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ORIGINAL REPORT

DETERMINANTS OF THE SHOULDER PAIN AND DISABILITY INDEX IN PATIENTS WITH SUBACROMIAL SHOULDER PAIN

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Objective: **To examine the influence of determinants on the Shoulder Pain and Disability Index.**

Design: **A cross-sectional study. Baseline registrations were applied.**

Patients: **Two hundred patients with subacromial shoulder pain lasting at least 3 months.**

Methods: **A questionnaire consisting of possible determinants, 2 independent variables regarding pain and 2 regarding function, and the outcome measurement. Two multiple regression models (one with and one without the independent variables of pain and function) for the Shoulder Pain and Disability Index, the 2 subscales, and the determinants, were performed.**

Results: **The included determinants explained 29% of the variance of the Shoulder Pain and Disability Index (25% for pain and 33% for disability subscale) with pain medication, emotional distress, flexion, and the hand-behind-back range accounting for 26%. When pain and function were included, the final model explained 65% of the variance, with gender, education and range of flexion showing significance.**

Conclusion: **The determinants explained 26% of the variance of the Shoulder Pain and Disability Index, but explained only a minor proportion when pain and function were included. This supports the Shoulder Pain and Disability Index as a shoulder pain and disability questionnaire.**

Key words: subacromial shoulder pain; determinants; Shoulder Pain and Disability Index; multivariate analysis.

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INTRODUCTION

Subacromial shoulder pain is a common musculoskeletal disorder, with terms such as calcific tendonitis, rotator cuff disease, and subacromial impingement syndrome being used synonymously (1). Diverse aetiologies have been suggested, but the exact source and mechanism of the pain is unknown (2, 3). Several clinical trials investigating the short- and long-term effects of various treatments have applied different outcome measures and provided conflicting results (4, 5).

The best outcome measures for evaluation of subacromial shoulder pain have been questioned. Measures of impairments such as range of motion (ROM) and muscle strength have frequently been used to evaluate the effectiveness of treatment (6, 7). Although such measures may have acceptable reproducibility, disease- or region-specific shoulder questionnaires that reflect the patients' perception of their problem or quality of life, have been proposed (6–8).

Several shoulder disability questionnaires, and in particular the Shoulder Pain and Disability Index (SPADI), have been recommended for these patients in order to capture the patients' perception of pain interference during daily activities (9, 10). SPADI consists of 2 subscales (pain and disability), and studies support the validity of the instrument (11, 12). It is reported to be more specific and sensitive to change for patients with subacromial shoulder pain than other shoulder questionnaires (7, 13, 14).

Studies have shown that subacromial pain tends to be more common in middle-aged and older people (15). Factors such as previous episodes of shoulder pain, duration of symptoms, pain intensity, work status, sick leave, and use of non-steroidal anti-inflammatory drugs (NSAIDs) are found to differentiate those who seek medical attention from those who do not (16). Gender, age, education, sick leave, emotional distress, medication use, and work status influence reported pain and disability (10, 17–20).

Previous studies of SPADI have shown that patients on pain medication report higher scores (i.e. report more pain and disability) (7). Lower scores are documented for patients with better ROM (21). The determinants may vary according to the included factors. If their contribution differs between groups being compared, these determinants may potentially become confounding variables and, in the absence of adjustment, lead to an over- or under-estimation of the treatment effect.

However, which determinants influence the SPADI scores and how they exert their influence have not been elucidated in patients with subacromial shoulder pain. Such knowledge may provide a broader understanding of the validity and meaning of the scores and might have implications for clinicians and researchers in planning rehabilitation and studies (7).

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The aim of the present study was to examine the contribution of determinants to the SPADI scores. More specifically, the aim was to assess the relative contribution of sociodemographic variables, duration of pain, medication use, emotional distress, and impairments (active range of motion (AROM)) to the variance in the SPADI total and the subscale scores. A further aim was to investigate the contribution of these determinants when the independent variables related to pain during rest and activity and the 2 questions regarding function were included.

MATERIAL AND METHODS

Design

The study had a cross-sectional design and included patients from 2 separate clinical trials: a double-blind injection study, and a study comparing 2 non-operative treatment methods for patients with subacromial shoulder pain (11, 22).

The registrations were examined and assessed by a blinded researcher.

Patients

All the patients consulted a physician at the outpatient clinic of Physical Medicine and Rehabilitation, Oslo University Hospital, Ullevaal, Norway between March 2005 and August 2007. Patients were between 18 and 70 years old and had had subacromial shoulder pain for at least 3 months. The same recommended inclusion criteria were used for the 2 trials: dysfunction or pain on abduction, a normal passive glenohumeral ROM, pain during 2 of 3 isometric tests (abduction at 0º or 30º, external or internal rotation), and a positive impingement sign.

Exclusion criteria were: bilateral shoulder pain, previous surgery on the affected shoulder, instability, referred pain from the neck, rheumatoid arthritis, clinical and radiological signs of glenohumeral or acromioclavicular arthritis, inability to understand Norwegian, or serious somatic or psychiatric disorder.

Two hundred patients were included, 109 women (54.5%) and 91 men (45.5%). Patients gave their informed, signed consent after receiving written and oral information. The study protocol was approved by ethics committee for Medical Research, Health region I, Norway.

Determinants

Subjects completed a comprehensive questionnaire including age, education ($\leq$ 12 years, > 12 years in school/college/university), work status (not working/working or partly working), sick leave (no/yes or part-time), use of pain, sleep or antidepressant medication (daily/weekly/less often than weekly/never), and duration of pain (months). Emotional distress was measured with the Hopkins Symptom Check List (HSCL – 25 items), each item rated from 1 (not at all) to 4 (very much) (23).

For 104 of the 200 patients, AROM for flexion and abduction were measured bilaterally while seated, and registered using a roller curtain within an accuracy of 5º (24, 25). The other 96 patients were evaluated using a Cybex EDI 320 digital inclinometer (26, 27). For all the patients, the hand-behind-back range was registered as the position of the thumb in reference to the pelvis (trochanter major) or level of columna (28). The patients decided when pain limited the movement.

In addition, the independent variables of pain during rest and activity in the last week were measured on 9-point Likert scales, where 1 indicates no pain and 9 indicates severe pain (4). Two independent variables regarding shoulder functioning were also addressed: "Can you carry a shopping bag (5 kg)?" and "Can you take down something from a wall cupboard?". These were scored on a scale from 1 (easy) to 7 (impossible) (4).

Outcome measurement

The SPADI is designed to measure the impact of shoulder pathology in terms of pain and disability for both current status (last week) and change over time (29). It was developed as both a discriminative and evaluative instrument, rated on horizontal visual analogue scales (VAS) ranging from 0 to 11 (29). The total SPADI score is calculated by averaging the pain and disability subscale scores (according to the original scoring system described by Roach et al.(29)) resulting in a total score ranging from 0 to 100, where a higher score indicates more shoulder pain and disability (Appendix1).

Statistical analysis

Descriptive statistics with means and standard deviations (SD) were applied for continuous variables, and numbers (percentages) for dichotomized variables.

Univariate analyses were carried out to test the associations between the dependent variables (SPADI total score and the pain and disability subscales) and each of the explanatory variables. Spearman's rho was used to check correlations between the independent variables, and variables with $r < 0.7$ were included in the analysis. Standard multiple regression analysis with the variables entered in 3 steps (sociodemographics, self-reported questionnaire, and measures of impairments) was performed for SPADI total and the pain and the disability subscales. A multiple regression analysis with the 2 independent variables related to pain and the 2 related to function was also performed. The most non-significant variables were taken out one at a time. Beta (B) (unstandardized coefficient) with 95% confidence intervals (CI) for B and *p*-values are reported. Beta is reported in the units measured by the actual independent variable. The residuals were inspected for model assumptions.

From the multiple regression models, equations for the development of prognostic index for predicting the dependent variable were performed: SPADI score = constant $+ a_1x_1 + a_2x_2 + a_3x_3 + \ldots + a_nx_n$) (30), where $a_{(1-n)}$ variables express the B values of the corresponding explanatory variables and the constant is the best estimate of SPADI when x_1, x_2, $x_3 \ldots x_n$, are zero.

The data were analysed using the Statistical Package for Social Sciences (SPSS) for Windows, version 15.

RESULTS

The mean age of the study group was 49.8 (SD 10.9) years. The mean SPADI baseline score was 49.2 (SD 20.1), with a mean score of 59.1 (SD 21) for the pain subscale and 40.1 (SD 22.2) for the disability subscale. Characteristics of the patient population according to gender are shown in Table I.

The univariate associations for the determinants with SPADI total score and the 2 subscales are presented in Table II. In the multivariate analyses, the included determinants explained 29.1% of the variance in SPADI total and 24.9% and 33.1% of the variance in pain and disability subscales, respectively (Table III). As Table III shows, use of pain medication, high scores for emotional distress, reduced flexion on the affected side, and the hand-behind-back range were statistically significantly associated with SPADI. None of the sociodemographic variables (gender, age, education and work status) showed significant associations individually, but together they accounted for 7.8% of the variance of the SPADI total score ($p = 0.005$), 4.7% in the pain subscale ($p = 0.07$) and 11.8% in the disability subscale ($p < 0.01$). The variables in the second (self-reported questionnaire) and the third (range of motion) steps explained approximately the same amount of variance, between 10% and 11% ($p < 0.01$) (Table III). The statistically significant variables; pain medication, distress,

Table I. *Characteristics of the patient population (n = 200)*

	Females (*n* = 109)	Males (*n* = 91)
Age, years, mean (SD)	48.7 (11.2)	51.1 (10.3)
Education, *n* (%)		
≤ 12 years in school	63 (57.8)	49 (53.8)
> 12 years in school/college/university	44 (40.4)	40 (44.0)
Work status, *n* (%)		
Working	71 (65.1)	64 (70.3)
Not working	38 (34.9)	27 (29.7)
Sick leave	38 (34.9)	19 (20.9)
Seeking workers' compensation	4 (3.7)	11 (14.6)
Symptoms, *n* (%)		
Pain between 3–6 months	26 (23.6)	31 (34.1)
Pain between 6–12 months	38 (34.9)	24 (26.4)
Pain between 12–24 months	14 (12.8)	16 (17.6)
Pain > 24 months	31 (28.4)	20 (22.0)
Treatments, *n* (%)		
Medicine for pain, daily / weekly / less than weekly / never	7 (6.4) / 37 (33.9) / 57 (52.3) / 8 (7.3)	6 (6.6) / 16(16.6) / 42 (46.2) / 27 (29.7)
Antidepressants / sleeping or relaxation medicine, daily / weekly / less than weekly / never	4 (3.8) / 12 (11.3) / 26 (24.5) / 63 (59.4)	3 (3.4) / 4 (4.5) / 22 (24.2) / 58 (63.7)
Scoring, mean (SD)		
Pain at rest (9-point)	4.1 (2.1)	3.4 (1.9)
Pain on activity (9-point)	6.2 (1.6)	5.4 (1.9)
Function/carry a bag (5 kg) (7-point)	4.5 (1.7)	3.1 (1.8)
Function/take something down from a wall cupboard (7-point)	5.2 (1.3)	4.5 (1.6)
Hopkins symptom checklist	1.58 (0.43)	1.43 (0.43)
Impairments, mean (SD)		
Active range of motion (AROM)		
Flexion affected side	146.2 (28.6)	154.8 (25)
Abduction affected side	124.3 (37.8)	132.8 (35.6)
External rotation	52.5 (19.8)	46.4 (17.6)
Hand-behind-back (HBB)*	13 (median)	11 (median)
Outcome measure, mean (SD)		
SPADI†	51.2 (19.1)	46.7 (21.0)

*The position of the thumb in reference to the pelvis (trochanter major = 1) and level of columna.
†Shoulder Pain and Disability Index.
SD: Standard deviation.

Table II. *Univariate regression coefficients with confidence interval (CI) for Beta of the determinants (sociodemographic variables, duration of pain, medication, emotional distress, and ranges of motion) and the dependent variable, Shoulder Pain and Disability Index (SPADI), the 2 subscales pain and disability and the percentage of variance (R^2), n = 200*

	SPADI total			Pain subscale			Disability subscale		
	R^2 (%)	Beta (95% CI)	*p*-value	R^2 (%)	Beta (95% CI)	*p*-value	R^2 (%)	Beta (95% CI)	*p*-value
Sociodemographic variables									
Gender	1.3	4.5 (–1.1 to 10.1)	0.11	1.2	4.5 (–1.3 to 10.4)	0.13	1.0	5.2 (–1.0 to 11.4)	0.1
Age	0.3	0.1 (–0.2 to 0.4)	0.46	0.0	–0.2 (–0.3 to 0.25)	0.88	2.0	0.3 (0.004 to 0.6)	0.047
Education (1, 2)	3.9	–6.0 (–10.2 to –1.8)	0.006	1.5	–4.0 (–8.4 to 0.5)	0.08	5.5	–7.9 (–12.5 to –3.3)	0.001
Work status (0,1)	4.9	–9.5 (–15.3 to –3.6)	0.002	3.0	7.7 (–13.9 to –1.6)	0.014	7.5	–12.9 (–19.3 to –6.6)	< 0.001
Variables from self–reported questionnaire									
Duration of pain (1–4)	0.9	1.7 (–0.8 to 4.1)	0.18	2.3	2.8 (0.3 to 5.3)	0.031	0.0	–0.21 (–2.5 to 2.9)	0.88
Medication for pain (1–4)	9.2	–7.5 (–10.8 to– 4.2)	< 0.001	7.1	–6.9 (–10.4 to –3.4)	< 0.001	7.1	–8.9 (–12.5 to –5.2)	< 0.001
Anti-depressant medication (and sleep) (1–4)	2.3	–3.5 (–6.8 to –0.2)	0.036	0.5	–1.7 (–5.2 to 1.8)	0.34	8.4	–5.0 (–8.6 to –1.4)	0.007
Distress (HSCL 25)	9.0	13.9 (7.6 to 20.2)	< 0.001	8.0	13.6 (7.0 to 20.3)	< 0.001	8.4	14.9 (7.8 to 21.9)	< 0.001
Active range of motions affected side (impairments)									
Abduction	6.5	–0.14 (–0.2 to –0.06)	< 0.001	6.9	–0.15 (–0.23 to –0.7)	< 0.001	6.2	–0.15 (–0.23 to –0.07)	< 0.001
Flexion	12.1	–0.3 (–0.4 to –0.2)	< 0.001	11.7	–0.26 (–0.37 to –0.16)	< 0.001	12.2	–0.28 (–0.4 to –0.2)	< 0.001
External rotation	1.9	–0.15 (–0.3 to 0.001)	0.052	0.8	–0.1 (–0.25 to 0.06)	0.2	2.5	–0.18 (–0.4 to –0.02)	0.026
Hand behind back (HBB)	8.1	–1.6 (–2.4 to –0.85)	< 0.001	5.3	–1.4 (–2.2 to –0.6)	0.01	12.3	–2.2 (–3.0 to –1.4)	< 0.001

Gender (1: male; 2: female); education (1: ≤ 12 years; 2: > 12 years in school/college/university); work status (0: not working, 1: working or partly working); duration of pain (1: 3–6 months, 2: 6–12 months, 3: 12–24 months, 4: > 24 months; medicine (1: daily , 2: weekly, 3: less than weekly, 4: never).

Table III. *Multivariate regression coefficients with confidence interval (CI) for Beta of the determinants (sociodemographic variables, duration of pain, medication, emotional distress, range of motions) and the dependent variable, Shoulder Pain and Disability Index, n = 200*

	SPADI total			Pain subscale			Disability subscale		
	R^2 (%)	Beta (95% CI)	*p*-value	R^2 (%)	Beta (95% CI)	*p*-value	R^2 (%)	Beta (95% CI)	*p*-value
Sociodemographic variables									
Gender	1.02	1.2 (–4.5 to 6.9)	0.68	0.9	0.4 (–5.7 to 6.4)	0.9	1.3	2.7 (–3.3 to 8.8)	0.37
Age	0.0015	0.0 (–0.3 to 0.3)	0.95	0.2	–0.06 (–0.4 to 0.2)	0.65	0.9	0.1 (–0.2 to 0.4)	0.4
Education (1,2)	1.5	–3.5 (–7.7 to 0.7)	0.11	0.8	–2.3 (–6.8 to 2.2)	0.32	1.2	–3.8 (–8.4 to –0.7)	0.1
Work status (0,1)	2.8	0.5 (–6.2 to 7.2)	0.89	1.9	1.3 (–5.9 to 8.5)	0.73	4.3	–0.8 (–8.0 to 6.4)	0.83
	R^2=7.8			R^2=4.7			R^2=11.8		
Variables from self-reported questionnaire									
Duration of pain (1–4)	0.4	1.5 (–0.8 to 3.9)	0.2	1.2	2.3 (–1.5 to 4.8)	0.065	0.04	0.2 (–2.3 to 2.7)	0.26
Medication for pain (1–4)	6.0	–4.2 (–8.0 to –0.5)	0.028	4.9	–4.3 (–8.4 to –0.3)	0.036	6.5	–4.5 (–8.5 to –0.4)	0.032
Anti-depressant medication (and sleep) (1–4)	0.08	–1.1 (–4.9 to 2.1)	0.5	0.2	0.46 (–2.9 to 3.8)	0.8	0.2	–2.0 (–5.4 to 1.4)	0.26
Distress (HSCL 25)	4.5	9.6 (3.0 to 16.2)	<0.001	4.0	10.1 (3.0 to 17.2)	0.006	3.3	10.4 (3.3 to 17.5)	<0.001
	R^2=11.1			R^2=10.6			R^2=10.2		
AROMs affected side (impairments)									
Abduction	0.06	–0.006 (–0.1 to 0.09)	0.9	0.4	–0.3 (–0.1 to 0.7)	0.62	0.04	0.009 (–0.09 to 0.1)	0.86
Flexion	4.5	–0.2 (–0.3 to –0.03)	0.015	7.2	–0.2 (–0.3 to –0.04)	0.014	4.1	–0.2 (–0.3 to –0.03)	0.02
External rotation	1.5	–0.09 (–0.2 to 0.05)	0.22	0.8	–0.06 (–0.2 to 0.1)	0.46	1.7	–0.1 (–0.3 to 0.05)	0.17
Hand behind back (HBB)	2.0	–1.0 (–1.9 to –0.06)	0.036	1.0%	–0.8 (–1.7 to 0.2)	0.12	4.7	–1.4 (–2.4 to –0.4)	0.005
	R^2=10.2			R^2=9.6			R^2=11.1		
Total	R^2=29.1			R^2=24.9			R^2=33.1		

Gender (1: male; 2: female); education (1: ≤12 years; 2: > 12 years in school/college/university), Work status (0: not working, 1: working or partly working); duration of pain (1: 3–6 months; 2: 6–12 months; 3: 12–24 months; 4: <24 months); medicine (1: daily; 2: weekly; 3: less than weekly; 4: never).

flexion, and hand-behind-back range; explained 25.8% of the total variance ($p < 0.01$) (Table IV). Moreover, an equation for predicting the SPADI total score with these significant determinants was deduced: SPADI score = 81–(4.6 × pain medication) + (11.7 × distress)–(0.17 × flexion)–(1 × hand-behind-back) (where, pain medication: (daily = 1, weekly = 2, less than weekly = 3, never = 4).

Table IV. *Multiple regression models (stepwise) with Beta values, The Shoulder Pain and Disability Index (SPADI) as the dependent variable and the total percentage of variance (R^2), n = 200*

SPADI	R^2 (%)	Beta (95% CI)	*p*-value
*Part 1**			
Medication for pain (1–4)	3.8	–4.6 (–8.0 to –1.3)	<0.01
Distress (HSCL 25)	7.5	11.7 (5.8 to 17.7)	<0.01
Flexion aff side	5.2	–0.17 (–0.3 to –0.07)	<0.01
Hand behind back (HBB) (aff side)	3.1	–0.97 (–1.8 to –0.19)	0.015
Total R^2	25.8		
Part 2†			
Gender	5.0	–6.3 (–10.1 to –2.6)	<0.01
Education (1,2)	5.1	–3.8 (–6.4 to –1.14)	<0.01
Flexion affected side	4.6	–0.1 (–0.17 to –0.034)	<0.01
Pain at rest	16.2	1.9 (0.9 to 2.9)	<0.01
Pain on activity	6.7	3.9 (2.6 to 5.2)	<0.01
Carry a shoppingbag (5 kg)	5.7	2.1 (0.9 to 3.4)	<0.01
Take down from a wall cupboard	11.0	3.3 (1.7 to 4.8)	<0.01
Total R^2	64.9		

*Part 1: without the independent variables of pain and function from questionnaire.
†Part 2: with the independent variables of pain and function from questionnaire.
Gender (1: male; 2: female).
Education (1: ≤12 years; 2: > 12 years in school/college/university).
Medicine (1: daily; 2: weekly; 3: less than weekly; 4: never).

With variables related to pain during rest and activity and the 2 questions regarding function included, from 51.9% (disability subscale) to 59.8% of the variance (SPADI total) were explained, with pain on activity (R^2 = 45.6%) explaining the greatest proportion (univariate analysis, data not shown). The model (Table IV, part 2), showed significant associations with the determinants gender, education (step 1, 5.2%), and range of flexion (step 3, 1%). Only flexion showed significance in both models. Altogether this final model explained 64.9% of the total variance ($p < 0.01$) and a further equation was deduced: SPADI score = 28.3–(6.4 × gender)–(3.8 × education) + (4 × pain on activity) + (1.9 × pain at rest) + (2.1 × function "carry") + (3.3 × function "take down from a cupboard")–(0.1 × flexion) (where, gender: male=1 , female = 2; education: ≤ 12 years = 1, > 12 years in school/college/university = 2).

DISCUSSION

The main finding of this study is that although the determinants pain medication use, emotional distress, flexion, and hand-behind-back range of the affected side explained 25.8% of the total SPADI score, these variables explained remarkably little of the variance when the 2 variables related to pain and

the 2 questions regarding function were included. In the final model, when pain and function were included, approximately 65% of the variation in SPADI score was explained, with the determinants gender, education, and active range of flexion accounting for only a minor proportion (6.2%). If tested in a prospective design, this final model might assist clinicians in predicting change in SPADI scores. The observed contributions of the variables related to pain and function (59%) in this study were obvious for SPADI as a shoulder-specific pain and disability questionnaire and indicate the good construct validity of the instrument.

The SPADI scores are in line with other studies (7, 31). Pain on activity showed the strongest association with SPADI in the univariate analysis and is thus the strongest determinant of SPADI in patients with subacromial shoulder pain. A previous publication reported that when patients were asked how much difficulty they had in performing various activities, they regarded pain as the main limitation (6).

Having 12 or fewer years of education was associated with higher SPADI scores when the variables of pain and function were included. Moreover, a lower level of education often accompanies heavy physical or repetitive work, which are reported to be risk factors for subacromial shoulder pain (10, 19, 32, 33).

Studies on musculoskeletal pain are usually adjusted for gender, because women tend to report pain as more frequently, of longer duration, and higher severity as compared to men (15, 34). In the present study, the observed change in SPADI score for men in the last model is difficult to explain, but suggests that in addition to other confounders, gender may influence the scoring of SPADI.

Emotional distress has been reported to interfere with pain and function in other studies, but was not significant when the variables of pain and function were included in the model. Van der Windt et al. (18) concluded that distress and somatization were more strongly associated with low back pain than shoulder pain. This suggests that shoulder pain might be regarded as a more specific complaint; however, this issue warrants further investigation in prospective studies.

AROM explained approximately 10% of the variance, and less when pain and function were entered in the model. Previous articles have reported that AROM explains up to 23% of the variance (6, 29). For the patients included in this study, the shoulder may feel painful in the presence of full AROM and the patient's experience of, or fear of pain, may also have influenced the results (35). Fear of pain was not examined in the present study. However, most of the included patients had minor limitations in AROM, which may contribute to the small proportion of explained variance. In addition, AROM and SPADI may evaluate different constructs in patients with subacromial pain, and the observed limitations in AROM may not be a criterion for disability (31). Thus, focus on AROM in rehabilitation may be overestimated. On the other hand, measures of impairments, such as AROM, might be relevant as a supplementary outcome for other patients with shoulder pain (36). We also observed that duration of pain, sick leave and work status did not contribute to an explanation of the variation in SPADI scores, although these factors are recommended outcome variables in patients with subacromial pain (18, 37). Self-reported questionnaires such as SPADI do not evaluate all dimensions of a shoulder problem. However, clinicians may be more able to treat patients diagnosed with subacromial impingement syndrome if the main complaint is pain and disability than if the problem presented is more comprehensive. SPADI was applied because of its documented psychometric properties for patients with subacromial pain. The Norwegian version of the questionnaire is acceptable for assessing this patient group (11, 12). It is reported to be the quickest questionnaire to complete and the scores do not change significantly in stable subjects (12).

Advantages of the present study are the use of the recommended clinical diagnostic criteria for subacromial shoulder pain, the inclusion of several possible determinants (predictors) in the analyses, and the relatively large sample size (4, 13, 37).

Of importance is that the present results are only referred to patients with subacromial pain. The sample included at the Physical Medicine and Rehabilitation Department may also have an effect on the observed cofactors. A considerable limitation is that the evaluations of the measurement properties of SPADI are based on classical test theory (CTT) and do not contain an evaluation of item response theory (IRT) models such as Rasch analysis. IRT has previously been applied only for the SPADI disability subscale (38). Unequal interval measures and an imprecision in measuring the status of patients with lower and higher shoulder functioning (postoperative patients also included) was reported (38). This indicates that SPADI as a scoring system needs further investigation. Another possible limitation is the cross-sectional study design, in which no conclusions regarding the predictive or prognostic impact of the variables are allowed. We expected that emotional distress might affect the variation in SPADI scores (10, 20). However, a registration of emotional distress (and other factors) only at baseline excludes the possible influence of a transition or change in this variable over time from acute to more chronic pain problems (10). Muscle strength measurements were not included. An association between strength measurements and pain and disability has been reported in other studies (7). The limited explanation of the included confounders may reflect the measurement errors of the independent variables and SPADI, and the fact that a limited number of independent variables were included. Other variables might have been included as confounding factors or been considered in the evaluation of SPADI's variance. Examples are variables related to sleeping disturbances, occupational and recreational disability, physical activity level and other pain comorbidities, such as neck and hand pain (15, 31, 39). In addition, another approach using qualitative models may have been appropriate in order to explore the variance of SPADI.

We assume that SPADI is a continuous variable, although it is composed of 2 subscales reported on 13 VAS scales (38). SPADI has been shown to have no floor or ceiling effects; however, Ekeberg et al. (11) found moderate floor effects for 3 items and no evidence of a ceiling effect for this group of

patients (8, 38). Furthermore, our statistical models were carefully evaluated and the assumptions for conducting uni- and multi-variate linear regression analyses were met (30).

In conclusion, determinants such as sociodemographic and clinical variables explained approximately 30% of the variance in both SPADI total score and the subscales of pain and disability in a multivariate model. When the 2 variables of pain and function were included in the analysis these factors explained remarkably little of SPADI's variance, which supports the use of SPADI as a shoulder pain and disability questionnaire and the construct validity of the instrument.

We still do not fully understand the relationship between patient-evaluated outcomes and clinician-evaluated measures, such as AROM, but suggest that different constructs are measured.

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Conflicts of interest

No competing interests exist. All authors followed the criteria for authorship. All authors declare that the answers to the questions on competing interests were all negative.

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APPENDIX I. The Shoulder Pain and Disability Index (SPADI) contains the following questions, rated on horizontal visual analogue scales (VAS) (not pain at all/no difficulty to worst pain Imaginable/so difficult required help). (Comment: These endpoints are according to the original version)

Pain: How severe is your pain?
- PS.1 At its worst?
- PS.2 When lying on the involved side?
- PS.3 Reaching for something on a high shelf?
- PS.4 Touching the back of your neck?
- PS.5 Pushing with the involved arm?

Disability: How much difficulty do you have…
- DS.1 Washing your hair?
- DS.2 Washing your back?
- DS.3 Putting on an undershirt or pullover sweater?
- DS.4 Putting on a shirt that buttons down the front?
- DS.5 Putting on your pants?
- DS.6 Placing an object on a high shelf?
- DS.7 Carrying a heavy object of 10 pounds?
- DS.8 Removing something from your back pocket?