Test-retest reliability at the item level and total score level of the Norwegian version of the Spinal Cord Injury Falls Concern Scale (SCI-FCS)

Kirsti Skavberg Roaldsen^{1,2} , Åsa Blad Måøy^{1,3}, Vivien Jørgensen^{1,2} , Johan Kvalvik Stanghelle^{1,3}

¹Sunnaas Rehabilitation Hospital, Department of Research, Oslo, Norway, ²Karolinska Institutet, Department of Neurobiology, Care Sciences and Society, Division of Physiotherapy, Huddinge, Sweden, ³University of Oslo, Faculty of Medicine, Oslo, Norway

Objectives: Translation of the Spinal Cord Injury Falls Concern Scale (SCI-FCS), and investigation of test-retest reliability on item-level and total-score-level.

Design: Translation, adaptation and test-retest study.

Setting: A specialized rehabilitation setting in Norway.

Participants: Fifty-four wheelchair users with a spinal cord injury. The median age of the cohort was 49 years, and the median number of years after injury was 13.

Interventions/measurements: The SCI-FCS was translated and back-translated according to guidelines. Individuals answered the SCI-FCS twice over the course of one week. We investigated item-level test-retest reliability using Svensson's rank-based statistical method for disagreement analysis of paired ordinal data. For relative reliability, we analyzed the total-score-level test-retest reliability with intraclass correlation coefficients (ICC_{2,1}), the standard error of measurement (SEM), and the smallest detectable change (SDC) for absolute reliability/measurement-error assessment and Cronbach's alpha for internal consistency.

Results: All items showed satisfactory percentage agreement ($\geq 69\%$) between test and retest. There were small but non-negligible systematic disagreements among three items; we recovered an 11–13% higher chance for a lower second score. There was no disagreement due to random variance. The test-retest agreement (ICC_{2,1}) was excellent (0.83). The SEM was 2.6 (12%), and the SDC was 7.1 (32%). The Cronbach's alpha was high (0.88).

Conclusion: The Norwegian SCI-FCS is highly reliable for wheelchair users with chronic spinal cord injuries.

Keywords: SCI, Fear of falling, Psychometrics, Nonparametric, Parametric

Introduction

Falls, fall-related injuries, and negative consequences of falls are a growing health concern in the spinal cord injury (SCI) population. The SCI population is aging,¹ and the incidence of SCI in the elderly increases slightly each year due to falls, particularly among men older than 60.^{1,2} Falls and fear of falling have been shown to be closely related in people with neurological diseases³ and the elderly.^{4,5} The recently developed Spinal Cord Injury Falls Concern Scale (SCI-FCS) is the first

scale to measure fall-related psychological issues in individuals with SCI.⁶ This scale addresses the concerns of wheelchair users about falling.

Even though falls are common in individuals with SCI,^{7–10} the problem is not widely discussed, and the literature on fear of falling and other fall-related psychological issues is scarce. Boswell-Ruys *et al.*⁶ hypothesized that concerns about falling negatively affect independence by restricting a person's willingness to mobilize and participate in activities. The general increase in the number of fall-induced cervical spine injuries^{1,2} may have fall-related psychological consequences. A fall-causing SCI might lead to the fear of

Correspondence to: Kirsti Skavberg Roaldsen, Karolinska Institutet, NVS, SE-23 100, 141 83 Huddinge, Sweden.
Email: Kirsti.Skavberg.Roaldsen@ki.se

falling later on and can thus affect rehabilitation potential.¹¹ The clinical impression is that unwarranted and unmotivated concerns about falling are a possible threat to independence and may limit an individual's level of functioning and activity. It is therefore important that fall-related concerns be addressed in rehabilitation.

The SCI-FCS⁶ was published in Australia in 2010 as a self-report scale addressing concerns about falling. The scale includes 16 daily living activities associated with falling and targets people with SCI who depend upon wheelchairs. The SCI-FCS is based on the Falls Efficacy Scale - International (FES-I),¹² which is considered to be the gold standard for assessing fall-related psychological issues in the elderly ambulatory population.¹³ Although not stated by the original authors, it is reasonable to assume that the SCI-FCS operationalizes the same construct as the FES-I, ie, a concern about falling while performing specific daily activities. According to Boswell-Ruys *et al*,⁶ the SCI-FCS can be used as a screening tool for fall concerns in people with SCI in both research and clinical practice. The psychometric properties of the scale have been judged to be either good or excellent⁶ (internal reliability, Cronbach's alpha = 0.92, and test-retest-reliability intra-class correlation coefficient (ICC_{2,1}) = 0.93).

However, studies of falls concerns of different SCI populations are notably absent in the literature. The aim of our study was to translate and create a cross-

cultural adaptation of the SCI-FCS. Additionally, we investigated the item-level test-retest reliability and total score level in a Norwegian-speaking sample of individuals with SCI who use wheelchairs for mobility.

Methods

Translation and cross-cultural adaptation

We translated and back-translated the SCI-FCS according to guidelines^{14,15} (Fig. 1). Permission was obtained from the scale's original authors. Initially, a professional translator and a bilingual physiotherapist familiar with the terminology separately translated the SCI-FCS from English to Norwegian. The translation was conceptual and cultural rather than word-by-word. The versions produced by each translator were synthesized into version 1 by the researchers. Thereafter, an expert group of four physiotherapists with expertise in SCI met to discuss the translation. Issues were identified and resolved to create version 2, and a report was written before version 2 was ready for back-translation. Two independent translators (native English speakers) who possessed good knowledge of Norwegian performed the back-translation. One of the translators was a linguistic professional, and the other translator was a physiotherapist. The back-translators had no knowledge of the original English version. They were asked to consider cultural differences that would require adjustments

Figure 1 The translation and cross-cultural adaptation of the Norwegian version of the SCI-FCS.

during back-translation. The two back-translations were synthesized into one back-translated English version.

Next, the expert group compared and interpreted the linguistic and cultural differences between the versions and modifications, and discrepancies were discussed until a consensus was reached. The author of the original version of SCI-FCS was contacted by email, and the conversation with her was incorporated into the expert group's discussions. The concept of "pushing wheelchair" (items 11–14) in the original version was discussed since some people occasionally propel the wheelchair themselves; other individuals are sometimes pushed by an assistant. Another group of wheelchair users alternates between using manual and electric wheelchairs. We decided to modify the concept into "propelling wheelchair/being pushed" (Table 2).

Item 12 was changed due to climate differences between operating a wheelchair on uneven surface and on uneven, snowy, or icy surface. We enacted changes to address translation and cultural concerns; these changes were synthesized into version 3. To check on comprehensibility and feasibility, we conducted a pilot study with 14 fulltime wheelchair users (13 men and 1 woman aged 24–82 years, level of injury C5–L10, AIS A–C, mean time since injury: 13.6 years [range: 1–40 years]) recruited from Sunnaas Rehabilitation Hospital (Oslo, Norway). Version 3 was found to be easy to understand and use. No changes were made after the pilot study, and consensus was reached to finalize the version.

Participants

We conducted data collection from September 2012 through January 2013. All of the participants were consecutively recruited at Sunnaas Rehabilitation Hospital (Oslo, Norway) during regular follow-up hospital stays as part of the mandatory life-long follow-up program that includes evaluation, problem solving, and/or training stays as well as readmissions due to secondary SCI conditions. Inclusion criteria in our study were complete or incomplete SCI, wheelchair use for at least 75% of mobility needs, the ability to move 10 meters or more in a wheelchair, at least one year elapsed since the injury date, an age of 18 years or above, and the ability to collaborate and understand spoken and written Norwegian. Individuals dependent upon a ventilator during the daytime were excluded from the study.

All 56 eligible individuals agreed to participate in the study. However, two individuals were excluded due to missing data. The demographic data of the 54 participants are shown in Table 1. Two participants (4%) were able to walk for short distances with walking aids but used wheelchairs more than 75% of the time.

Procedure

Medical background data were taken from the medical charts, and we collected relevant demographic data in a structured interview in connection with the administration of the SCI-FCS. Over three quarters of study individuals (76%) reported falling within the past year, and nearly two-thirds of study individuals (65%) reported a fear of falling according to a single-item question: "In general, are you afraid of falling?"¹⁷ (Table 1).

Reliability

We evaluated reliability using test-retest. Individuals completed the Norwegian version of the SCI-FCS twice within a period of one week; the median time period between versions was three days. A physiotherapist with thorough knowledge of the SCI-FCS and the study population was present. The time points at which individuals completed the SCI-FCS are referred to as Time 1 (T1) and Time 2 (T2).

SCI-FCS

The SCI-FCS consists of 16 items, and the scale applies a four-category ordinal scale (1 = "not at all concerned", 2 = "somewhat concerned", 3 = "fairly concerned" and 4 = "very concerned"). For each activity, individuals are asked to mark how concerned they are about falling. When replying, the participants were asked to consider how they typically engaged in a certain activity. If they currently did not engage in the activity (e.g. if someone did their shopping for them), they were asked to consider whether they thought they would be concerned about falling if they did perform the activity. All scores were summed to obtain a single total score varying from 16–64 points; lower scores indicate less concern about falling. The participants completed the questionnaire in approximately 5–20 minutes. Six people who were incapable of filling out the questionnaire by themselves (e.g. due to paralysis) received practical help from the second author.

Statistics

We assessed the degree of agreement between item scores at test and retest using percentage agreement (PA),^{18,19} which was confirmed at $\geq 70\%$ agreement between item scores at test and retest.²⁰ We investigated the item-level reliability using the Svensson method, which is a rank-based statistical method for analyzing disagreements in paired ordinal data.¹⁹ This rank-invariant method separately estimates systematic disagreement in assessments (relative position [RP] and relative concentration [RC]) from disagreements caused by individual variability in assessments (relative rank variance [RV]).¹⁹ RP expresses the extent to which the score

Table 1 Demographic and SCI-related characteristics for the 54 participants in the reliability study

Characteristics	Median (Q1-Q3; min-max) Numbers (frequency)
Age in years: median (Q1-Q3;min-max)	49 (33–62; 20–92)
Sex, n (%)	
Men	45 (83)
Time since injury (years): median (Q1-Q3;min-max)	13 (6–30; 1–58)
Complete or incomplete SCI: n (%):	
Complete SCI	30 (56)
Level of injury, n (%):	
C1-C8	21 (39)
T1-T6	10 (19)
T7-T12	18 (33)
L1-S4/5	5 (9)
ASIA motor score: median (Q1-Q3;min-max)	50 (32–57; 2–91)
AIS classification (n/%):	
A	31 (57)
B	6 (11)
C	9 (17)
D	8 (15)
Education, n (%):	
Primary school	3 (6)
Secondary school	6 (11)
High school	24 (44)
University College/ University	21 (39)
Falls last year, n (%):	
Yes	41 (76)
Number of falls last year, n (%):	
0	13 (24)
1	16 (30)
> 1	25 (46)
Fear of falling:"In general, are you afraid of falling?" ¹⁷	
n (%):	
Yes	35 (65)

Level of Injury: C1-8 = cervical, T1-6 = Upper thoracic, T7-T12 = Lower thoracic and L1-S4/5 = lumbar and sacral = cauda equine injury. Completeness of SCI classified according to American Spinal Injury Association (ASIA) Impairment Scale (AIS). ASIA motor score: Scale with sum score 0-100 (0-50 for upper extremity and 0-50 for lower extremity) for muscle strength, where each item is scored from 0-5, with 0 indicating paralysis and 5 indicating normal strength. AIS classification: A = No motor or sensory function is preserved in the sacral segments S4-S5; paralysis below injury level. B = Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5. C = Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade of less than 3. D = Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more. E = Motor and sensory function are normal (not relevant here). Q1-Q3 = first and third quartile. Fear of falling (Yardley and Smith, 2002): The answers were dichotomized into YES (a little, quite a bit, and very afraid of falling) and NO (not at all afraid of falling).

distribution from one assessment to another is systematically shifted toward higher or lower scale categories. RP ranges from –1 to 1; 0 means that there is no difference between the assessments. RC ranges from –1 to 1 and expresses the extent to which the distribution of scores from the paired ordinal data is systematically more or less concentrated toward the central scale categories. A high concentration of scores yields a high RC value. RP and RC values can be interpreted as probabilities and are expressed as percentages. The random individual variation between two assessments (RV) expresses the level of dispersion in the observed distribution of pairs from the rank-transformable pattern.¹⁹ RV ranges between 0 and 1; 0 means negligible

individual random variation. According to Svensson,¹⁹ statistically significant RP, RC, and RV values are indicated by a 95% confidence interval (95% CI) that does not cover the zero value.

In accordance with Nordin *et al*,²¹ RP and RC values of > –0.1 or < 0.1 (< 10%) indicate negligibly small systematical disagreement; values of ≤ –0.1 or ≥ 0.1 (≥ 10%) indicate relevant systematic disagreement. RV values of < 0.1 generally imply a negligible difference. We used a free Microsoft Excel software program to calculate the measures of agreement and disagreement and the 95% CI.²²

Statistical analyses on the total score level were performed using IBM-SPSS Statistics Versions 18 and 20.0

Table 2 Median score and number of persons scoring the different scores (1-4) at test (T1) and retest (T2) in the Norwegian version of the Spinal Cord Injury Falls Concern Scale¹ (SCI-FCS) (n = 54)

Item	Median score	T1				T2			
		1	2	3	4	1	2	3	4
1. Getting dressed or undressed	1	42	10	0	2	46	6	1	1
2. Moving around the bed	1	47	7	0	0	45	7	1	1
3. Inserting enema or toileting	1	39	10	3	2	38	12	2	2
4. Washing or showering self	1	36	13	3	2	39	14	0	1
5. Transferring on/off a commode or toilet	1	33	16	2	3	35	15	1	3
6. Transferring in/out of bed	1	37	15	0	2	43	10	0	1
7. Transferring in/out of a car	1	34	18	2	0	40	11	2	1
8. Reaching for high objects	1	42	7	3	2	39	13	1	1
9. Picking objects up from the floor	1	35	13	2	4	42	8	1	3
10. Cooking or food preparation	1	44	8	0	2	45	7	0	2
11. Propelling wheelchair/being pushed on flat ground	1	49	4	1	0	53	1	0	0
12. Propelling wheelchair/being pushed on uneven, snowy or icy surface	2	16	24	11	3	19	27	7	1
13. Propelling wheelchair/being pushed up/down gutters or curbs	2	21	20	10	3	19	27	2	1
14. Propelling wheelchair/being pushed up/down a slope	1	31	20	3	0	34	17	2	1
15. Shopping	1	47	5	2	0	47	5	2	0
16. Lifting heavy objects across body	1	37	14	2	1	36	15	2	1

¹ Author's translation of the Norwegian version.

(IBM Corp., Armonk, NY, USA). The categorical data are presented as frequencies, percentages, and ranges (min-max) for each item scored. The numerical data are presented as the mean and standard deviations (SDs) or median and first and third quartiles (Q1-Q3) and ranges. The one-sample *t*-test and the 95% CI were used to test for differences between total scores in T1 and T2.

ICC_{2,1} was used to establish total score relative reliability, which is the relationship between two or more sets of repeated measures. We used one-way repeated-measure analysis of variance (ANOVA) to obtain the variances to calculate the ICC_{2,1} values. The strength of agreement for the ICC_{2,1} values was classified according to McDowell:²³ poor = < 0.40, moderate = 0.41–0.59, good = 0.60–0.74, and excellent > 0.75. Absolute reliability, the variability of the scores from measurement to measurement, was analyzed using the standard error of measurement (SEM) = SD diff/√2; SEM% = SEM/*m* × 100, where *m* is the mean value for T1 and T2, and the smallest detectable change (SDC). SDC was calculated as SDC = SEM × 1.96 × √2 and SDC% = SDC/*m* × 100. The SDC represents the smallest change indicating a real difference on an individual level.²⁴ We calculated the limits of agreement as *d* ± SD diff × 2, where *d* is the mean difference between T1 and T2. P-values ≤ 0.05 were considered to be statistically significant.

We measured internal consistency using Cronbach's alpha based on measurements at T1. This measure depends on the correlation between the items, the number of items, and the variance of the total score.

An alpha value between 0.70 and 0.90 is good according to Streiner and Norman.²⁵ The presence of floor and ceiling effects was confirmed if more than 15% of the individuals scored the lowest or highest possible score of the total score or the item score.²⁶

Ethics

The study protocol was approved by the Regional Committee for Medical Research Ethics in South-East Norway in August 2012 (No. 2012/531) and the Ombudsmann for Privacy in Research at the Norwegian Social Science Data Services in June 2012. All individuals gave their written informed consent prior to participating.

Results

The activities that yielded the most fall concerns were propelling wheelchair/being pushed on an uneven, snowy or icy surface (item 12) and propelling wheelchair/being pushed up/down gutters or curbs (item 13). The activities associated with the least fall concerns were propelling wheelchair/being pushed on flat ground (item 11), moving around the bed (item 2), and shopping (item 15) (Table 2). The median SCI-FCS score was 21 (range: 16–46); lower scores indicated fewer fall concerns.

Item-level test-retest reliability

The responses to each of the 16 items at T1 and T2 are presented in Table 2. The individual responses cover virtually the entire range of the scale for most of the items at both T1 and T2. For 14 out of the 16 items the

median score was 1, meaning that at least 50% of the participants scored 1 (“not at all concerned”) at both T1 and T2. The exceptions were item 12 (propelling wheelchair/being pushed on uneven, snowy or icy surface) and item 13 (propelling wheelchair/being pushed up/down gutters or curbs), for which the median was 2 (“somewhat concerned”) (Table 2).

Percentage agreement (PA), systematic disagreement in position (RP, RC), and individual variability (RV) between assessments at the item level are shown in Table 3. A satisfactory PA ($\geq 70\%$) was noted for all 16 items except for item 12 (propelling wheelchair/being pushed on uneven, snowy or icy surface), which was just below the satisfactory level (69%). A small but non-negligible systematic disagreement was determined for items 6 (transferring in/out of bed), 9 (picking objects up from the floor), and 12 (propelling wheelchair/being pushed on uneven, snowy or icy surface). There was no disagreement due to RV between the test and retest.

Total score level test-retest reliability

The mean of the total scores of the SCI-FCS was 22.6 (SD: 6.7) at T1 and 21.7 (SD: 6.3) at T2 ($P = 0.04$; 95% CI: $-2.1, -0.1$; Table 4). The relative test-retest reliability for the total score of the SCI-FCS was excellent as indicated by the ICC_{2,1} value of 0.83. The absolute reliability, ie, the SEM and SDC, were 2.6 and 7.1, respectively (Table 4).

A Bland and Altman scatterplot of the sum scores²⁷ is shown in Figure 2 to illustrate the difference between T1 and T2 plotted against the mean in sum scores of the two tests. Each dot represents one or more participants. Two outliers were evident, and a tendency toward heteroscedasticity could be seen in the larger differences in individuals with higher mean scores on the SCI-FCS compared with individuals with lower scores. The Bland and Altman plot also shows a concentration of low scores in the group, i.e., minimal concerns about falling. The limits of agreement (LoA) were 6.1 to

Table 3 Percentage agreement (PA), systematic disagreement (relative position, RP and relative concentration, RC) and individual variability (RV) between test 1 and test 2 for the 16 items of the Norwegian version of the Spinal Cord Injury Falls Concern Scale¹ (SCI-FCS) (n = 54)

	PA %	RP 95% CI	RC 95% CI	RV 95% CI
1. Getting dressed or undressed	87	-0.07 -0.155; 0.011	-0.02 -0.06; 0.02	<0.01 0.000; 0.004
2. Moving around the bed	87	-0.05 -0.050; 0.130	-0.04 -0.10; 0.01	<0.01 0.000; 0.011
3. Inserting enema or toileting	80	0.01 -0.090; 0.115	0.03 -0.05; 0.10	0.01 0.000; 0.030
4. Washing or showering self	70	-0.07 -0.200; 0.052	0.08 -0.01; 0.16	0.02 0.000; 0.054
5. Transferring on/off a commode or toilet	74	-0.04 -0.160; 0.080	<0.01 -0.09; 0.09	0.03 0.000; 0.062
6. Transferring in/out of bed	85	-0.11* -0.211; -0.015	<0.01 -0.05; 0.06	<0.01 0.000; 0.017
7. Transferring in/out of a car	74	-0.10 -0.210; 0.008	-0.06 -0.17; 0.04	<0.01 0.000; 0.017
8. Reaching for high objects	81	0.04 -0.058; 0.135	0.09 0.00; 0.18	<0.01 0.000; 0.028
9. Picking objects up from the floor	70	-0.13* -0.234; -0.022	-0.03 -0.16; 0.10	0.01 0.000; 0.021
10. Cooking or food preparation	83	-0.02 -0.121; 0.074	<0.01 -0.07; 0.06	<0.01 0.000; 0.009
11. Propelling wheelchair/being pushed on flat ground	89	-0.07 -0.160; 0.011	0.02 -0.02; 0.06	<0.01 0.000; 0.004
12. Propelling wheelchair/being pushed on uneven, snowy or icy surface	69	-0.12* -0.227; -0.019	0.09 -0.06; 0.24	0.01 0.000; 0.030
13. Propelling wheelchair/being pushed up/down gutters or curbs	72	-0.06 -0.159; 0.042	0.09 -0.04; 0.21	0.02 0.000; 0.059
14. Propelling wheelchair/being pushed up/down a slope	80	-0.05 -0.157; 0.054	-0.02 -0.14; 0.09	0.03 0.000; 0.078
15. Shopping	93	0.00 -0.049; 0.049	0.00 -0.06; 0.06	<0.01 0.000; 0.000
16. Lifting heavy objects across body	81	0.02 -0.090; 0.125	0.01 -0.07; 0.08	0.02 0.000; 0.046

¹Author's translation of the Norwegian version. RP/RC $\geq 10\%$ ($\geq 0 \pm 0.1$) are in bold. *Statistically significant non-negligible disagreement; RP/RC $\geq 10\%$ and 95% CI that do not cover zero. CI: Confidence interval; PA: percentage agreement; RP: relative position; relative concentration; RV: relative rank variance.

Table 4 Total score test-retest reliability parameters for the Norwegian version of the Spinal Cord Injury Falls Concern Scale (SCI-FCS)

n = 54	Test 1 Mean (SD) (min-max)	Test 2 Mean (SD) (min-max)	Mean Difference (95% CI)	ICC _{2,1}	SEM	SEM%	SDC	SDC%	LoA	Cronbach's alpha
SCI-FCS	22.6* (6.7)(16–46)	21.7 (6.3)(16–44)	–1.1(–2.1,–0.1)	0.83	2.6	11.7	7.1	31.9	6.1, –8.2	0.88

Mean value, standard deviation (SD), min-max for T1 and T2 (test-retest), mean difference between T1 and T2 (95% confidence interval, CI), intraclass correlation coefficient (ICC_{2,1}), standard error of measurement (SEM), variation of measurement error (SEM%), smallest detectable change (SDC), limits of agreement (LoA) and internal consistency (Cronbach's alpha) for (n = 54). *Significant difference in sum score between T1 and T2 (P = 0.04).

–8.2. In total, 48 out of 54 individuals (89%) scored 16–28 points, the lower quarter of the scale. Six participants scored 32–42 points, and only one individual scored in the upper half of the scale.

Floor and ceiling effects

None of the individuals scored the highest total score (64 points); 7% of the individuals at T1 and 15% at T2 scored the lowest total score (16 points). The highest item score (4) was scored by 0–7% of the individuals at T1 and 0–6% of the individuals at T2; the lowest item score (1) was scored by 30–91% of the individuals at T1 and 35–98% of the individuals at T2 (Table 2).

Discussion

All items exhibited satisfactory percentage agreement between assessments ($\geq 70\%$) except for one (69%).

Figure 2 Bland and Altman Plot presenting the test-retest results from the Norwegian version of the Spinal Cord Injury Falls Concern Scale (SCI-FCS). The difference in sum scores between the two tests, T1 and T2, is plotted against the mean in sum scores of the two tests. The solid line represents the mean difference between the two tests, and the dotted lines, limits of agreement (LoA).

The systematic disagreement was negligible for 13 items. For items 6 (transferring in/out of bed), 9 (picking objects up from the floor), and 12 (propelling wheelchair/being pushed on uneven, snowy or icy surface), there was an 11–13% systematic tendency toward lower second test scores. The relative test-retest reliability measured by ICC_{2,1} was excellent. The internal consistency measured by Cronbach's alpha was good. There was a floor effect on the item-level score since 30% or more of the individuals scored the lowest item score (1) on both occasions.

This study addresses the item-level reliability of the SCI-FCS for the first time using a method adapted to the operationalization of the properties of the data material (i.e. ordinal). Minor systematic disagreements occurred in items 6, 9, and 12 with a small but systematic shift toward lower scale categories on the second test. Most of the systematic disagreement originated from differences between scores 1 and 2, the two most frequently used categories and corresponded to “not at all concerned” and “somewhat concerned.” The systematic shift toward lower scale categories on the second test could be related to difficulties distinguishing between scale steps 1 and 2 in the three items. Another explanation is a possible learning effect. The SCI-FCS is a new instrument, and the participants had never seen the scale before the first test nor had they been asked to consider the items. By the second test, the participants were familiar with the scale and had had the opportunity to do the activities discussed in it. In outcome studies, familiarizing participants with the scale during pre-tests seems to be important to preempting the learning effect.

We determined excellent test-retest reliability for the Norwegian SCI-FCS (ICC_{2,1} = 0.83). This reliability is in accordance with the original Australian version⁶ (ICC_{2,1} = 0.93). One explanation for our slightly lower retest reliability may be that the Australian study used telephone and in-person interviews; we used self-assessments. Furthermore, the spread in fall concern was

narrow and on the lower range of the scale between individuals in the present study, indicating low levels of fall concerns in specific activities. Thus far, there have been no other psychometric studies on fall-related psychological issues in the wheelchair-using SCI population. Similar to the original version, our results primarily apply to subjects with low-to-moderate fall concerns.

The internal consistency was good (Cronbach's $\alpha = 0.88$) but slightly lower than that of the Australian version (0.92). Cronbach's α describes the extent to which all of the items measure the same construct. A very high Cronbach's α may indicate overlap between items, so the slightly lower Norwegian values might not be a weakness.

This study addresses the absolute reliability of the SCI-FCS for the first time. The SEM and SDC are important when using the SCI-FCS to evaluate changes over time or rehabilitation efforts on the group or individual level. The low SEM score showed that a reasonably small improvement is enough to detect changes in a group (~ 3 points), which shows that the instrument is sensitive to change on a group level. However, on the individual level, improvements have to be considerable (~ 7 points) to exceed the measurement error, which might be unrealistic since most individuals already have minimal fall concerns and thus have limited improvement potential. One might therefore consider the SCI-FCS to be more suitable for screening and epidemiological studies than outcome studies. However, the SCI-FCS can be used as an outcome measure if the intervention is actually targeting individuals with high levels of concern, individuals who have an acute injury or even individuals who obtained their SCI as a result of a fall. The tendency toward greater variation in the total score among subjects with more pronounced fall concerns may indicate that the SEM and SDC may be even larger in these groups or individuals. It is important to consider this fact when evaluating SCI-FCS outcomes in studies to come.

As anticipated, fall concerns were higher for items 12 and 13 (propelling wheelchair/being pushed on uneven, snowy or icy surfaces and up or down gutters or curbs, respectively); these tasks demand good wheelchair skills. The median item score was 1 ("not at all concerned"), in all items except for these two items with a median score of 2, which corresponded to "somewhat concerned". This outcome is consistent with previous findings.⁶ Propelling a wheelchair on an uneven surface is challenging and complex and is more physically demanding than activities such as moving around the bed. These items are also important to ensuring independence in outdoor activities.

The total score range was 16–46 (median: 21; mean: 23 at T1), indicating relatively low fall concerns. The scores were comparable to those in the Australian reliability study (range: 16–35; mean: 23 at T1).⁶ Our low scores may result from the inclusion of participants who had been injured for more than one year and who were more skilled to move and cope with their situation than individuals who had been more recently injured. Therefore, our results should be interpreted with caution for such individuals.

From a clinic point of view, our results are somewhat surprising. Forty-one individuals (76%) had experienced at least one fall in the previous year, and 35 individuals (65%) self-reported a fear of falling when asked a single-item question. This discrepancy likely arises from the fact that although fear and a concern of falling are similar, they represent unique constructs. Both fear and a concern of falling should therefore be measured and spoken of as unique and not compared, which unfortunately is not the case today.²⁸ The SCI-FCS should accordingly be used to measure task-specific fall concerns, i.e. when performing specific activities of daily living, and not the more general fear of falling. To better capture SCI-relevant fear of falling, the SCI-FCS could be complemented with some specific questions when used in the clinic; What exactly are you afraid of in terms of a fall from your wheelchair?; In which circumstances (other than the SCI-FCS items) are you afraid of falling?

The low scores in both the present and original studies⁶ may indicate that the SCI-FCS fails to accurately capture fall-related concerns of more active, higher-functioning individuals, and that it is better suited to evaluating lower-functioning individuals with SCI. Findings by Boswell-Ruys *et al.*,⁶ support this assumption as they found that independence in floor to chair transfers and good self reported sitting ability was associated with lower SCI-FCS scores. One can argue that two-thirds of the items are relatively non-hazardous activities, which is substantiated by most individuals scoring near the bottom in these activities (the floor effect). Items regarding recreational activities such as physical activity are not included, and social effects of falling that independently contribute to avoidance of activity were not evaluated (i.e. concerns about the social consequences of falling such as embarrassment).¹⁷

At Sunnaas Rehabilitation Hospital, we foresee using the SCI-FCS in rehabilitation to identify levels of fall concerns in relation to specific activities such as daily living activities or moving down a slope. Furthermore, we hope to develop tailored interventions that address

excessive fall concerns to hopefully maximize mobility, independence, and community participation. The SCI-FCS can also be used to set activity goals for individuals, prevent falls in specific situations, and encourage mastery of SCI-FCS activities, which correspond to some of the most basic and complex skills necessary for an individual with SCI to live independently. Additional studies are necessary to validate the Norwegian SCI-FCS.²⁹

This study was limited by the inclusion of people in the chronic stage after SCI (>1 year after injury) to fit the target group in an ongoing longitudinal study, the SCIP FALLS study. Our results are therefore likely not applicable to people with acute SCI. Furthermore, our results should be interpreted with caution for people who might have significant concerns of falling.

Our study population was recruited from individuals who routinely stayed for regular follow-up at Sunnaas Rehabilitation Hospital, which may not be representative of the Norwegian SCI population. The mean age of our cohort (49 years) was somewhat higher than that of the general SCI population in Norway (43 years).² However, the wide variation in injury severity, motor and sensory affection, injury level, and injury completeness in our population indicates that our cohort is adequate for reliability testing the Norwegian SCI-FCS. The Australian study used a convenience sample of individuals from community and local hospitals specializing in SCI. The inclusion criteria were similar to those of the present study. However, the Australian study included individuals with both acute (less than one year since injury) and chronic (one year or more since injury) injuries.

Another limitation of our study is that the participants responded to the Norwegian SCI-FCS by themselves. Using trained data collectors and interviewer-administered tests rather than self-administered tests is generally recommended to ensure question comprehension and adequate answers. However, a physiotherapist was present, which enabled informants to discuss the most appropriate scores and hence minimize possible sources of error.

Conclusion

The Norwegian version of the SCI-FCS is a highly reliable instrument for assessing concerns about falling in people with chronic SCI who depend on wheelchairs. On an individual level the SCI-FCS might be better suited as a screening instrument than an outcome measure. The SCI-FCS can be used as an outcome measure if the intervention is targeting individuals with pronounced concerns of falling.

Disclaimer statements

Contributions of authors Kirsti Skavberg Roaldsen: idea, conceptualization, study design, data analysis, interpretation, and drafting of the manuscript. Åsa Måøy: study design, data collection, data analysis, interpretation, and drafting of the manuscript. Vivien Jørgensen: study design, data collection, and critical review of the manuscript. Johan Kvalvik Stanghelle: conceptualization, study design, interpretation, and critical review of the manuscript.

Conflicts of interest/funding The authors declare that there are no conflicts of interest. This work was supported by grants through the Department of Research, Sunnaas Rehabilitation Hospital (Oslo, Norway).

Acknowledgments

We thank all of the participants in the study. We extend special thanks to Claire Boswell-Ruys, Prince of Wales Medical Research Institute, New South Wales, Australia and the Institute of Health and Society, Faculty of Medicine, University of Oslo for working with us. We also thank Britt Elfving and Irene Lund at Karolinska Institutet, Stockholm, for a critical review of the manuscript and for guidance in the statistical calculations and interpretations.

ORCID

Kirsti Skavberg Roaldsen <http://orcid.org/0000-0003-0933-3875>

Vivien Jørgensen <http://orcid.org/0000-0001-9437-7009>

Johan Kvalvik Stanghelle <http://orcid.org/0000-0002-7139-7258>

References

- DeVivo MJ. Sir Ludwig Guttmann Lecture: trends in spinal cord injury rehabilitation outcomes from model systems in the United States: 1973-2006. *Spinal Cord* 2007;45(11):713-21.
- Hagen EM, Eide GE, Rekand T, Gilhus NE, Gronning M. Traumatic spinal cord injury and concomitant brain injury: a cohort study. *Acta Neurol Scand* 2010;122(Suppl. 190):51-7.
- van Vliet R, Hoang P, Lord S, Gandevia S, Delbaere K. Falls Efficacy Scale-International: a cross-sectional validation in people with multiple sclerosis. *Arch Phys Med Rehab* 2013;94(5):883-9.
- Cumming RG, Salkeld G, Thomas M, Szonyi G. Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *J Gerontol Series A: Biological Sciences and Medical Sciences*. 2000;55(5):M299-M305.
- Delbaere K, Close JC, Mikolaizak AS, Sachdev PS, Brodaty H, Lord SR. The Falls Efficacy Scale International (FES-I). A comprehensive longitudinal validation study. *Age Ageing* 2010;39(2):210-6.
- Boswell-Ruys CL, Harvey LA, Delbaere K, Lord SR. A Falls Concern Scale for people with spinal cord injury (SCI-FCS). *Spinal Cord* 2010;48(9):704-9.
- Saverino A, Moriarty A, Playford D. The risk of falling in young adults with neurological conditions: a systematic review. *Disabil Rehabil* 2014;36(12):963-77.

- 8 Nelson AL, Groer S, Palacios P, Mitchell D, Sabharwal S, Kirby RL, *et al*. Wheelchair related falls in veterans with spinal cord injury residing in the community: A prospective cohort study. *Arch Phys Med Rehabil* 2010;91(8):1166–73.
- 9 Wirtz M, Müller R, Bastiaenen C. Falls in persons with spinal cord injury: validity and reliability of the Berg Balance Scale. *Neurorehabil Neural Repair* 2011;24(1):70–7.
- 10 Brotherton SS, Krause JS, Nietert PJ. A pilot Study of factors associated with falls in individuals with incomplete spinal cord injury. *J Spinal Cord Med* 2007;30(3):243–50.
- 11 John LT, Cherian B, Babu A. Postural control and fear of falling in persons with low-level paraplegia. *J Rehabil Res Dev* 2010;47(5):497–502.
- 12 Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). *Age Ageing* 2005;34(6):614–9.
- 13 Moore DS, Ellis R. Measurement of fall-related psychological constructs among independent-living older adults: a review of the research literature. *Aging Ment Health* 2008;12(6):684–99.
- 14 Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine* 2000;25(24):3186–91.
- 15 Guillemin F, Bombardier C, Beaton D. Cross-cultural adaptation of health-related quality-of-life measures—literature review and proposed guidelines. *J Clin Epidemiol* 1993;46(12):1417–32.
- 16 Helbostad JL, Taraldsen K, Granbo R, Yardley L, Todd CJ, Sletvold O. Validation of the Falls Efficacy Scale-International in fall-prone older persons. *Age Ageing* 2010;39(2):256–9.
- 17 Yardley L, Smith H. A prospective study of the relationship between feared consequences of falling and avoidance of activity in community-living older people. *Gerontologist* 2002;42(1):17–23.
- 18 Cohen J. Weighted kappa: nominal scale agreement with provision for scaled disagreement or partial credit. *Psychol Bull* 1968;70(4):213–20.
- 19 Svensson E. Different ranking approaches defining association and agreement measures of paired ordinal data. *Stat Med* 2012;31(26):3104–17.
- 20 Kazdin AE. Artifact, bias, and complexity of assessment: the ABCs of reliability. *J Appl Behav Anal* 1977;10(1):141–50.
- 21 Nordin Å, Murphy MA, Danielsson A. Intra-rater and inter-rater reliability at the item level of the Action Research Arm Test for patients with stroke. *J Rehabil Med* 2014;46(8):738–45.
- 22 Avdic A, Svensson E. Svenssons method 1.1 ed. Örebro 2010 Interactive software supporting Svenssons method. Accessed from http://www.oru.se/hh/Elisabeth-Svensson/Svenssons_metod2014-09-10
- 23 McDowell I. Measuring health. A guide to rating scales and questionnaires. Third edition. Oxford University Press. 2006, p 45.
- 24 Bland JM, Altman DG. Measuring agreement in method comparison studies. *Stat Methods Med Res* 1999;8(2):135–60.
- 25 Streiner DL, Norman GR. Health Measurement Scales, 4th edition, Oxford University Press, New York. 2008, p 91.
- 26 McHorney CA, Tarlov AR. Individual-patient monitoring in clinical practice: are available health status surveys adequate? *Qual Life Res* 1995;4(4):293–307.
- 27 Altman DG. Practical statistics for medical research. Chapman & Hall, London, 1991.
- 28 Moore DS, Ellis R. Measurement of fall-related psychological constructs among independent-living older adults: A review of the research literature. *Ageing Ment Health* 2008;12(6):684–99.
- 29 Butler Forslund E, Roaldsen KS, Wahman K, Franzén E. Concerns about falling in wheelchair users with spinal cord injury — validation of the Swedish version of the spinal cord injury falls concern scale. *Spinal Cord*. 2015 Aug 11. [Epub ahead of print]