was 0.837 with 0.736 for the respiration and sphincter management subscale, and 0.877 for the mobility subscale (Table 4).

Discussion

In this study a Chinese version of the SCIM-SR was developed through complete forward and backward

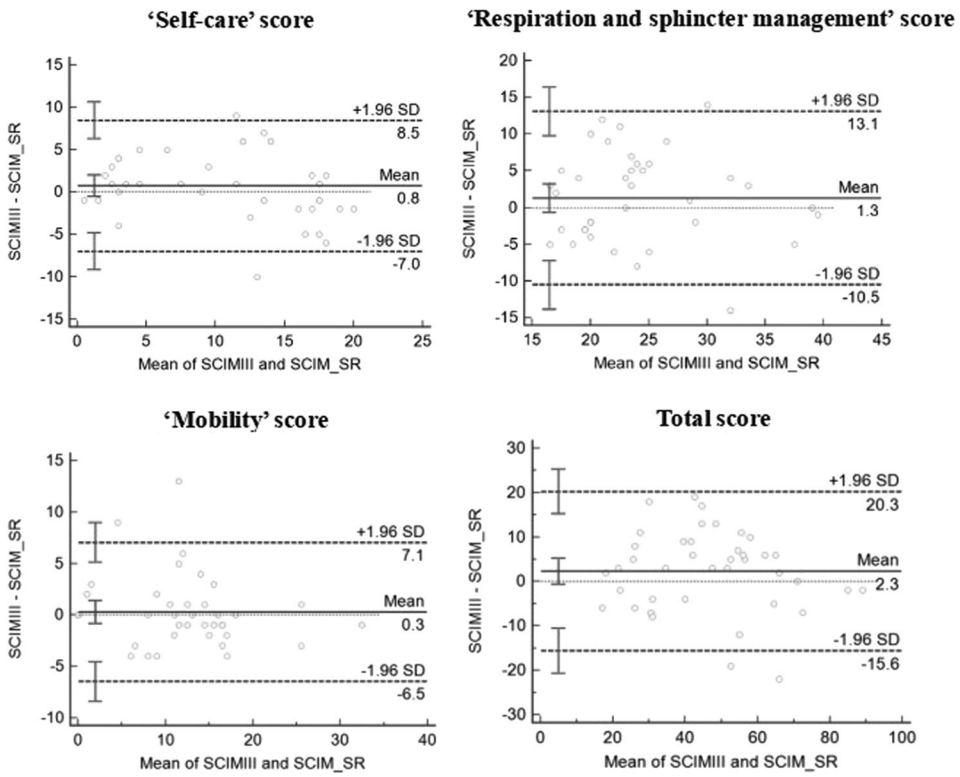

Fig. 2 Bland–Altman plots for agreement between the SCIM III and SCIM-SR. The graph shows the plotting of the scores of the SCIM III and SCIM-SR. 95% of the points are within the limits of agreement for the total scale and subscales, thus indicating strong agreement between the two scales.

Table 4 Internal consistency reliability and test–retest reliability coefficient of SCIM-SR.

Scales	Cronbach's α coefficient ($N = 147$)	Test–retest reliability coefficient ($n = 40$)
Self-care	0.913	0.837[a]
Respiration and sphincter management	0.555	0.736[a]
Mobility	0.895	0.877[a]
Total	0.908	0.876[a]

SCIM spinal cord independence measure, *SCIM-SR* self-report version of SCIM III.

[a]At 0.01 level (double tail), the correlation was significant.

translation according to the Brislin guidelines [15]. The results demonstrate its satisfactory validity and reliability in a Chinese SCI population.

The satisfactory language equivalence, cultural relevance, and content validity indicate that the Chinese version of the SCIM-SR is suitable for measuring the functional independence of patients with SCI by self-reporting. The strict forward and backward translation protocol apparently ensured the instrument's sufficiently accurate language and cultural adaptation. Collectively, the results confirm good validity for the Chinese instrument.

The criterion-related validity results demonstrate that the Chinese version of the SCIM-SR can evaluate the functional independence of SCI patients comparably to the SCIM III. Similar statistical methods were used in testing the German, Italian, and other language versions to test criterion-related validity. The results showed good consistency between the SCIM III and SCIM-SR in all cases [11, 12]. Here too no significant difference was observed between the SCIM-SR and SCIM III scores, and the Bland–Altman analysis results and the ICCs also confirm good criterion-related validity for the Chinese version of the SCIM-SR.

The scores of the SCIM-SR and its three subscales were slightly lower than those measured with the SCIM III, but the differences were not significant. The functional rehabilitation of SCI patients is a long-term process, but most patients in this study had a relatively short course of disease (<2 years), so the impact of dysfunctions on functional independence may still have been prominent. In addition, the SCIM-SR is a self-reported scale. The patients' subjective feelings may affect their judgments of their own functional independence. The SCIM-SR can nevertheless be used as a reliable tool for assessing the functional independence of SCI patients.

The internal consistency of the SCIM-SR as quantified using Cronbach' s α. The α was above the minimum acceptable level of 0.70 for the subscales and the total scores, except for the respiration and sphincter management subscale. This is similar to the results obtained with the Thai version where the respiration and sphincter management subscale also had the lowest Cronbach' s α [23]. The number of test items and their inter-relatedness affects the value of Cronbach' s α [24]. So in this study, one possible reason for the different α values could be that the number of items in the respiration and sphincter management subscale was fewer than in the other two subscales. Also, the items in respiration and sphincter management belong to different ADL domains and their correlations may be relatively lower. So it was not surprising that its internal consistency was slightly worse than in the other two subscales.

The good test–retest reliability reflected the stability of the SCIM-SR, indicating that it can stably measure the functional independence of patients with SCI. Other studies have not measured test–retest reliability [1, 11, 12], but functional independence is an important and relatively stable situation. Any useful tool should therefore have good test–retest reliability.

The study's participants were all inpatients. And the 147 participants almost all had been injured for <2 years. In future studies, the Chinese version of the SCIM-SR should be tested with community- or home-based populations with SCI, as well as in SCI patients with a longer course of disease.

Conclusions

The Chinese version of SCIM-SR is suitable for the functional evaluation of patients with SCI in China. As a patient-reported tool, the SCIM-SR accurately reflects such patients' functional status. It can help reduce the time and effort devoted to routine patient care. And it can capture useful information about the functional evaluation of SCI patients at home. The assessment results will help medical staff to monitor changes in their patients' functional independence and identify their problems. The SCIM-SR can therefore be implemented in future intervention studies, especially those studying home-based SCI patients.

Data Archiving

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

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Author contributions TW drafted and revised the manuscript. JT was responsible for the statistical analysis and reviewed the manuscript. JT, SX, XH, and YW participated in the study's implementation. TL and MJ were responsible for the translation work and data collection. KL was responsible for the project's design and implementation, quality control, and manuscript revision.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Statement of Ethics The study was approved by the ethics committees of the university and the participating rehabilitation centers (2017ZSLYEC-0620). We certify that all applicable institutional and government regulations concerning the ethical use of human volunteers were followed during the course of this research. The translation of the scale was authorized by the original author of the SCIM-SR.

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