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A short activity-related scale for measuring shoulder function in patients with subacromial pain: the DASH 7

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Background: Subacromial pain is a common cause of shoulder dysfunction that negatively affects quality of life. Currently, most outcome measures for shoulder pain are applied to a heterogeneous group of patients. Of these measures, the Disabilities of the Arm, Shoulder, and Hand (DASH) is the most widely recognized test with which to assess patients with subacromial pain. The primary aim of this study was to assess the content validity of DASH for patients with subacromial pain, with a secondary aim to test responsiveness to a modified set of DASH items tailored to these patients.

Methods: There were 129 patients who reported activities in the Patient-Specific Functional Scale (PSFS). To assess validity, 5 independent physiotherapists matched PSFS activities to the most appropriate DASH item. DASH items identified as being of greatest importance to patients were those corresponding to the highest number of PSFS-matched activities. Calculations were made for responsiveness and internal consistency.

Results: Physiotherapists matched DASH items to 271 PSFS activities, reaching agreement for almost 80%. Seven DASH items (DASH 7) were identified as being particularly important. Effect size data (Cohen's *d*) were 0.93 for DASH 7, 0.92 for DASH 30, and 0.85 for QuickDASH; the corresponding Cronbach's α values (for DASH 7, DASH 30, and QuickDASH) were 0.84, 0.94, and 0.86, respectively.

Conclusions: DASH 7 is a short, patient-centered, and activity-related scale that can measure shoulder function in patients with subacromial pain using a quarter of the original DASH items. DASH 7 demonstrated responsiveness, with a satisfactory level of internal consistency.

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Among the general population, shoulder pain is the third most common musculoskeletal disorder, which incurs substantial quality of life issues in terms of everyday function, the capacity to work,²² and sleep quality.³² In those patients with shoulder pain, as many as 30% are diagnosed with subacromial impingement syndrome.^{9,34} Given the negative impact and high frequency of shoulder disorders, it is crucial that the best possible measures be used in evaluating shoulder function.

This analysis has been performed on patients from a randomized controlled trial (Clinical Trial registration: NCT01885377; SWESS: The Swedish Exercise Shoulder Study in Primary Care for Patients with Subacromial Pain; Unique Protocol ID: 8820 PV-JN-1) with an ethical approval from the regional ethical review board (diary number 2011/320-31). This psychometric analysis of the instrument was not presented in the initial protocol, but we cannot see any ethical problem in how the data have been used for this paper.

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Any assessment of shoulder function in the clinical or research setting should involve and engage the patient through the use of varied but relevant patient-reported outcome measurements (PROMs). PROMs can be used to quantify individual patients' perceived degree of impairment and are also valuable for making group comparisons.¹ To maximize the patient's interest, participation, and goal setting, it is important that the included items be relevant to the patient while demonstrating sensitivity to change over time. This is particularly important in studying cohorts of specific patients in clinical or research studies. Currently, we lack a valid and specific PROM with which to assess patients identified with a subacromial cause of pain and disability. Thus far, the majority of PROM scores have been applied to a broadly heterogeneous group of patients. Of these scores, the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire is widely acknowledged to be one of the most commonly evaluated tests in terms of its measurement properties.^{2,5,33} DASH comprises 30 items and was developed for the evaluation of disability and symptoms in the upper extremity (viewed as a unit), with the ability to evaluate any joint or condition within that extremity.¹³ Further developments resulted in a

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shorter, 11-item version of DASH, termed QuickDASH, that aims to evaluate the same population as the original DASH test.⁴

A questionnaire that addresses the whole upper extremity, hand, elbow, and shoulder may lack sensitivity for patients with joint-specific diagnoses. For example, despite DASH's demonstrable sensitivity to shoulder function,^{1,5,27,33} the question remains as to whether a subset of items within the score might prove to be superior in measuring shoulder function in patients with subacromial pain.

The primary aim was to assess the content validity of DASH for patients with subacromial pain by comparing DASH with the Patient-Specific Functional Scale (PSFS). A secondary aim was to test responsiveness to a modified set of DASH items tailored to these patients. The hypothesis was that some of the DASH items will prove to be more relevant to patients with subacromial pain and are therefore more sensitive to change. If true, for these patients, responsiveness should be higher to that subset of more relevant items vs. a DASH test that incorporates all 30 items.

Materials and methods

Study design

The design of the study was psychometric testing for validity and responsiveness.

Data collection

Data for 129 patients were collected between September 2011 and January 2015 from a randomized controlled trial (RCT) in a primary care setting in Linköping, Sweden. Characteristics of the patients are shown in Table I. The RCT included patients with subacromial pain, and its aim was to evaluate the effect of a specific treatment strategy. Data in the RCT were collected at baseline and then at different follow-ups. In the current analysis of content validity, PSFS and DASH data were collected at baseline, with DASH and Patient Global Impression of Change (PGIC) data collected at the 3-month follow-up to analyze responsiveness.

Inclusion criteria for the RCT were a typical history of pain located in the lateral proximal part of the upper arm, especially with the arm lifted above the shoulder, and a minimum of 3 positive findings in the following clinical tests^{12,16,24}: impingement sign according to Neer,²⁶ impingement sign according to Hawkins-Kennedy,¹⁰ Jobe test,¹⁵ and Patte maneuver.²¹ Participants had to be aged 30–67 years, with pain of at least 2 weeks in duration.

Exclusion criteria for the RCT included frozen shoulder, clinically verified polyarthritis, rheumatoid arthritis, fibromyalgia, instability in any joints of the shoulder girdle, previous fractures or surgery in the affected shoulder, radiologically verified malignant disease, osteoarthritis in the glenohumeral joint, acromioclavicular arthritis,

Table I
Characteristics of the patient cohort (n = 122–129)

Age, y	52 (8.5)
Sex, female	62.4%
Pain duration, mo	15.2 (31.2)
With dominant shoulder affected	52.5%
EQ-5D index	0.622 (0.264)
EQ VAS	69.2 (20.2)
VAS pain in provocative activity	75.3 (18.6)
VAS pain at rest	15.5 (21.2)
VAS pain at night	47 (27.4)
Rotator cuff status, with full-thickness tear	3.8%
Rotator cuff status, with partial-thickness tear	11.6%

EQ-5D, EuroQol-5 Dimension questionnaire; EQ VAS, EuroQol visual analog scale; VAS, visual analog scale.

Continuous variables are presented as mean (standard deviation).

symptoms from the cervical spine, and inability to understand written and spoken Swedish.

All participants received oral and written information about the RCT and, before inclusion, provided written consent.

Measurements

In the PSFS, the patients are asked to identify important activities with which they have difficulty or that they are unable to perform. The patients rate their ability to perform each activity on a scale of 0 to 10, where 0 is “unable to perform activity” and 10 is “able to perform activity at the same level as before the injury or problem.”²⁹ The measurement properties of the PSFS have been reported to be satisfying for patients with primary shoulder complaints.^{11,18} In the current study, each patient was asked to choose the 2 or 3 most important activities that were affected by the shoulder complaint. The PSFS was completed first to prevent DASH items from influencing the PSFS activities chosen.

DASH and QuickDASH are self-administered questionnaires. The instruction to the patients is to answer every item on the basis of their condition during the previous week, irrespective of which arm is used for the task. Scores for each item range from 1 to 5, where 1 is “no disability/symptoms” and 5 is “severe disability/symptoms.”¹³ Possible scores range from 0–100, where 0 indicates no difficulty or symptoms and 100 denotes severe difficulty. The measurement properties of both DASH and QuickDASH have been reported to be satisfactory for patients with primary shoulder complaints^{1,2,19,27,28,33,35}; the DASH test was used in the current study.

The PGIC scale ranges from 1 to 7. One is “no change, or condition got worse,” and 7 is “a great deal better, and a considerable improvement that has made all the difference.” PGIC has an additional scale ranging from 0 to 10, where 0 is defined as “much better,” 5 denotes “no change,” and 10 is “much worse.”¹⁴ This additional scale was not used in this study. In our analyses, the PGIC scale was converted into a dichotomous scale, with 1 indicating better/much better (rates 6 and 7 in the PGIC scale) and 2 indicating slightly better/unchanged/worse (rates 1 to 5). The cutoff was chosen to minimize the risk of overestimation.

Validation of DASH items

The definition of content validity used in this study agrees with the Consensus-based Standards for the Selection of Health Status Measurement Instruments (COSMIN) taxonomy, “the degree to which the content of a health-related patient-reported outcome instrument is an adequate reflection of the construct to be measured.”²⁵ The validation of DASH was made by comparisons with PSFS activities. This validation process is described in 3 steps.

Step 1: matching DASH items to PSFS activities

Patient-selected PSFS activities were recorded and listed. Five different physiotherapists independently selected 1 or 2 corresponding DASH items for each PSFS activity. If 2 DASH items were chosen, the physiotherapists were asked to prioritize items, with 1 and 2 denoting the closest and then second-best match. All 5 physiotherapists were selected for participation on the basis of their prior experience and expertise in working with patients with subacromial pain and with administering the DASH test and the PSFS in either a primary care setting or an orthopedic department.

Step 2: agreement between physiotherapists in matching DASH items to PSFS activities

To make a final decision as to which DASH item (1 or 2) best corresponded to each PSFS activity, the levels of agreement between the physiotherapists' selection of corresponding DASH items were compared. In cases of disagreement, the DASH item selected by the

majority of the physiotherapists was used. If 2 or more of the 5 physiotherapists were unable to select a DASH item corresponding to a specific PSFS activity or if all the physiotherapists selected totally different corresponding DASH items, these PSFS activities were defined as impossible to classify and were excluded from further analysis.

Step 3: DASH items of particular importance to the patient

To identify which of the 30 DASH items were of most importance to patients with subacromial pain on a group level, the analysis started by examining the distribution of DASH items that matched PSFS activities. On the basis of this distribution, different cutoff levels were tested. The cutoff level finally chosen was the one that included as many patients with corresponding PSFS activities as possible but with a minimal amount of DASH items.

Responsiveness for DASH

The definition of responsiveness used in this study agrees with the COSMIN taxonomy, “the ability of a health-related patient-reported outcome instrument to detect change over time in the construct to be measured.”²⁵ Comparison of change from baseline to the 3-month follow-up was made between DASH 30 items, QuickDASH, and DASH items identified as important to the patients with subacromial pain. A comparison was also made between score change in the different versions of DASH and rated change in the PGIC at the 3-month follow-up, using the dichotomized scale to define improvement.

Statistical analyses

SPSS Statistics 23 software (IBM, Armonk, NY, USA) was used for all statistical calculations except for effect size, which was calculated in Psychometrica.²⁰ Descriptive statistics were used for sample characteristics, the distribution of DASH items, and rated PGIC. Agreement among the 5 different physiotherapists in terms of selecting the most appropriately matched DASH item (to a PSFS activity) was described in terms of percentage agreement. The paired *t*-test was used for comparison of change over time in different versions of the DASH scores. Effect size according to Cohen’s *d* for groups with unequal sample size⁶ was calculated, using the dichotomous scale in PGIC and by comparing score changes for the different versions of DASH. To test the internal consistency of the original DASH, QuickDASH, and the new shortened version of DASH, Cronbach’s α was calculated on baseline scores.

Results

Validation of DASH

Step 1: matching DASH items to PSFS activities

A total of 271 PSFS activities were recorded and listed from 127 patients who had chosen PSFS activities at baseline of the original 129 patients. Ninety patients (70.9%) chose 3 PSFS activities, 35 patients (27.6%) chose 2 PSFS activities, and 2 patients (1.6%) chose 1 PSFS activity. Nineteen of the original 30 DASH items were identified as corresponding to 1 or more of the 271 PSFS activities, with 11 DASH items left unmatched to any PSFS activity (Table II).

Step 2: agreement between physiotherapists in matching DASH items to PSFS activities

Between the 5 physiotherapists, the total agreement was almost 80% in identifying the 1 or 2 DASH items that best corresponded to each PSFS activity (Table III). For 39.5% of the 271 PSFS activities, the 5 physiotherapists identified a PSFS activity that matched

Table II
DASH items corresponding to patients’ PSFS activities

Item in DASH	Patients (%) with PSFS activity corresponding to DASH item
1	0
2	2.3
3	0
4	0
5	2.3
6	23.8
7	17.5
8	6.2
9	2.3
10	9.5
11	11.7
12	3.1
13	13.6
14	15.9
15	43.2
16	0
17	7
18	38.7
19	13.7
20	5.4
21	0
22	2.3
23	27.4
24	0
25	0
26	0
27	0
28	0
29	24.6
30	0

DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; PSFS, Patient-Specific Functional Scale. The most commonly matched DASH items are in **boldface**.

a single DASH item. For 39.1% of PSFS activities, 1 or 2 of the same matching DASH items could be identified.

A total of 13 PSFS activities were impossible to classify and were excluded from further analysis. Nine further PSFS activities were excluded as all the physiotherapists had selected totally different matching DASH items. An additional 4 PSFS activities were excluded after the failure of 2 or more physiotherapists to select a DASH item corresponding to that specific PSFS activity (Table IV).

Step 3: DASH items of particular importance to the patient

Using a 15% cutoff level resulted in a total of 7 DASH items for which 122 patients of the 127 (96.1%) had at least 1 corresponding DASH item represented. The results showed that 23.6%, 49.6%, and 22.9% of the patients had DASH items corresponding to 1, 2, or 3 of their PSFS activities (Table V). Cutoff levels of 10% and 20%

Table III
Percentage agreement between the 5 physiotherapists in matching DASH items to PSFS activities

No. of DASH items selected as corresponding to each PSFS activity	Agreement (%) between physiotherapists in matching DASH items to PSFS activities (No.)
1	39.5 (107)
2	39.1 (106)
3	15.9 (43)
4	4.1 (11)
5	1.5 (4)
Total	100.0 (271)

DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; PSFS, Patient-Specific Functional Scale. The values in **boldface** represent the results fulfilling the criteria of agreement between physiotherapists on 1 or 2 of the same matching DASH items.

Table IV

PSFS activities excluded from further analysis because all physiotherapists selected totally different corresponding DASH items or because 2 or more of the 5 physiotherapists could not select a DASH item as corresponding to that PSFS activity

PSFS activities for which all the physiotherapists selected different matching DASH items	PSFS activities for which 2 or more of the 5 physiotherapists could not select a corresponding DASH item
Pushing a shopping trolley	Get dressed/pull up pants
Painting/wallpapering	Getting out of bed
Dress/undress the kids	Crawl under a machine
Dry the table	Put on a car seat belt
Adding wood to the fireplace	
Rapid arm movements	
Turn off the lamp by the sofa	
Closing the car door	
Opening and closing a shutter	

DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; PSFS, Patient-Specific Functional Scale.

Table V

Correlates for patients matching 0–4 DASH items to 1, 2, or 3 PSFS activities, with a 15% cutoff*

No. of corresponding DASH items	Patients reporting 1 PSFS activity	Patients reporting 2 PSFS activities	Patients reporting 3 PSFS activities	Total No. of patients (%)
0	0	3	2	5 (3.9)
1	2	8	20	30 (23.6)
2	0	23	40	63 (49.6)
3	0	1	26	27 (2.3)
4	0	0	2	2 (1.6)
Total No. of patients	2	35	90	127 (100)

DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; PSFS, Patient-Specific Functional Scale.

* A minimum of 15% of the patients had at least 1 PSFS activity corresponding to a specific DASH item.

resulted in a distribution of 11 and 5 DASH items, respectively, with 123 and 113 patients having corresponding DASH items.

Using the 15% cutoff resulted in the identification of 7 important activity-related DASH items in evaluating shoulder function in patients with subacromial pain (Table II). Those items were item 6 (*Place an object on a shelf above your head*), item 7 (*Do heavy household chores*), item 14 (*Wash your back*), item 15 (*Put on a pullover sweater*), item 18 (*Recreational activities in which you take some force or impact through your arm, shoulder, or hand*), item 23 (*During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder, or hand problem?*), and item 29 (*During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder, or hand?*). Henceforth, these items are referred to collectively as DASH 7 (Appendix S1), with the original DASH items referred to as DASH 30.

Responsiveness for DASH

Effect size calculations according to Cohen's *d* demonstrated that DASH 7, DASH 30, and QuickDASH were all within the range of "a

Table VI

Responsiveness of DASH 30 items, QuickDASH, and DASH 7 items

	DASH 30 (n = 83)	QuickDASH (n = 83)	DASH 7 (n = 83)
Score change, 0–3 mo	13.59 (14.32)	14.71 (15.88)	19.41 (20.13)
Score change in group rating PGIC as better/much better (n = 40)	19.81 (14.3)	21.15 (16.32)	28.24 (19.9)
Score change in group rating PGIC as slightly better/unchanged/worse (n = 43)	7.8 (11.81)	8.73 (13.0)	11.2 (16.74)
Effect size (Cohen's <i>d</i>)	0.92	0.85	0.93

DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; PGIC, Patient Global Impression of Change. Score changes are reported as mean (standard deviation).

large effect"³⁰ (Table VI). The calculations of internal consistency for DASH 7, DASH 30, and QuickDASH resulted in a Cronbach's α of 0.84, 0.94, and 0.86, respectively.

Discussion

This study demonstrates that it is possible to use only 7 of the items in DASH 30 to identify the activities most relevant to patients with subacromial pain while maintaining internal consistency and satisfactory responsiveness.

A strength of the method used is that independently, 5 physiotherapists matched the most suitable DASH item to each of the 271 PSFS activities, with a level of agreement of almost 80%.

Only 13 PSFS activities could not be classified in the validation process, either because 2 or more of the 5 physiotherapists had failed to identify a corresponding DASH item or because they chose totally different DASH items. This failure rate of <5% indicates that the DASH items are, in general, able to capture the activities chosen as important to patients with subacromial pain. The items selected for DASH 7 therefore cover the most important patient-selected (by 96% of patients) activities.

Another strength of the method is that it introduces the patient's perspective by using the patient's prioritized activities on the PSFS as a reference point, with the addition of a professional's expert opinion in identifying the best corresponding DASH items. In developing DASH 30, item selection was based primarily on expert opinion, with the items selected from 13 published and unpublished measurement scales. Initially, 821 items were reduced to 78 items, field tested by patients for face validity, then reduced to the ultimate 30-item scale.^{13,23} In developing QuickDASH, the goal was to get a shortened version of the test that nevertheless targeted the same population as the original DASH while maintaining a Cronbach's α at >0.90. Three statistical item reduction techniques were used to develop 3 different scales; the final selection as to which scale to use was determined by the correlation and measurement properties most similar to the original DASH.⁴

In this study, the DASH item "recreational activities with force or impact" was identified as one of the most important patient-selected activity-related items to patients with subacromial pain. This is in contrast to a recent study, based on the professionals' expert opinion about usefulness of different DASH items, in which the same item was identified as informative but problematic and even suggested to be taken out from the DASH in the future. The study by Kennedy and Beaton,¹⁷ was performed with reference to patients with varied upper extremity conditions, in contrast to this study with focus on subacromial pain. This illustrates our suggestion that different items are valid for different groups with upper extremity disorders.

The Swedish version of DASH that was used in this study was translated from the English version, with cross-cultural adaptation.³ We acknowledge that cultural context may reprioritize PSFS activities in an unpredictable manner. That said, shoulder function as affected by subacromial pain tends to be manifested in the same fashion worldwide, which would support the broad applicability of our data.

The calculations of internal consistency resulted in a Cronbach's α at an acceptable level³⁰ for all 3 DASH versions used in this study. A Cronbach's α of >0.90 can indicate redundant items,³¹ which may warrant a reduction in item number for the DASH 30 test in evaluating shoulder function in patients with subacromial pain. The modest reduction of Cronbach's α for DASH 7 vs. QuickDASH and DASH 30 can be interpreted as a demonstration of its high level of internal consistency.³¹ Data from the current study showed a large score change over time for all DASH versions. Given the greater variation for DASH 7, the effect size between DASH 7 and DASH 30 was almost identical, with a small disadvantage for QuickDASH. This result would support rejecting our hypothesis. Even though we identified 7 DASH items as being more important to the patients with subacromial pain, their responsiveness to DASH 7 was not improved compared with DASH 30 or QuickDASH in terms of evaluating shoulder function in patients with subacromial pain.

One advantage with the DASH 7 and QuickDASH tests vs. DASH 30 is their length. Short questionnaires, being less time-consuming, might be more attractive to use as they minimize administrative time and the burden placed on the respondent and therefore enhance responsiveness by minimizing the risk of missing responses.⁴

A comparison has been made between the DASH and the International Classification of Functioning, Disability and Health (ICF) model.⁷ Applying this classification to the different DASH versions (DASH 30 and QuickDASH) showed that items were represented at each ICF level (impairment, activity limitation, and participation restrictions). ICF classification in terms of DASH 7 resulted in the selection of activity limitation and participation restriction criteria only, with no items related to impairment. This result is to be expected in making comparisons with a test based on patient activity.

The choice of developing an activity-related measurement scale results in the exclusion of items related to specific symptoms, such as pain. Pain is a central cause of shoulder dysfunction in patients with subacromial pain, and therefore it is important to complement the DASH 7 test with a separate measurement for pain. Measuring pain and shoulder function separately is in line with the recommendations from the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials regarding pain measurement.⁸ Measuring different core domains separately enhances the possibility for deriving meaningful comparisons of change within different domains, both on an individual level and between research studies.⁸

Conclusions

In matching commonly reported patient-specific activities to DASH, 7 DASH items (DASH 7) were prioritized as being the most important in evaluating patients with subacromial pain. The DASH 7 test is able to detect change over time to the same high degree as DASH 30, uses only a quarter of the items, and maintains a similar level of internal consistency to QuickDASH in evaluating shoulder function in patients with subacromial pain.

Clinical implications and future research

The DASH 7 questionnaire is a short PROM that focuses on those activities prioritized by patients with subacromial pain. This could be a useful assessment tool in the clinical setting, given its brevity and relevance to the patient, and may facilitate the patient's interest and participation. Future research efforts should test DASH 7 with patients suffering subacromial pain in different clinical contexts and states of the disorder.

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Appendix: Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.jses.2017.04.001>

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