

# Development and Validation of a Self-Care Scale for Older Adults undergoing Hip Fracture Surgery: The HFS-SC

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## Research Article

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## Abstract

**Background:** The ability to take care of oneself after hip fracture surgery is important for older adults. Various scales have been developed for evaluation of this ability, but a scale specifically focusing on hip fracture has not been developed. The aim of this study was to develop and validate a scale (Hip Fracture Surgery Self-Care Scale, HFS-SC) to evaluate self-care for older adults undergoing hip fracture surgery.

**Methods:** The scale was developed according to the guidelines by DeVellis. Initial items were derived from a literature review and individual interviews with 11 older adults who underwent hip fracture surgery. To confirm the suitability of the questions, a preliminary survey was conducted on 25 older adults. Psychometric testing was performed on 300 older adults 65 years old or over living at home after surgery for hip fracture. Psychometric properties of the scale were examined by content validity, construct validity, concurrent validity, internal consistency reliability, and test-retest reliability.

**Results:** Exploratory factor analysis and confirmatory factor analysis demonstrated that the 18-item scale comprised five factors (functional independence, symptom recognition and management, positive mental health, participation and support in social activities, and a safe environment). The reliabilities of the scale were 0.91 for Cronbach's alpha and 0.815 for test-retest reliability.

**Conclusions:** The HFS-SC has acceptable validity and reliability and is expected to be useful for evaluating the levels of self-care for older adults undergoing hip fracture surgery.

## Background

Hip fracture (HF), a break in the area where the femur and pelvis are connected [1], is the most common adverse condition that occurs in adults over 65 years of age [2]. In South Korea, the incidence rate of HF is about [3], and the mortality rate within one year from onset has risen to 20% [3]. Surgery is generally recommended for patients with HF to minimize complications [4]. For older adults, those who undergo surgery for HF are more likely to experience a decreased quality of life than those who do not undergo surgery [5]. Approximately 50% of patients experience reduced functional performance and difficulties in daily life after HF [6]. Since HF sites are not easily regenerated, the hospital stay after surgery is often lengthy, and older adults tend to not recover their full functional performance as before the fracture at the time of discharge [7]. Furthermore, more than 10% of older adults with HF do not return to their home after discharge, posing a social and economic burden for long-term care [8, 9]. Therefore, it is important to help the patients return to daily life through appropriate self-care.

Self-care is defined as an activity carried out by an individual to maintain one's life, health, and well-being [10]. Self-care consists of three main concepts: universal self-care, developmental self-care, and health-deviated self-care. Universal self-care includes activities that are common to all humans and are necessary to maintain daily life. Developmental self-care includes activities that are required in the developmental process in various situations. Health-deviated self-care is care related to disease states, diagnosis, and treatment [10]. Scales for measuring self-care were developed between the late 1900s and 2000s. There has been a need for the development of more disease-specific scales that can reflect these domains and can be applied to specific age groups.

Older adults undergoing HF surgery require a high level of self-care for functional recovery [11]. Although self-care is important for maintaining the quality of life, a scale to measure the functional level of the older adults with HF has not yet been developed. General evaluation scales such as Activities of Daily Living (ADL), Independence in the Activities of Daily Living (IADL), and EuroQoL-5Dimensions 5Levels (EQ-5D-5L) are often used to evaluate the functional level of older adults with HF surgery. While these scales are widely used, they include items that are not specific for HF surgery. For example, the ADL [12] items related to physical aspects of self-care, while the IADL [13] focuses on cognitive function aspects such as phone use or shopping. The EQ-5D-5L [14] contains multi-dimensional indicators but the content of the items is rather comprehensive as it is not developed for a specific disease or age group. The scale has limitations in measuring the environmental and social aspects in self-care in older adults with HF surgery. To evaluate self-care in older adults with HF surgery, a scale should comprehensively include specific attributes that may affect patient rehabilitation, including emotional aspects (anxiety, depression, or fear of falling), social aspects (social activities, relationships and support), environmental aspects (safe living environment), and cognitive and physical aspects (awareness of one's health status, self-care performance).

Assessing self-care for the older adults with HF surgery plays an important role in evaluation of the recovery stage and setting up treatment and education plans, which may contribute to improving their quality of life. Therefore, this study aimed to develop a scale

that comprehensively measures the level of self-care in older adults after hip fracture surgery by focusing on their transition to daily living at home and examines its validity and reliability.

## Methods

This study examined the reliability and validity of the Self-Care Scale for Older Adults undergoing Hip Fracture Surgery (HFS-SC). The scale was developed based on the guidelines by DeVellis [15], which include scale development stage and scale examination stage. In the scale development stage, the constituent factors and properties of the self-care concept of older adults in hip fracture surgery were identified, and preliminary questions were constructed through a literature review and patient interviews. After content validity was tested by experts, a preliminary survey of the items was conducted with a sample of older adults who underwent hip fracture surgery. In the scale examination stage, a main survey was conducted by applying the HFS-SC scale to older adults who underwent hip fracture surgery. Final items were confirmed through construct validity, concurrent validity, and reliability tests (Fig. 1).

## Scale Development Process

### Stage 1: Constructs of the Scale

To analyze the concept of self-care in older adults in hip fracture surgery, an integrated literature review method suggested by Whittemore and Knafl [16] was used. Using various search engine databases, the literature on self-care models, self-care concept analysis, self-care scales, and HF published up to August 31, 2020 were reviewed.

To specify the concept of self-care for older adults with HF surgery derived from the literature review, 11 subjects were individually interviewed from November to December, 2020 using a content analysis method. The validity and reliability of the data were secured through credibility, fitness, auditability, and confirmability as suggested by Sandelowski (1986) [17]. Examples of the main questions for the interviews include the following: What do you think self-care is for hip fracture patients? What efforts are you making to take care of yourself after hip fracture surgery? After hip fracture surgery, what were you most worried about in your daily life living at home?

### Stage 2: Item Composition

Based on the literature review and individual interviews, a total of 73 preliminary questions on the HFS-SC scale were derived.

### Stage 3: Determination of Scale

A 5-point Likert scale was used to measure the HFS-SC scale.

### Stage 4: Test of Content Validity

The first content validity test was conducted by 10 experts, including 3 orthopedic surgeons, 2 nursing professors, and 5 nurses with more than 10 years of nursing experience in the orthopedic ward. Based on the results of the first content validity, the second content validity test was performed by 6 experts who participated in the first test. An Item-level content validity index (I-CVI) higher than 0.78 [18] and Scale-level content validity index/average (S-CVI/Ave) higher than 0.90 [19] were used as the item selection criteria.

### Stage 5: Item review and preliminary survey

Since the HFS-SC scale is aimed at older adults, some of the items were modified after consulting with a scholar with a major in the Korean language to check whether the grammar or overall sentence flow is appropriate and ensure that subjects can easily read and understand the items. Data for the preliminary survey were collected from 25 older adults in January 2021. After completion of the questionnaire, data were collected in a sealed envelope. The degree of understanding of each item was measured on a 4-point scale (1 point = very easy to understand; 4 points = very difficult to understand). Items with high frequency of responses with 3 or 4 points or with an opinion requesting correction were revised accordingly.

### Stage 6: Scale Application

A large-sample survey was conducted to verify the validity and reliability of the HFS-SC. The inclusion criteria for study participants included those who underwent hip fracture surgery at two hospitals in Gyeonggi-do, Korea within 2 months to 1 year, those who were able to walk before hip fracture and had no abnormality in balance ability, those who are over 65 years old and who can communicate

and respond to questionnaires, and those who understood the purpose of this study and agreed to participate. The sample size was set to 300, as at least 100 subjects are needed for exploratory factor analysis [20] and at least 150 samples for confirmatory factor analysis [21] anticipating a dropout rate of 20%. Study participants were requested to fill out the questionnaire; if participants required help, the researcher provided direct assistance to complete the survey questionnaire. After completion of the questionnaire, it was collected in a sealed envelope, and a gift certificate worth \$5 was provided as compensation for study participation.

## **Stage 7: Evaluation of the Scale**

Construct validity was examined by item analysis, Exploratory factor analysis (EFA), and Confirmatory factor analysis (CFA). For item analysis, the normality of the items was confirmed by Skewness, Kurtosis, Kolmogorov-Smirnova test, Shapiro-Wilk test, standard deviation, and distribution of each item. The corrected item-total correlation coefficient was conducted to confirm the relevance of each item to the scale, and only items with a correlation coefficient value of 0.3 or higher were selected for the scale [22, 23].

For factor analysis, the study participants were randomly divided into two groups. The first group was used for EFA. An Eigen value of 1.0 or higher and a Scree plot were used to determine the number of factors. The items were selected based on factor loading higher than 0.5 [22], communality higher than 0.5, and accumulative variance higher than 60% [20].

The other group was used for CFA. CFA was analyzed through the structural equation model estimated using Maximum likelihood estimator (MLE). The values of Root mean square error of approximation (RMSEA), Standardized root mean square residual (SRMR) and Goodness of fit index (GFI), were included as the model fit indices. The fit of the model was evaluated using the Tucker-lewis index (TLI), Comparative fit index (CFI), and Incremental Fit index. Convergent validity of subdomains was examined by confirming that the standardized factor loading was higher than 0.5, the Critical ratio (C.R) was higher than 1.96, the Average variance extracted (AVE) value was higher than 0.5, and the Construct reliability (CR) was higher than 0.7 [24]. Discriminant validity was evaluated by confirming that the square root of the variance extraction index of the model was larger than the correlation coefficient of each factor.

Concurrent validity was examined through correlation analysis between the HFS-SC scale and the EQ-5D-5L. The EQ-5D-5L is a health-related quality of life measurement scale that consists of five domains. The EQ-5D-5L score is calculated by applying a weight to each area that is predicted by the estimation formula applied to calculate a value between the maximum value of .83 and the minimum value -.07.

Reliability of the HFS-SC was evaluated by Intraclass correlation coefficient (ICC), test-retest reliability, and internal consistency reliability.

## **Results**

### **Scale Development**

#### **Stage 1: Constructs of the Scale**

For the literature review, a total of 9,969 studies were retrieved from the search engines. Of the studies, 4,730 duplicate papers were excluded, resulting in a remaining 5,239 studies. After excluding 4,476 papers that were not related to this study, 763 papers were selected. Then, 731 articles were excluded based on the selection criteria. Of the remaining 32 papers, 3 were systematic review studies, which already had quality evaluation, and 29 papers were evaluated using the critical by Joanna Briggs Institute [25]. As a result, 13 studies with methodological flaws were excluded, resulting in the final 19 studies for review.

A review of the 19 studies showed that essential attributes of the domain of universal self-care were maintaining proper nutritional status, balance between rest and activity, assistance-independence balance, participation and support in social activities, improvement of the residential environment, and overcoming fear of falling. Important attributes of the domain of developmental self-care were self-efficacy, improvement of resilience, and stress management. In the domain of health-deviated self-care, the essential attributes derived from the literature review were health status recognition, problem-solving skills, knowledge acquisition, rehabilitation implementation, daily life change adaptation, and pain/discomfort management. A total of 14 factors and 52 priori items were developed from the literature review.

For patient interviews, 11 older adults of varying age, gender, education level, family type, religion, and time after operation were recruited. Through individual interviews, the domain of spiritual support was derived as an attribute of self-care after hip fracture surgery

and was thus added into the item pool. As a result, a total of 15 factors and 45 codes were derived and validated from the individual interviews.

## **Stage 2: Item Composition**

Similarities and differences among the 15 factors and 45 priori items were identified through a conceptual reasoning process, which resulted in 7 components with 73 preliminary items: 4 items for maintaining a normal nutritional status, 17 items for effort in rehabilitation, 13 items for symptom recognition and management, 11 items for a safe environment, 11 items for participation in and support for social activities, 13 items for positive mental health, and 4 items for spiritual support.

## **Stage 3: Determination of the Scale**

A 5-point Likert scale was used to measure the levels of SC in each item, ranging from 1 (*not at all*) to 5 (*strongly agree*).

## **Stage 4: Test of Content Validity**

For the primary content validity, only items with an I-CVI of 0.78 or higher were selected. If the meanings of the items were duplicated based on the expert opinions, they were revised by deletion, correction, and integration. Out of 73 preliminary questions, 11 questions were revised and 42 questions were deleted, resulting in a total of 31 preliminary questions. In the process of examining S-CVI, 3 items were deleted and 7 items were revised, leading to 28 items. The secondary content analysis test showed that the I-CVI of all items was 0.78 or higher, ranging from 0.83 to 1. The S-CVI/AVE was 0.95, which met the criterion value of 0.90 or higher, thus securing the content validity of the scale.

## **Stage 5: Item review**

After the linguistic adequacy of the items was reviewed by a scholar with major in Korean literacy, 3 items were revised. The preliminary survey containing 28 questions was conducted on 25 older adults who underwent HF surgery. The average survey time was 19.6 min. Based on a Likert 5-point scale, the overall clarity score of the questions was  $3.85 \pm .92$ , and the overall understandability of the questions was  $3.43 \pm .78$ .

## **Scale Verification**

### **Stage 6: Scale application**

Table 1 shows the general characteristics of the subjects. The average age of the participants was 83.25 years old, and 58.33% of the individuals were female. Regarding the educational level, 44.67% of the participants were uneducated. The majority of subjects lived with family. Approximately half of the participants were not employed, and 65.33% were religious. The functional state before hip fracture was normal in 216 patients. Regarding the type of surgery, 49.33% had total hip arthroplasty. The overall characteristics were homogeneous, as there were no significant differences in general characteristics between EFA and CFA groups (Table 1).

Table 1  
General characteristics of participants for main survey (N = 300)

Characteristics	Total(n = 300)	EFA(n = 143)	CFA(n = 157)	χ <sup>2</sup> or t	p
	n(%) or M ± SD	n(%) or M ± SD	n(%) or M ± SD		
Age(year)					
(Range 65 ~ 89)	83.25 ± 5.36	82.97 ± 4.93	83.54 ± 5.78	.81	.54
Sex					
Male	125(41.67)	59(41.26)	66(42.04)	.01	.97
Female	175(58.33)	84(58.74)	91(57.96)		
Education level					
Uneducated	134(44.67)	65(45.45)	69(43.95)	3.84	.65
Elementary	85(28.33)	41(28.67)	44(28.03)		
Middle	37(12.33)	17(11.89)	20(12.73)		
High	44(14.67)	20(13.99)	24(15.29)		
Family type					
Spouse	126(42.00)	59(41.26)	67(42.68)	2.62	.51
Offspring	51(17.00)	22(15.38)	29(18.47)		
Spouse + offspring	37(12.33)	21(14.69)	16(10.19)		
Solitary	86(28.67)	41(28.67)	45(28.66)		
Work					
Part-time	83(27.67)	37(25.87)	46(29.30)	.76	.48
Full-time	49(16.33)	24(16.78)	25(15.92)		
None	168(56.00)	82(57.34)	86(54.78)		
Religion					
Protestant	83(27.67)	40(27.97)	43(27.39)	1.24	.92
Catholic	47(15.66)	19(13.29)	28(17.83)		
Buddhism	66(22.00)	31(21.68)	35(22.29)		
None	104(34.67)	53(37.06)	51(32.48)		
Functional status					
Normal	216(72.00)	102(71.33)	114(72.61)	.07	.63
Minimal Assistance	84(29.00)	41(28.67)	43(27.39)		
Type of HFS					
THR	148(49.33)	68(47.55)	80(50.96)	1.06	.75
BHA	82(27.33)	40(27.97)	42(26.75)		
PFNA	47(15.67)	23(16.08)	24(15.29)		
ORIF	23(7.67)	12(8.39)	11(7.00)		

Note. M = Mean; SD = Standard deviation; EFA = Exploratory factor analysis; CFA = Confirmatory factor analysis; HFS = Hip fracture surgery; THR = Total hip replacement; BHA = Bipolar hemiarthroplasty; PFNA = Proximal femoral nail antirotation; ORIF = Open reduction and internal fixation

Characteristics	Total(n = 300)	EFA(n = 143)	CFA(n = 157)	$\chi^2$ or t	p
	n(%) or M $\pm$ SD	n(%) or M $\pm$ SD	n(%) or M $\pm$ SD		
Period of HFS(months)					
Comorbidity	9.17 $\pm$ 1.53	8.96 $\pm$ 1.18	9.37 $\pm$ 1.86	.93	.68
Present	191(63.67)	90(62.94)	101(64.33)	.42	.28
None	109(36.33)	53(17.67)	56(35.67)		
<i>Note.</i> M = Mean; SD = Standard deviation; EFA = Exploratory factor analysis; CFA = Confirmatory factor analysis; HFS = Hip fracture surgery; THR = Total hip replacement; BHA = Bipolar hemiarthroplasty; PFNA = Proximal femoral nail antirotation; ORIF = Open reduction and internal fixation					

## Stage 7: Evaluation of the scale

### Construct Validity

When the value of the Kolmogorov–Smirnova test or the Shapiro–Wilk test is  $p > .05$ , it can be considered to satisfy normality. The items of this scale did not show normality with  $p < .001$ , so the normality was re-assessed by skewness and kurtosis values. The corrected item-total correlation coefficients ranged from .128 to .615 and the total Cronbach's alpha reliability for the 28 items was 0.82. A total of 24 items were used for EFA, as 4 items with a correlation coefficient less than .3 were deleted from the pool.

As the result of primary EFA on 24 items, five factors were extracted. After deleting two items showing the communality of less than .5, secondary factor analysis was conducted on the 22 remaining items. There was no problem in communality, but one item was not loaded into any factor and thus was deleted. Tertiary factor analysis was performed on the 21 items. The results showed that the Kaiser-Meyer-Olkin (KMO) value and Bartlett's test of sphericity were statistically significant, confirming that the data was suitable for factor analysis. The communality ranged from .571 to .812, and the factor loadings ranged from .514 to .870. The cumulative explanatory power of the factors was 66.32%.

In EFA, a total of five factors were extracted from the data. The first factor included 5 items and was named as 'functional independence.' This factor was composed of behaviors to enhance proper nutrition and rehabilitation and focused on functional aspects in the recovery of hip fracture surgery. Factor 2 included five items and was named 'symptom recognition and managements.' Factor 3 was composed of five items and was named 'positive mental health.' Factor 3 included constructs of positive mental health and spiritual support and focused on the older adults' psychological capacity to adjust themselves to changes in daily life and overcome barriers to rehabilitation. Factor 4 included three items and was named 'participation in and support for social activity.' Factor 5 was composed of three items and was named 'safe environment.' (Table 2).

Table 2  
Final Results of Exploratory Factor Analysis on HFS-SC (N = 143)

Factor	Item	Communi- nality	F1	F2	F3	F4	F5
Functional independence	2. I try to do my daily living by myself without any help.	.658	.778				
	8. I take painkiller on prescription after checking the pain intensity.	.573	.727				
	1. I try to be well-nourished.	.632	.706				
	7. I participate in rehabilitation considering my other health issues or the current situation.	.584	.679				
	6. I regularly work out on a daily basis.	.571	.514				
Symptom recognition and management	9. Continuous management is required for hip fracture.	.774		.870			
	11. I know when to visit an emergency room.	.665		.833			
	12. I know what postures or exercises I have to avoid after surgery.	.598		.764			
	22. I regularly visit the clinic to check my medical condition.	.812		.721			
	3. I make sure there is no aggravated pain in the surgical site, no adverse effect, etc. while participating in activity.	.603		.611			
Positive mental health	24. I am afraid falling again.	.737			.742		
	26. I am depressed as I have limitation to move by myself.	.623			.708		
	25. I can deal with stress.	.646			.624		
	28. Religion is very helpful for my recovery.	.634			.579		
	27. Religion helps me think positively.	.608			.563		
Participation in and support for social activities	21. I have a good relationship with family members, friends and neighbors, and often meet with them.	.722				.778	
	20. I have a person who I can ask for help in need.	.660				.723	
	18. I currently participate in economic activity.	.589				.645	
Safe environment	13. I remove any objects that might obstruct the pathway in order not to trip over.	.801					.710
	16. I wear shoes with rubber sole that are easy to put on.	.667					.579
	17. I leave some lights on but not too bright to disturb my sleep.	.652					.563
	Eigen value		5.373	4.076	2.508	2.144	1.816
	Variance(%)		22.387	16.984	10.450	8.933	7.569
	Cumulative Variance(%)		22.837	39.370	49.821	58.753	66.322

CFA was conducted on 157 study participants to confirm the model fit of the five factors derived from the EFA and to verify the convergent and discriminant validity of the constructs. The initial model fit indices tested with 21 items did not meet the standard

values. After removing three items with an Standardized regression weights (SRW) less than .5 and an Squared multiple correlation (SMC) value of less than .5, the secondary CFA was performed. In the analysis of the model of the secondary CFA, the value of  $\chi^2$  did not fit the standard value. However, since  $\chi^2$  value tends to be easily rejected due to its overt sensitivity to sample size [24], the overall model fit should be evaluated with other fitness indices along with  $\chi^2$  value. Other goodness-of-fit indices showed that the model was adequate and well explained by the data. Although the GFI value was slightly below the standard of the fit index, the overall model fit was good in consideration of other fit indices such as TLI and CFI.

In terms of convergent validity, all ranges satisfied the recommended criteria of factor loadings, C.R, AVE, and CR, supporting the convergent validity of the scale. Discriminant validity was secured, as all of the AVE values were larger than .727 squared, .529, which is the largest correlation coefficient between the primary discriminant validity outcome factors. The secondary discriminant validity was also secured, as the value obtained by multiplying the correlation coefficient  $\pm 2$  between the two factors by the standard error did not include 1 (Table 3, Fig. 2).

Table 3  
Confirmatory Factor Analysis (N = 157)

Factor	Item	Standardized estimates	SE	Critical Ratio(C.R.)	p	AVE	Construct Reliability(CR)
F1	2	.769	.199	12.63	< .001	.758	.926
	8	.792	.165	12.95	< .001		
	1	.803	.275	13.17	< .001		
	6	.737	.129	11.56	< .001		
F2	9	.741	.295	11.82	< .001	.673	.891
	11	.785	.371	12.45	< .001		
	12	.694	.173	11.01	< .001		
	22	.812	.284	13.39	< .001		
F3	24	.733	.372	11.74	< .001	.687	.897
	26	.648	.183	10.31	< .001		
	25	.759	.165	12.21	< .001		
	27	.783	.258	12.97	< .001		
F4	21	.774	.229	12.43	< .001	.715	.882
	20	.692	.216	10.72	< .001		
	18	.638	.147	10.11	< .001		
F5	13	.693	.196	10.94	< .001	.763	.906
	16	.731	.134	11.32	< .001		
	17	.617	.103	9.85	< .001		
Fitness index	Absolute fit index				Relative fit index		
	$\chi^2(p)$	$\chi^2/df$	RMSEA	SRMR	GFI	TLI	CFI
Criteria	(.05)	3	.10	.08	.90	.90	.90
Model	375.83(< .001)	2.14	.07(.06 ~ .10)	.05	.88	.91	.92

*Note.* AVE = Average variance extracted; F1 = Functional independence; F2 = Symptom recognition and management; F3 = Positive mental health; F4 = Participation in and support for social activities; F5 = Safe environment

Concurrent validity was examined with the Pearson correlation coefficients between the HFS-SC scale and the EQ-5D-5L. There were significant positive correlations among the subdomains of the HFS-SC and the EQ-5D-5L. There was also a high correlation between the

HFS-SC and the EQ-5D-5L total scores, supporting the concurrent validity of the HFS-SC.

## Reliability

To examine test-retest reliability, 52 subjects were evaluated using the HFS-SC scale at four weeks after the baseline measurement point. The ICC of the HFS-SC scores at the two time points was .82. In internal consistency reliability, Cronbach's alpha was .91 for the HFS-SC. By subdomain, Cronbach's alpha reliabilities were .88 for factor 1, .89 for factor 2, .86 for factor 3, .83 for factor 4, and .85 for factor 5 (Table 4).

Table 4  
Reliability of HFS-SC scale (N = 300)

Factors	Test-retest(N = 52)			M ± SD	Cronbach's α
	Test score	Retest score	ICC(95% CI)		
Functional independence	3.35 ± .47	3.48 ± .37	.87(.64 ~ .92)	3.42.61	.883
Symptom recognition and management	3.29 ± .25	3.33 ± .38	.84(.71 ~ .90)	3.37.54	.890
Positive mental health	3.06 ± .53	3.16 ± .45	.78(.60 ~ .89)	3.18.58	.861
Participation in and support for social activities	3.27 ± .41	3.23 ± .29	.81(.75 ~ .92)	3.31.63	.834
Safe environment	3.39 ± .53	3.47 ± .54	.85(.69 ~ .93)	3.53 ± .67	.852
HFS-SC	3.27 ± .42	3.33 ± .38	.815	3.36 ± .51	.906

*Note.* ICC = Intraclass correlation coefficient; M = Mean; SD = Standard deviation,

## Stage 8: Scale optimization

The psychometric properties of the HFS-SC were examined and confirmed. The HFS-SC consists of 18 items with inclusion of two inverse items. The scale is composed of 5 sub-domains: functional independence, symptom recognition and management, positive mental health, participation and support in social activities, and safe environment. The total score ranges from 18 to 90, with a higher score indicating a higher level of self-care for older adults who underwent HF surgery.

## Discussion

The purpose of treatment for older adults with HF surgery is to improve the quality of life through recovery of function and mobility. While the importance of accurate and specific assessment of perceived self-care ability has been emphasized, there has been needs for specific scale to measure the levels of self-care in patients with HF. Reflecting the need to focus not only on outcomes of health status but also healing processes after HF surgery, the HFS-SC scale was developed to evaluate self-care that is multi-dimensional and specifically tailored to hip fracture.

In this study, the validity of HFS-SC was proven through several validity indicators. The five subdomains explained 66.32% of the total variance of the HFS-SC, indicating they reflect the 18-item scale validly. The essential attributes of self-care for older adults with HF surgery are functional independence, recognition and management of symptoms, positive mentality, participation in and support for social activity, and safe environment. In other words, to achieve high levels of self-care, an older adult who undergoes hip fracture surgery needs to maximize physical functions, be aware of their own health status, be engaged in daily living activities with positive thinking, maintain a social support system with active social participation, and make efforts to accommodate safety in their living environment. This multidimensionality of HFS-SC was also supported through CFA, which showed model fit, convergent and discriminant validity of the scale and high correlation of items in each subdomain, whereas correlations among subdomains were fairly low. The HFS-SC was also found to be highly correlated with EQ-5D-5L, confirming the concurrent validity of the scale. This finding is consistent with the view that the quality of life in older adults with HF measured with the EQ-5D scale decreased when appropriate self-care was not performed [5].

The stability of the HFS-SC was established with test-retest reliability. The internal consistency reliability of the scale was also confirmed, as the Cronbach's alpha of the total scale was 0.91. Therefore, the HFS-SC is regarded to accurately assess self-care of older adults with HF surgery.

The HFS-SC differs from other scales in that it reflects both the characteristics of HF illness and the transition of HF patients from acute treatment stage to daily living at home after discharge. In the HFS-SC scale, multidimensionality was achieved by including physical, cognitive, emotional, social, and environmental domains as the components to capture how the patient functions at home in relation to their disease experience, disease characteristic, and perceived health status.

From the theoretical standpoint, this study expanded the scope of Orem's self-care theory [10] by applying the theory into an older patient group treated with HF surgery. Whereas Orem's self-care theory has been mostly used for patient with cancer or chronic diseases, it has been rarely applied on the recovery process of a specific clinical condition in a comprehensive way. From the standpoint of nursing practice, HFS-SC can be used in discharge planning for older patients with HF surgery. Based on the levels of SC measured using the scale, clinicians can estimate the functional performance of older adults with HF surgery and psychological adjustment of the patient at the post-fracture period.

Nurses can develop interventions based on the results of the HFS-SC scores and increase accuracy for the monitoring of the patient, which may contribute to improving the patient's quality of life. Further research should examine the psychometric properties of the HFS-SC through replication studies and identify the effects of the use of the HFS-SC scale on health outcomes such as medical expenses, psychological burden of the patient's family, and mortality.

This study has several limitations. Data were collected from a few regions of Korea, and caution should be applied in generalizing the study results. The HFS-SC scale was primarily developed to measure the levels of self-care in older adults and thus its psychometric properties should be tested in other age groups. The factor structure of the HFS-SC scale also needs to be confirmed in patients with other types of fracture in future methodological studies to expand the scale applicability.

## Conclusion

The HFS-SC, a new scale to measure the level of self-care in older adults who underwent HF surgery, was developed and its psychometric properties were examined. The HFS-SC consists of 18 items and is relatively easy to apply to older adults.

## Abbreviations

ADL  
Activities of daily living  
AVE  
Average variance extracted  
CFA  
Confirmatory factor analysis  
CFI  
Comparative fit index  
CR  
Construct reliability  
C.R  
Critical Ratio  
EFA  
Exploratory factor analysis  
EQ-5D-5L  
EuroQol-5dimensions 5Levels  
GFI  
Goodness of fit index  
HF  
Hip fracture  
HFS-SC

Hip fracture surgery self-care  
IADL  
Independence in the activities of daily living  
ICC  
Intra-class correlation coefficient  
I-CVI  
Item-level content validity index  
M  
Mean  
MLE  
Maximum likelihood estimator  
RMSEA  
Root mean square error of approximation  
S-CVI/AVE  
Scale-level content validity index/Average  
SD  
Standard deviation  
SRMR  
Standardized root mean square residual  
TLI  
Turker-lewis index.

## **Declarations**

### **Acknowledgment**

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### **Author's contributions**

All authors conceptualized and designed the study. Study concept and design: HA, KY and EJ. Data acquisition and Analysis: HA, EJ. Drafting the manuscript: KY, EJ. Translational/adaptation: HA, EJ. Critical revision: HA, KY and EJ. Approval of the final version: HA, KY and EJ. All authors read and approved the final manuscript.

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### **Availability of data and materials**

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

### **Ethical approval and consent to participate**

This study was conducted with prior approval from the Public Institutional Bioethics Committee designated by the Ministry of Health and Welfare (IRB No. P01-202011-21-022). The purpose of the study, provision and protection of personal information, and withdrawal of consent were explained to the subjects prior to the survey. Data were collected on a voluntary basis.

### **Consent for publication**

Not application

### **Competing interests**

The authors declares that they have no competing interests.

### **Author details**

## Figures

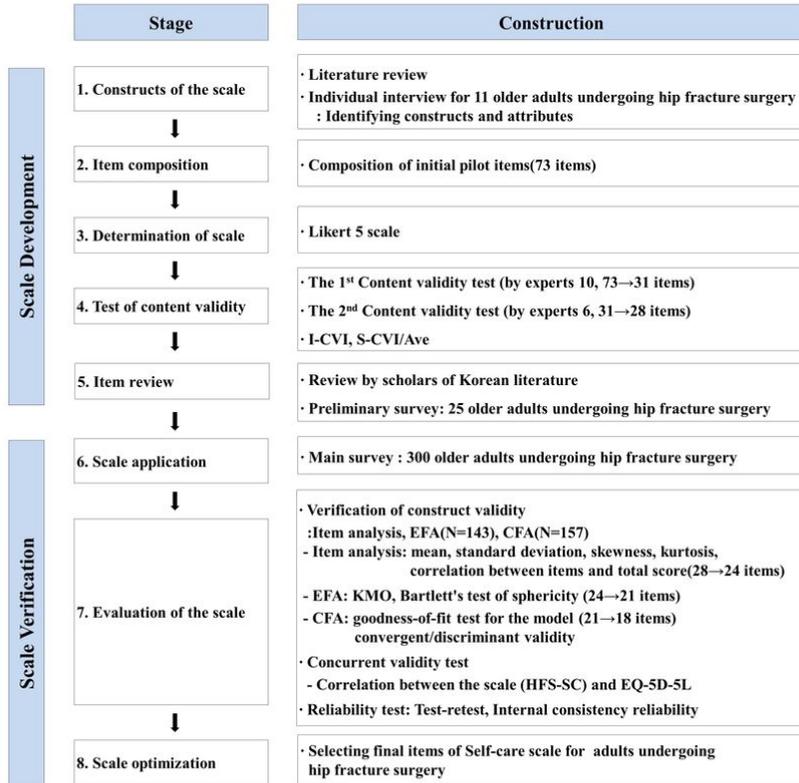


Figure 1

Caption not included with this version.

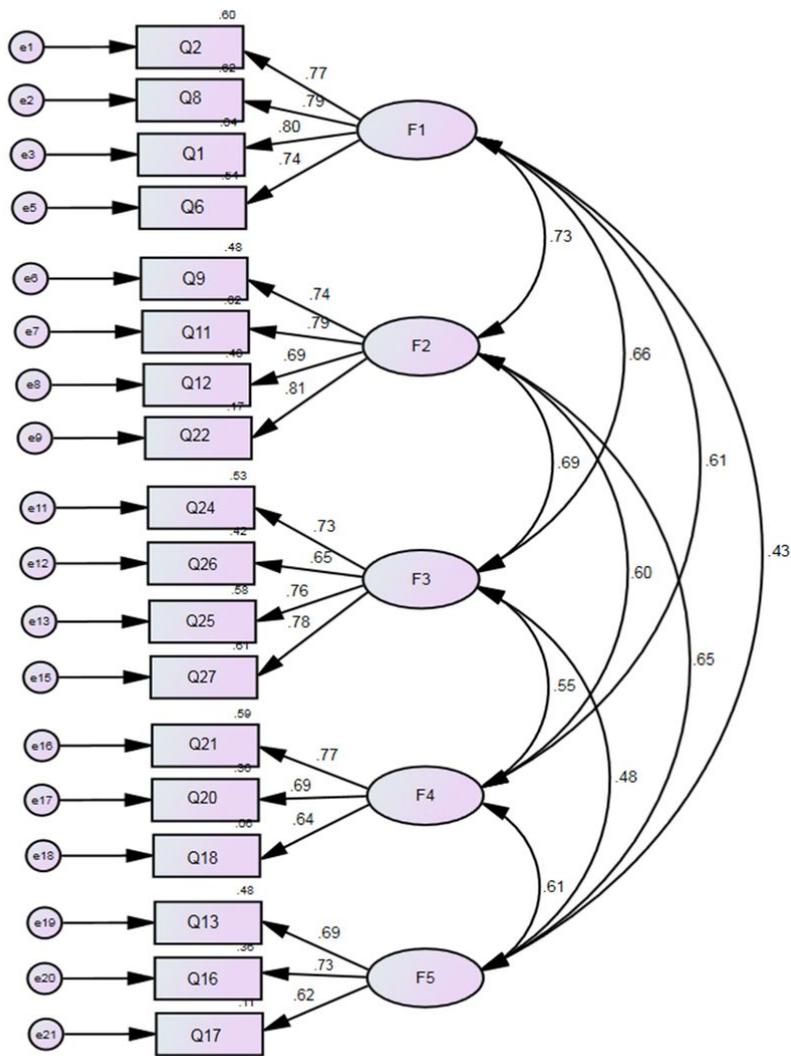


Figure 2

Caption not included with this version.