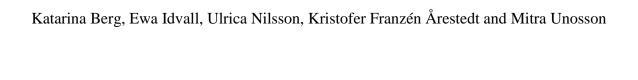
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# Psychometric evaluation of the post-discharge surgical recovery scale



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### Psychometric evaluation of the Post-discharge Surgical Recovery scale

Running title: Evaluation of the PSR scale

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validation study

#### **Abstract**

Rationale, aim and objectives: Day surgery patients are discharged after a short period of postoperative surveillance, and reliable and valid instruments for assessment at home are needed. The aim of this study was to evaluate the psychometric properties of a Swedish version of the Post-discharge Surgical Recovery (PSR) scale, an instrument to monitor the patient's recovery after day surgery, in terms of data quality, internal consistency, dimensionality and responsiveness

Methods: Data were collected on postoperative days 1 and 14 and included 525 patients. Data quality and internal consistency were evaluated using descriptive statistics, correlation analyses and Cronbach's α. The dimensionality of the scale was determined through an exploratory factor analysis. Responsiveness was evaluated using the standardized response mean (SRM) and the area under the receiver operating characteristics curve (AUC). The correlation between change score in PSR and change score in self-rated health was assessed using Pearson's correlation coefficient. Patients' ability to work and their self-rated health on postoperative day 14 were used as external indicators of change.

**Results:** Six items showed floor or ceiling effects. Cronbach's coefficient α was 0.90 and the average inter-item correlation coefficient was 0.44 after the deletion of two items. The items were closely related to each other, and a one-factor solution was decided on. A robust ability to detect changes in recovery (SRM 1.14) was shown. The AUC for the entire scale was 0.60. When initial PSR scores were categorized into three intervals, the ability to detect improved and non-improved patients varied (AUC 0.58-0.81). There was a strong correlation between change scores in PSR and health (0.63).

**Conclusions:** The Swedish version of the PSR scale demonstrates acceptable psychometric properties of data quality, internal consistency, dimensionality and

responsiveness. In addition to previous findings, these results strengthen the PSR scale as a potential instrument of recovery at home.

#### Introduction

Day surgery has increased during recent decades in many Western countries [1, 2], including a wide range of procedures and patients with multiple diagnoses, for instance elderly patients [3]. This increased incidence and complexity in day surgery implies that health care professionals have to adapt to a shift from inpatient to outpatient care, as well as a need for the development of instruments with good measurement properties and clinical applicability for monitoring patients' recovery progress after discharge.

Postoperative recovery encompasses many different themes, and previous studies have assessed postoperative recovery after day surgery using clinically oriented outcomes such as pain and fatigue [4] and postoperative nausea and vomiting [5], as well as by processes of care measures such as prolonged recovery room stay [6] or unanticipated admission after discharge [7]. It has also been measured using clientassessed outcomes like patient satisfaction [8, 9] and quality of recovery [10]. In a concept analysis [11], postoperative recovery was defined as an energy-requiring process of returning to normality and wholeness regarding activities of daily living and psychological well-being. Recovery at home may also be described in terms of what patients are able to do, i.e. how close they are to their "usual self" and the extent to which problems interfere with their daily lives [12]. Consequently, postoperative recovery can be measured from different perspectives [13]. An important indicator of successful postoperative recovery is the patient's ability to resume normal activities. The recovery period after day surgery is therefore important to evaluate from the patient's perspective [14]. However, no fully validated instruments are available that measure postoperative recovery from this perspective [15].

Instruments for the assessment of postoperative recovery can be used for the discriminative purpose of distinguishing between patients with different levels of recovery and for the evaluative purpose of measuring the longitudinal change of recovery in individuals or groups of patients [16]. A prerequisite for this is that the instrument accurately assesses postoperative recovery and monitors true change over time. The property of responsiveness, defined as the ability of an instrument to detect clinically relevant changes over time, is central in the choice of an evaluative instrument [17]. In a recent systematic review regarding postoperative recovery [15], 12 questionnaires designed to measure postoperative recovery were identified. Although great differences in quality criteria for measurement properties were found, the Post-discharge Surgical Recovery (PSR) scale was found to be among the instruments with the best psychometric properties but its data quality and responsiveness have not been evaluated. These properties are required when evaluating whether a patient has undergone an important change.

The clinical applicability of the PSR scale and comparisons of findings from different countries through cross-cultural research were the reasons we used the PSR scale in a Swedish sample of day surgery patients. The PSR scale was available only in an English version and instruments developed in other countries need to be translated, culturally applicable and appropriately psychometrically tested to be valid in a new population [18]. Therefore, the purpose of this study was to evaluate the psychometric properties of a translated version of the Post-discharge Surgical Recovery (PSR) scale in a Swedish day surgery sample in terms of data quality, internal consistency, dimensionality and responsiveness.

#### **Methods**

The Post-discharge Surgical Recovery scale

The PSR scale was developed to measure at-home postoperative recovery, and is a self-report measure of recovery with a target population of patients discharged from the day surgery unit. The PSR scale comprises 15 items rated on a ten-point semantic differential scale. For computation of the actual PSR score, the sum score is divided by total possible scale score and multiplied by 100, resulting in a score range of 10 to 100 with higher scores indicating better recovery. The items elucidate different aspects of postoperative recovery including health status, activity, fatigue, work ability and expectations [12].

The Swedish version of the PSR scale

The original version of the PSR scale was received from its originator and permission to use it was obtained. The Swedish version of the scale was constructed through a translation/back-translation procedure, with the original version being translated into Swedish and then back-translated into English by native translators on different occasions [18]. The authors examined the consensus between the original and back-translated instruments and all items were evaluated for their relevance in a Swedish day surgery context.

The item in the original instrument concerning the "normal self" of the patient was split into two items in the Swedish version, one focusing on emotional recovery and the other on return to life as usual. The original item 'Today I feel almost back to my normal self – very different from my normal self' was replaced by a) 'Right now I

feel not at all back to my usual frame of mind – completely back to my usual frame of mind' and b) 'Right now I feel not at all back to normal life – completely back to normal life'. Further, two original items were excluded, one concerning time to recover and one concerning returning to work. This was done to allow the respondents to give a more specific estimate of the expected number of days required for recovery and return to work. The adjustments resulted in a 14-item Swedish version of the PSR scale, assessed from 1 to 10 between the anchor words. Seven items have anchor words from negative to positive, and seven items are constructed in the opposite direction.

#### Procedure and participants

Day surgery was defined as surgery performed on a patient who was admitted and operated on during the same day and discharged without an overnight stay at the surgery unit. The overall study is a prospective study with postoperative follow-ups. For the present study, data from days 1 and 14 after day surgery were analysed. Patients who were 18 years or older, able to read and understand Swedish, and scheduled for day surgery were qualified to participate.

During data collection (October 2003 to January 2005), 851 consecutive patients (429 men, 422 women) within three departments were eligible to be asked to participate. Of these, 640 (75%) gave informed consent to participate, and 211 did not participate (135 subjects declined participation and 76 subjects missed being asked). No significant difference regarding age or gender was seen between patients participating versus those who declined participation or missed being asked. Among patients not

participating, significantly more (p<0.001) were scheduled for general surgery compared with those who participated.

Of those patients who gave informed consent to participate, 33 were excluded, mainly due to postoperative hospitalization. An additional 82 patients dropped out of the study on postoperative day 1 due to failure to respond to the questionnaire. No significant difference regarding age, gender, ASA classification or surgical procedure was seen between patients responding to the questionnaire on postoperative day 1 and those who did not. This resulted in a response rate of 82% (n=525), 246 men and 279 women, on postoperative day 1. Of those patients who responded, 19 had not fully completed their questionnaires on day 1. Consequently, 506 patients (244 men and 262 women) were included in the analysis (Fig. 1). Of these, 462 (91%) responded on day 14. These participants were older (51.9 years, SD=15.2) than the drop-outs from day 1 (44.3 years, SD=14.3) (p<0.001), but no differences existed regarding gender, surgical procedure or ASA classification.

Before surgery, demographic data were collected and a physician or a specially trained nurse assessed the patient's preoperative physical state using the American Society of Anesthesiologists (ASA) classification [19]. When patients left the day surgery unit for discharge, they received a questionnaire including the PSR scale and two supplementary questions in a postage-paid envelope, to be answered on the first postoperative day. The supplementary questions consisted of a five-point rated question about the ability to work or handle usual business at home (1=not at all, 5=all the time) and a global question about the patient's self-rated health, rated on a ten-point scale (1=very bad health, 10=very good health). A couple of days before

postoperative day 14, the patients received an additional questionnaire by mail in a postage-paid envelope to be answered on the fourteenth day after surgery.

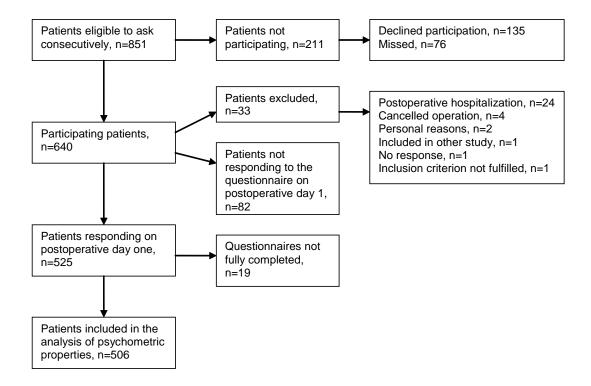


Figure 1. Flow chart of patients included.

#### Data analysis

Reversed items in the PSR scale were turned from negative into positive when computing the data. Univariate statistics were used to describe demographic data and scale characteristics. For comparisons between participants and drop outs, non-parametric tests were used (chi-square test for nominal and Mann-Whitney U test for ordinal data). Comparisons of age were analysed using Student's t-test. Floor and ceiling effects were present if more than 15% of the respondents answered on the lowest or highest possible score [20].

To evaluate whether individual items on the PSR scale were consistent to one another and measured the same concept (internal consistency), Cronbach's  $\alpha$  coefficient and inter-item and item-total correlation were calculated using Pearson's product moment correlation [21]. We consider item-item correlations 0.30-0.70, item-total correlation  $\geq$ 0.40 and Cronbach's  $\alpha$  0.70-0.90 to be measures of good internal consistency [22].

To determine the dimensionality of the PSR scale, an exploratory factor analysis with a principal axis extraction (PAF) and an oblique rotation (*Promax* and  $\kappa$ =4) were chosen. Before the factor analysis was conducted, a measure of sampling adequacy (MSA), the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett test of sphericity were applied to ensure adequacy of sampling [23]. The number of factors was determined using the scree plot, eigenvalues >1 and common variance explained by the factors [23]. When a principal axis extraction is used, the scree plot is recommended over the eigenvalue >1 criterion [24].

We used the standardized response mean (SRM) to evaluate internal responsiveness. For the evaluation of external responsiveness, the area under the receiver operating characteristics (ROC) curve (AUC) and a correlation analysis were used [25]. The SRM characterizes the ability of the PSR scale to change over time, and was calculated as the mean change in the PSR score from day 1 to day 14 after surgery, divided by the SD of this change [26]. A SRM value ≥0.80 indicates that the change is great relative to the background variability in the measurement [27].

The external responsiveness, reflecting the extent to which changes in the PSR scores relate to corresponding changes in an external criterion [25], was quantified using the

area under the ROC curve (AUC). For the ROC analysis, patient's assessment of his or her ability to work or handle usual business at home on postoperative day 14 was coded as a binary variable. Patients who rated their ability to work or handle usual business at home all the time (score 5 on the scale) were classified as improved, and those who rated their ability from not at all to almost all the time (scores 1-4 on the scale) were classified not improved. The AUC combines sensitivity and specificity for all possible cut-off change scores [28] and was interpreted as the probability of the PSR scale to distinguish patients who were improved or not improved according to the external criteria [25]. To determine whether external responsiveness varies depending on the magnitude of the initial PSR score, separate values for AUC were calculated at three different PSR score intervals (10-39, 40-69 and 70-100) based on patients' scores on postoperative day 1 [29]. An AUC of at least 0.70 was considered adequate [20].

For the evaluation of external responsiveness, changed scores in the PSR scale were also correlated to changed scores in self-rated health using Pearson's correlation coefficient [30]. According to Cohen [21], we hypothesized *a priori* a strong correlation (≥0.50). All statistical analyses were performed using SPSS 14.0 for Windows. A p-value of <0.05 was considered statistically significant.

#### **Ethical considerations**

On admission to the surgery unit, each subject received verbal and written information about the aim of the research project and clarification that participation was voluntary. Each patient gave verbal consent to participate. The study followed

common ethical principles in clinical research and was approved by the Regional Ethical Review Board at Linköping University, Sweden (Dnr 03-333).

#### **Results**

Patients underwent orthopaedic surgery (n=310), general surgery (n=156) and gynaecological surgery (n=59). Eighty patients were recruited from a county hospital, 231 from a private surgery unit and 214 from a university hospital, and had a mean age of 51.0 years (SD=15.3). The patients' characteristics at inclusion are presented in Table 1.

Table 1. Patient characteristics,  $n=525^a$ 

Patient characteristics	n (%)
Gender	
Male	246 (46.9)
Female	279 (53.1)
ASA classification	
I	378 (72.0)
II	133 (25.3)
III	13 (2.5)
Residence	
Cohabiting	400 (76.2)
Single	118 (22.5)
Employment	
Working	335 (63.8)
Retired	124 (23.6)
Unemployed	16 (3.0)
Other	40 (7.6)
Education	
Compulsory school	153 (29.1)
Secondary school	223 (42.5)
Degree from university	149 (28.4)

<sup>&</sup>lt;sup>a</sup> sample sizes vary slightly due to missing values ASA=American Society of Anesthesiologists

#### Data quality

Data quality is presented in Table 2. The mean value per item on postoperative day 1 varied between 3.9 and 8.8 (range 1-10). Items 6 (mobility) and 13 (normal life) showed a floor effect and four items, 8 (bowel function), 10 (personal care), 11 (expectations) and 14 (frame of mind) showed a ceiling effect. Missing data per item varied between 7 and 10.

#### Internal consistency

Except for two items (item 8 and 10), the average correlation was >0.30. The number of times when the proportion of items correlated in the range of 0.30-0.70 with other items varied between 0/13 and 12/13. Item 8 (bowel function) had no inter-item correlation in this range, and item 10 (personal care) had one. One inter-item correlation was >0.70, item 4 (normal activity) with item 6 (mobility). Item-total correlations were >0.40, except from items 8 (bowel function) and 10 (personal care). Cronbach's  $\alpha$  was 0.89 and the average inter-item correlation was 0.37 for the 14-item scale. Based on several inter-item correlation coefficients <0.30, item-total correlations <0.40 and a substantial ceiling effect, it was decided that items 8 (bowel function) and 10 (personal care) would be excluded. After the deletion of these two items, Cronbach's coefficient  $\alpha$  was 0.90 and the average inter-item correlation was 0.44 for total scale (Table 2).

#### Factor analysis

The MSA (range 0.85-0.94), KMO (0.91) and Bartlett's test of sphericity (p<0.001) ensured adequacy of sampling. The factor analysis produced a two-factor model according to unrotated eigenvalues of >1. The scree plot showed one factor more

prominently (eigenvalue 5.9 for the first factor and 1.2 for the second), and several cross loadings existed in the factor solution. All items loaded ≥0.46 in the first factor. Except for two items (alertness and physical strength), all items also loaded >0.40 in the second factor. The two-factor model accounted for 52% of the total common variance explained. The contribution from the second factor was 7%. Based on the examination of the rotated two-factor solution, inspection of the scree plot, common variance explained by the second factor and the correlation between the factors (0.68) [23], a one-factor solution was determined to be the most appropriate. According to the factor analysis, it seems that the remaining items measure a single dimension, called *perceived at-home postoperative recovery* like in the original study [12] (Table 3).

Table 2. Item description and internal consistency of the 14-items Post-discharge Surgical Recovery scale on postoperative day 1.

Iten	a,c	m	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Internal		Item descripti	on <sup>b</sup>
Hen	11	111	טט	1	۷	3	4	3	U	/	0	7	10	11	12	13	14	consisten	$cy^a$		
																		Item-total correlation	Cronbachs's $\alpha$ if item deleted	Floor/ceiling effect (%)	Missing data (n)
1.	alertness	6.2	2.4	-														0.58	0.88	2.5/9.5	9
2.	pain	5.9	2.2	0.51	-													0.58	0.88	0.8/5.8	8
3.	tiredness	5.9	2.1	0.59	0.39	-												0.65	0.88	2.1/1.9	7
4.	usual activity	4.3	2.5	0.35	0.38	0.47	-											0.68	0.88	13.7/2.3	8
5.	daytime nap	5.7	2.7	0.45	0.35	0.60	0.50	-										0.66	0.88	4.8/10.5	9
6.	mobility	3.9	2.5	0.25	0.38	0.37	0.74	0.42	-									0.59	0.88	15.6/3.1	7
7.	stay at home	5.8	2.9	0.48	0.46	0.59	0.61	0.67	0.57	-								0.78	0.87	10.3/12.4	10
8.	bowel function	8.8	2.3	0.19	0.14	0.20	0.15	0.26	0.05	0.28	-							0.25	0.90	1.7/65.4	7
9.	physical exercise	5.8	2.5	0.38	0.33	0.36	0.30	0.42	0.26	0.44	0.22	-						0.50	0.89	3.9/6.0	7
10.	personal care	8.8	2.3	0.14	0.20	0.17	0.27	0.17	0.17	0.19	0.12	0.10	-					0.29	0.90	2.1/65.3	7
11.	expectations	7.3	2.4	0.42	0.51	0.40	0.37	0.39	0.31	0.48	0.15	0.31	0.30	-				0.60	0.88	1.7/22.7	9
12.	•	6.0	2.6		0.50	0.49	0.54	0.49		0.64	0.20			0.51	_			0.69	0.88	6.2/6.0	7
13.	normal life	4.7	2.8	0.29	0.39	0.34	0.56	0.38	0.56			0.39	0.23	0.43	0.52	-		0.62	0.88	15.1/3.5	7
	frame of mind	7.4	2.7	0.47	0.34	0.41	0.35	0.38	0.26	0.40	0.13	0.37	0.24	0.45	0.38	0.45	-	0.55	0.89	3.9/30.9	7
d				9/13	11/13	11/13	10/13	11/13	7/13	11/13	0/13	10/13	1/13	12/13	11/13	10/13	10/13				
e	706			0.38	0.38	0.41	0.43	0.42	0.37	0.49	0.17	0.32	0.19	0.39	0.44	0.40	0.36				

<sup>&</sup>lt;sup>a</sup> n=506 <sup>b</sup> n=525

c Item assessment 1 to 10
d Proportion of times the item correlates between 0.30 and 0.70 with other items in the instrument e Average correlation of the item with all others in the instrument

Table 3. Basis for the one-factor solution. Factor loadings and communalities in common factor analysis with principal axis factoring and promax rotation of the Post-discharge Surgical Recovery scale on postoperative day 1 with two items deleted (n = 506).

	2 fa	ctor-solu	1 factor-	-solution	
Item	1	2	h <sup>2 a</sup>		$h^{2a}$
Right now I feel:					
1. drowsy – alert	0.73	0.38	0.57	0.62	0.38
2. pain – no pain	0.63	0.48	0.40	0.62	0.38
3. tired – energetic	0.72	0.52	0.53	0.69	0.48
5. in need of a daytime nap – not in need of a daytime nap	0.68	0.58	0.49	0.70	0.49
7. a wish to stay at home – no wish to stay at home	0.76	0.75	0.68	0.83	0.69
9. no strength for physical exercise – strength for physical exercise	0.54	0.39	0.29	0.52	0.29
11. worse than I expected – better than I expected	0.64	0.47	0.41	0.62	0.39
14. not back to my usual frame of mind – back to my usual frame of mind	0.61	0.41	0.37	0.57	0.33
4. unable to perform normal activities – able to perform normal activities	0.57	0.84	0.70	0.72	0.52
6. immobile – mobile	0.46	0.85	0.75	0.65	0.42
12. not recovered from surgery – recovered from surgery	0.67	0.68	0.54	0.74	0.54
13. not back to normal life – back to normal life	0.56	0.67	0.48	0.66	0.44
Initial eigenvalues (before rotation)	5.85	1.20		5.85	
Percentage of variance explained	45%	7%		44%	
Cronbach's α <sup>b</sup>	0.86	0.84		0.90	

<sup>&</sup>lt;sup>a</sup> Extraction (final) communalities <sup>b</sup> Cronbach's α reported for salient loadings

#### Responsiveness

The mean PSR score on postoperative day 1 was 57.4 (SD=17.7), and on day 14 77.4 (SD=16.9). From day 1 to day 14, the mean change score was 19.6 (SD=17.1) and the internal responsiveness assessed using the SRM was 1.14 (n=463). Most patients changed during the observation period: 388 (89%) became better, 41 (9%) became worse and 7 (2%) were unchanged. Changes in the PSR score from day 1 to day 14 varied between - 39.2 and 87.5. There was a significant difference in PSR score between postoperative day 1 and day 14 among patients who were back at work or handled usual business on day 14 (p<0.001) as well as among those who could not completely do this (p<0.001) (Table 4).

Table 4. Descriptive statistics for PSR scores on days 1 and 14 for patients in work or not, two weeks postoperatively.

weeks postoperatively	•				
	n	Postop day 1 m (SD)	Postop day 14 m (SD)	Change score m (SD)	p-value for changes <sup>a</sup>
Back to work	203	63.7 (18)	86.7 (11)	23 (15.5)	0.001
Not back to work	232	53.4 (15.6)	70 (17)	16.7 (16.2)	0.001

<sup>&</sup>lt;sup>a</sup> Student's paired-samples t-test

The area under the ROC curve (AUC) was 0.60 in the entire sample and varied between 0.58 and 0.81 at different initial PSR scale intervals (Table 5). The correlation coefficient between changed scores in the PSR scale and changed scores in the self-rated health was 0.63 (p<0.001).

Table 5. Numbers of patients who were improved/non-improved on postoperative day 14 and AUC<sup>a</sup> values in relation to the external criterion work or usual business.

PSR scale day 1		n	improved/	AUC	Standard	95% CI			
			non-improved		error				
entire scale	10-100	435	203/232	0.60	0.03	0.55-0.65			
intervals	10-39	67	21/46	0.81	0.05	0.70-0.91			
	40-69	255	103/152	0.73	0.03	0.67-0.80			
	70-100	113	79/34	0.58	0.06	0.48-0.69			

<sup>&</sup>lt;sup>a</sup> Area under receiver operating characteristics curve

#### **Discussion**

The Swedish version of the PSR scale has been slightly changed from the original version. In this study, after removing two items, we found the items in the PSR scale to be homogenous and closely related to each other, capturing a single dimension of postoperative recovery after day surgery. Items included are in the area of a patient's perception of a return to their "usual self"; thus a unidimensional scale seems relevant. The present study is the first to investigate the PSR scale's responsiveness in a cohort of patients after day surgery. According to internal and external responsiveness and chosen external criteria, the PSR scale was responsive to change in recovery from postoperative days 1 to 14. Longitudinal reproducibility is suggested to be directly related to responsiveness [20]. Postoperative recovery after day surgery is a dynamic process, and assessing reproducibility is complicated. Reproducibility of the PSR scale has thus not been evaluated in this study.

Translation is a critical part in cultural adjustments of instruments, as meanings can change across languages [18]. We do not believe that any essential nuances were lost through the translation/back-translation procedure. The translation to English was done by native English speakers and the items included in the PSR scale are not complicated. Moreover, the authors of this study have experience with anaesthesia and surgical nursing, which was also beneficial in the translation procedure

Although the PSR scale seems easy to understand and not particularly timeconsuming, some patients dropped-out. Patients scheduled for general surgery declined participation or missed being asked more often than those who participated. This possibly explains the ceiling effect of the discarded item regarding bowel function. Impaired intestinal motility is more common among general surgical patients, and it is possible that our non-participating patients would have had an effect on the results. The drop-outs from day 1 to day 14 were younger than those remaining in the study. It is possible that the younger patients had a more rapid recovery process and were back at work and therefore did not deem it important answer the questionnaire. No reminders were sent, as this would have delayed the assessment.

Missing items were rather few and were randomly spread throughout the questionnaire, which may indicate that no specific item was more difficult to respond to than others. Patients with an incomplete scale were excluded instead of adding an average score for missing items but missing items were judged not to influence the results. Except for the removed items ('bowel function' and 'personal care'), which showed ceiling effects, four others ('mobility', 'normal life', 'expectations on recovery' and 'frame of mind') showed floor or ceiling effects. Floor or ceiling effects may affect reliability when patients with the lowest or highest score cannot be distinguished from each other, and the responsiveness would also be negatively influenced [26]. It seems reasonable that patients' mobility and normal life are scored low the first postoperative day. The item 'frame of mind' is one that was modified in this version of the PSR scale, and having undergone a surgical procedure does not seem to have an impact on patients' frame of mind in this study. Patients in this study also seem to feel better than they thought they would.

We consider the internal consistency of the PSR scale satisfactory in the present study. Inter-item correlations above 0.30 and less than 0.70 [31] or 0.80 [23] are

advantageous. In this study, average inter-item correlation and homogeneity increased to 0.44 and 0.90, respectively, when the two items 'bowel function' and 'personal care' were discarded.

The stability of the factor structure of the PSR scale has not been evaluated in another sample than that used by the originator, general surgery and orthopaedic repair patients [12]. In our study we included all patients, the majority of whom were orthopaedic patients, followed by general surgery and gynaecologic patients. Both men and women of a wide range of ages were included, resulting in a heterogeneous sample.

The sample size of 506 patients in relation to the number of items on the scale seems sufficient for the computation of a factor analysis. Cases to variables produced a ratio of 36:1, which fulfils criteria reported in the literature. The recommendations vary widely, suggesting the ratio be at least 5:1 [23] to 10:1 [32] or at least 200 to 300 subjects [31]. According to the MSA, KMO and Bartlett test, measures for control of sampling adequacy suggested that the PSR correlation matrix was appropriate for factor analysis in our study. In the common factor analysis, the items were analyzed through principal axis factoring with oblique rotation (*Promax* and  $\kappa=4$ ). The principal axis factoring was chosen because of a better fit of the model to the data [22]. Due to an assumption that the factors were dependent on one another, an oblique rotation was performed. The choices of extraction method and rotation were also based on the procedure used during the original development of the PSR scale [12]. Our factor solution with one factor accounted for 45% of the common variance. The variance is in the lower boundary, but given that principal axis factoring (PAF) only

addresses common variance, recommended explained variance is lower for PAF than for the principal component analysis (PCA) [23]. Similar findings were demonstrated during the original development of the PSR scale. The PAF analysis with an oblique rotation resulted in a one-factor solution, explaining 40% of common variance. However, the original factor analysis was performed with 12 items, and three items were added to the instrument afterward. Items included after the factor analysis concerned expected time to recover, the ability to move around and bowel function [12]. No additional tests of the scale including these added items were described. Two of these later-included original items are not included in the Swedish version of the PSR scale. The item regarding expected time to recover was converted into a complementary question, and the item regarding bowel function was deleted due to low item-total and inter-item correlation as well as a ceiling effect.

Many definitions and methods of responsiveness have been proposed [33], but consensus on a definition, best study design and analysis strategy to assess the concept is still lacking [25, 33]. To assess the responsiveness of the PSR scale in this study, we used the SRM as a method of internal responsiveness. The SRM characterizes the ability of the PSR scale to change over a two-week period after day surgery [25]. The SRM is independent of sample size and is based on the variability of change [27], and provides information on which changes to expect on group level [34]. A large value of the internal responsiveness (SRM >0.80) was found in the present study, indicating that the PSR scale has a robust ability to detect changes in patients' perceived postoperative recovery at home. However, the direction of change was expected, as most patients experience postoperative recovery as a normal process getting well if no complication occurs. One disadvantage of the SRM is that the

measure is based on statistical estimations rather than patients' judgements of what constitutes an important change [33].

One recommended measure of external responsiveness is the area under the receiver operating characteristics (ROC) curve (AUC) [25, 33]. The AUC theoretically varies from 0.5 (no accuracy to distinguish patients) to 1.0 (perfect accuracy) [28]. In the present study, the AUC for the entire PSR scale was 0.60. An AUC value of 0.60 for the entire scale may be interpreted as a reduced probability of the PSR to correctly discriminate between improved and non-improved patients in relation to our external criterion. This may be explained by the heterogeneous sample. There was a wide range in surgical procedures and changed scores among the patients included. The AUC is a summary statistic proceeding from all possible cut-off change scores [28], resulting in a low AUC value in this heterogeneous sample. When patients were categorized into more homogeneous groups regarding PSR scores we found, indicated by the AUC values, that the PSR scale had a better ability to distinguish improved from non-improved patients if the initial score was  $\leq 70$ . In the upper interval ( $\geq 70$ ) of initial PSR scores, the PSR scale had a reduced ability to distinguish improved from non-improved patients, visualized by an AUC value of 0.58. A wide range in change was seen in this group, explaining the large amount of possible cut-off change scores and accordingly a more uncertain ability to discriminate between patients.

No gold standard of postoperative recovery is currently available, and in its absence we used the *ability to work or handle usual business* question as the external criterion of change. This criterion may be too rigorous when only the most upper level was chosen in the dichotomization, which may sacrifice information on the magnitude of change.

However, patient group, treatment and timing of data collection are factors that might have an effect on the significant change as well [34]. To provide greater insight into meaningful changes for patients, patients need to be asked. In the present study we did not do this; thus further studies are needed.

The correlation analysis indicated that change scores in the PSR scale were strongly related to change scores in self-rated health; according to this the PSR scale seems responsive.

In summary, the Swedish version of the PSR scale demonstrates satisfactory psychometric properties of data quality, internal consistency, dimensionality and responsiveness in day surgery patients. Responsiveness has not been studied previously and the remaining results are consistent with previous international studies [12, 15], which strengthens the argument for the PSR scale as a potential instrument for the assessment of postoperative recovery at home.

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