

Cross-cultural adaptation of the disabilities of the arm, shoulder, and hand (DASH) questionnaire into Hungarian and investigation of its validity in patients with systemic sclerosis

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Abstract

Objective

To adapt and validate the Hungarian version of the DASH and the shorter QuickDASH Outcome Measures and to establish their validity in patients with systemic sclerosis (SSc).

Methods

The Hungarian adaptation of the questionnaires was performed using forward/backward translations, expert and lay reviews. 128 patients completed the DASH, the Health Assessment Questionnaire (HAQ-DI), the Modified HAQ-DI for patients with SSc (SSc-HAQ), and the Short Form Health Survey (SF-36) questionnaire. 76 patients participated in a 12-month follow-up examination. Sensitivity to change was estimated using the standardized response mean (SRM).

Results

Cronbach alpha in the DASH sections were between 0.94-0.97. The intraclass correlation coefficient for the test-retest reliability of DASH was 0.89. DASH scores showed a correlation with both SSc-HAQ and the physical dimensions of the SF-36 (Spearman's rho: 0.89, -0.77 and -0.42, respectively). The SRM of DASH was 0.64 among the scleroderma patients with worsening HAQ-DI status.

Conclusions

The Hungarian version of the DASH and QuickDASH demonstrated equivalent reproducibility, internal consistency and validity to the originals. The strong correlations of the DASH and QuickDASH with the HAQ-DI, and with the physical dimensions of the SF-36 show that the disability of the patient with SSc is predominantly caused by the functional impairment of the upper limb. Because both questionnaires were valuable tools for measuring upper extremity function and joint damage in SSc patients, we recommend the shorter and simpler QuickDASH for everyday clinical use.

Key words

Systemic sclerosis, scleroderma, DASH, QuickDASH, disability, functional assessment questionnaire, quality of life, validation, sensitivity to change.

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Introduction

Systemic sclerosis (SSc) is a connective tissue disease affecting the skin, musculoskeletal system and internal organs by vascular lesions and fibrotic changes. End stage disease is characterized by obliterative vasculopathy and atrophy of the involved organs. Musculoskeletal manifestations of SSc include arthralgia, arthritis, contractures and deformations of both the small hand and large joints (1). Muscle weakness, soft tissue calcifications, fibrous tenosynovitis, carpal tunnel syndrome, and skin ulcers/scars also contribute to the impaired function of the upper extremities. Hand functions are influenced both by early phase digital skin thickening, swelling, stiffness and late stage digital skin tethering. The function of upper limbs can also be affected by Raynaud's phenomenon, and polyneuropathy. The restriction of upper limb movements has serious impact on the daily activities and quality of life of these patients. Musculoskeletal components are also important in Medsger's severity scale (MSS) (1, 2).

Health measurement scales are important tools to evaluate health status and medical intervention, such as the Disability of the Arm, Shoulder, and Hand (DASH) and the shorter QuickDASH questionnaire devised for region specific measurement (3-6). There are already some reliable and valid quantitative measurements of hand deformity in scleroderma including the Hand Mobility in Scleroderma Test (HAMIS) (7, 8), Arthritis Hand Function Test (AHFT) (9) and the Hand Anatomic Index (HAI) (10). All of them need some simple equipment, and also require some training in measurement which complicates the daily routine.

At present, there are few reliable and valid self-assessment questionnaires for the evaluation of upper limb function (11-14). The Duruöz Hand Index (12, 13) and the UK Scleroderma Functional Score (UKFS) (14) seem to be practical in everyday use with SSc patients. The Patient Rated Elbow Evaluation (PREE) questionnaire (15) has not yet been validated in patients with SSc. The DASH Outcome Measure is another self-administrated question-

naire, which evaluates the functions of the whole upper limb, and consequences regarding sleep and social activities. The DASH was jointly developed by the Institute for Work & Health and the American Academy of Orthopaedic Surgeons (AAOS) (3). The DASH is still more current than Duruöz Hand Index or the UKFS, and has been translated into more than ten languages and adapted in many countries (16-22), so it can be easily used in international trials. The DASH questionnaire has been shown to be reliable and valid in many upper limb surgical diseases (15, 18-20) and in rheumatoid arthritis or psoriatic arthritis (22, 23).

In this study, we first performed cross-cultural adaptation of the DASH and the QuickDASH into Hungarian. Our further aim was to evaluate joint changes, contractures and other scleroderma-related musculoskeletal/skin involvements of the upper limb in patients with SSc. We found higher DASH scores when arthralgia/arthritis and/or joint contractures of the upper limbs were present in patients with SSc. We demonstrated that contractures of the hands and mainly contractures of the shoulders cause severe disability and inability to perform the tasks of daily living in these patients.

Patients and methods

Patients

One hundred and twenty-eight consecutive patients with SSc (Table I) were enrolled in this study from December 2005 to June 2006 at the University of Pécs, Hungary, Department of Immunology and Rheumatology. Every patient fulfilled the criteria proposed by LeRoy and Medsger for SSc classification with diffuse or limited cutaneous involvement (24).

The local Ethical Committee authorized the validation process and all patients agreed to participate.

DASH

The main part of the DASH, called "the DASH disability-symptom" (DASH-DS) contains 30 questions: 21 about the degree of difficulty in performing various physical activities, 5 regarding severity of symptoms of pain, tingling,

Competing interests: none declared.

weakness and stiffness, and 4 dealing with problems affecting social activities, work and sleep, and with psychological impact. The DASH also contains two optional 4-item parts concerning ability to work (DASH-W) and ability to perform sports, or play musical instruments (DASH-SM). Each item has 5 response choices (1-5) ranging from "no difficulty" or "no symptom" to "unable to perform the activity" or "very severe symptom". The scores for all items are used to calculate final score ranging from 0 (no disability) to 100 (severest disability). If more than 10 percent of the items are left blank, then that part of the DASH is not calculated (3).

QuickDASH

QuickDASH contains only 11 items of the DASH-DS but has the same optional modules intended to measure symptoms and functions in workers, sportsmen and artists who require a high degree of physical performance (6, 21).

Cross-cultural adaptation

We used the forward/backward translation method (25) involving the following steps: the original DASH was first translated into Hungarian by three independent Hungarian translators, one was aware of the aim of the questionnaire and two were not. These translations were compared sentence by sentence, and a common Hungarian version was accepted. Next, two bilingual native English speakers, who were unaware of the required proprieties of the questionnaire, translated it back into English. A final translation was performed during a cognitive debriefing with experts and patients (n=11). Our adaptation process was accepted by the Institute for Work & Health and the translation form can be seen on their website (<http://www.dash.iwh.on.ca>).

For validation of the DASH Hungarian version, the following psychometric properties were assessed.

Reliability

Reliability was investigated by analysing internal consistency and reproducibility based on the test-retest method. The DASH was given to 45 new consecutive SSc patients to complete at

the hospital. The same questionnaire was mailed to the patients one and two weeks later to complete at home and return immediately.

Validity

Concurrent validity was assessed by searching for correlations between the different parts of the DASH and other well known instruments. All patients had a physical examination by a physician and two physical therapists and had to complete the Short Form Health Survey (SF-36) questionnaire (26), a measure of health related quality of life, and the modified Health Assessment Questionnaire Disability Index (HAQ-DI) for patients with SSc (SSc-HAQ) (27-29). The SSc-HAQ is a functional assessment instrument containing the original HAQ and 5 visual analog scales (SSc-VAS). These SSc-VAS scales help patient assessment of symptoms and problems related to Raynaud's phenomenon, digital ulcers, gastrointestinal tract and lung involvement, and overall disease severity. Moderate to high associations were expected between DASH scores and SF-36 physical dimension and between DASH scores and HAQ-DI, and no associations were expected with SF-36 emotional and mental items.

Upper limb range of motion, and HAI (open hand span minus closed hand span divided by the lateral height of hand) for both hands were measured for each patient. Modified Rodnan skin score (MRSS) (30, 31) and muscular and joint/tendon scores of MSS (1, 2) were calculated.

Discriminant validity explores the ability of the questionnaire to discriminate between groups of patients with different symptom severity. First, the DASH scores of lcSSc and dcSSc patients were compared, then all patients were divided into groups based on presence/absence of arthralgia/arthritis, or contractures of the hands or shoulders.

Floor and ceiling effects were considered present if more than 15% of respondents achieved the highest or lowest possible score (32).

Sensitivity to change

From December 2006 to March 2007, 76 patients (67 female, 9 male, mean

age 56.6±11.6 years, 50 patients with lcSSc and 26 with dcSSc) filled out the same questionnaires again after 12 months. Sensitivity to change was estimated using the standardized response mean (SRM, as the ratio of the mean to the standard deviation of the change), the effect size (ES, as the ratio of the mean change to the standard deviation of the first measure) and the responsiveness statistic (RS, as the ratio of the mean change to the standard deviation of change in patients that remain stable over time) (33-39).

Statistical methods

A test of normality (Shapiro-Wilks test) was performed to assess distribution of the DASH and the Quick-DASH. The interval measurements of DASH related data were not normally distributed (33). Therefore, nonparametric methods were used. Quantitative variables were described using means and standard deviations (SD). Descriptive statistics were expressed as median and quartiles. Regarding reliability, internal consistency was assessed by the use of Cronbach's alpha coefficient. Test-retest reliability was assessed with the intra-class correlation coefficient (ICC). A value of 0.4 to 0.6 is considered "moderate", 0.6 to 0.8 "good", and over 0.8 "excellent" agreement. (30). Structural validity: To support the hypothesized scale structure of the questionnaire a principal component analysis with orthogonal (varimax) rotation was performed to confirm the unidimensionality of the Hungarian DASH-DS.

Spearman's correlation coefficients were calculated to estimate the concurrent validities of the parts of DASH with HAI, HAQ-DI, SSc-HAQ and the eight dimensions of SF-36.

The discriminating ability of the DASH was examined comparing DASH indexes of different groups using the Mann-Whitney U-test.

To examine the sensitivity to change (33-39) of the DASH using the changes of HAQ-DI (here, these were calculated without corrections of aids and helpers), as an indicator of change in health status, three subgroups were formed: poorer health (worsened HAQ-DI), no change (same HAQ-DI) and improved

Table I. Demographic and disease data of 128 patients with systemic sclerosis (SSc).

	lcSSc (n=87)	dcSSc (n=41)
Gender (women/men)	82 / 5	34 / 7
Mean age \pm SD (years)	57.3 \pm 10.3	52.6 \pm 13.7
Disease duration \pm SD	11.3 \pm 7.9	9.7 \pm 8.4
ANA	70 (80%)	35 (85%)
Anti-Scl-70	22 (25%)	30 (73%)
Anti-centromere	18 (21%)	1 (2%)
Tender or swollen joints	34 (39%)	12 (29%)
Contractures in the hands	19 (22%)	22 (54%)
Contractures in the shoulders	17 (20%)	5 (12%)
Raynaud's phenomenon	87 (100%)	41 (100%)
Digital ulcers	15 (17%)	12 (29%)

lcSSc: limited cutaneous Ssc; dcSSc: diffuse cutaneous Ssc.
 \pm SD: standard deviation

health (better HAQ-DI). Changes between baseline and 12 months in DASH and other measures were tested with paired t tests in the three groups of change in HAQ-DI. In each group SRM, ES and RS values were also calculated for the DASH and QuickDASH scores and the dimensions of SF36.

SRM less than 0.5 considered to be insensitive to change (38). ES above 0.8 is considered large and 0.5 to 0.8 correspond to moderate (39).

Confidence intervals for the SRM and ES values were calculated based on the

bootstrap estimation of their standard deviation, obtained from the variation of the SRM and ES values of 20.000 random resamples (Microsoft Excel). Statistical analyses were made by SPSS 15.0 for Windows.

Results

Cross-cultural adaptation

The original and also the Hungarian DASH and QuickDASH versions can be seen on <http://www.dash.iwh.on.ca>. Because of cross-cultural differences in the 18th question (golf is hardly known

in Hungary), the expert team decided to use both "golf" and "dusting a carpet" which is a well known activity in the country, and in the 19th item (frisbee is uncommon in Hungary) using "playing frisbee" and "throwing a beach-ball" were accepted.

Twenty consecutive SSc patients (17 female, 3 male, mean age 56.0 \pm 8.7 (\pm SD) years) were given the Hungarian DASH Pre-final questionnaire for self-testing. The time needed to fill out the whole questionnaire varied between 7 and 14 minutes, the average time was 9 min 15s \pm 1 min 48s. No patients had difficulty completing the DASH questionnaire.

Instruments and physical measures

Data of physical measurements, DASH, SF-36 and SSc-HAQ, can be seen in Table I and Table II.

One hundred and twenty-eight patients completed all items or all but one item of the DASH-DS test (26.5% of the patients did not answer question 21 about sexual activities). The mean age of the nonrespondent group (n=34) was not significantly (*t*-test) higher (58.2 \pm 12 years) than the mean age of the respondent group (54.9 \pm 11 years)

Table II. Scores of Disabilities of the arm, shoulder, and hand questionnaire (DASH), QuickDASH, HAQ-DI, SSc-HAQ, dimensions of 36-item Short-Form Health Survey (SF-36) and Hand Anatomic Index (HAI) in a group of 128 patients with systemic sclerosis.

Instrument scale	No.	Median (quartiles)	Range	Floor and ceiling scores*
DASH-DS	128	31.3 (15.8;59.95)	0 - 88.3	1 (0.8%) - 0
QuickDASH-DS	128	34.0 (20.4;52.2)	0 - 88.6	3 (2.3%) - 0
DASH-W	48	25.0 (12.5;50.0)	0 - 87.5	10 (20.8%) - 0
DASH-SM	8	34.4 (12.5;75)	0 - 93.8	2 (25.0%) - 0
HAQ-DI	128	1.0 (0.38;1.63)	0 - 2.63	20 (15.6%) - 0
SSc-HAQ	128	0.95 (0.43;1.42)	0 - 2.54	3 (2.8%) - 0
Rodnan skin score	128	2.67 (1.33;4.33)	0 - 27	16 (12.5%) - 0
SF-36 PF	127	50.0 (30.0;65.0)	0 - 100	4 (3.0%) - 1 (0.8%)
SF-36 Role-Physical	128	0.0 (0.0;50.0)	0 - 100	70 (54.7%) - 20 (15.6%)
SF-36 Bodily Pain	128	41.0 (41.0;62.0)	0 - 100	7 (5.5%) - 12 (9.4%)
SF-36 General Health	127	30.0 (20.0;47.0)	0 - 87	8 (6.3%) - 0
SF-36 Vitality	127	45.0 (35.0;50.0)	0 - 95	1 (0.8%) - 0
SF-36 SF	128	75.0 (50.0;93.8)	0 - 100	4 (3.1%) - 32 (25.0%)
SF-36 RE	127	33.3 (0.0;100.0)	0 - 100	51 (40.2%) - 46 (36.2%)
SF-36 Mental Health	128	48.0 (40.0;68)	0 - 100	2 (1.6%) - 1 (0.8%)
VAS-pain	128	30.0 (5.0-50.0)	0 - 100	26 (20.3%) - 4 (3.1%)
VAS-Raynaud	128	0.95 (0.39;2.33)	0 - 3.0	20 (15.6%) - 7 (5.5%)
HAI on the right hand	126	2.13 (1.5;3.0)	0.04-12.25	- **

*Floor: minimum health status score; ceiling: maximum health status score.

**No theoretical minimum and maximum value could be established in the case of HAI.

DASH-DS: Disability/symptom scale of DASH; DASH-W: Work module of DASH; DASH-SM: Sport/music module of DASH; HAQ-DI: Health Assessment Questionnaire Disability Index; SSc-HAQ: Modified HAQ for patients with SSc; SF-36-PF: Physical Functioning; SF-36-SF: Social Functioning; SF-36-RE: Role-Emotional.

who completed all the items. Females were more frequent among the non-respondents to question 21 (NS by Chi-square test). Out of the 128 SSc patients 48 (37.5%) filled out the optional Work module the DASH-W (34 of 87 (39.1%) patients with lcSSc and 14 of 41 (34.1%) patients with dcSSc). The patients who filled out the DASH-W had better DASH-DS scores than those who did not ($p < 0.05$, by Mann-Whitney U-test). Only 8 patients (6.3%) filled out the optional DASH-SM.

Reliability

Out of 45 patients, there were 43 who completed all three DASH questionnaires for the test-retest reliability. Three repeated measures were performed and the period between the two consecutive tests was one week. The ICC for DASH-DS was 0.89 (95%CI 0.82-0.93) and 0.87 (95%CI 0.79-0.92) for Quick-DASH-DS. ICC for DASH-W (n=9) and DASH-SM (n=6, only the second and third measures were available for analysis) were 0.65 (95%CI 0.28-0.89) and 0.88 (95%CI 0.43-0.98), respectively. All ICC values indicated good reproducibility.

Internal consistency was assessed with Cronbach's alpha. The alpha coefficient for the 30 items of DASH-DS was high (0.969), because 93 patients completed all 30 DASH-DS items. When alpha was recalculated with each item deleted one by one, the range was 0.967-0.969. Alpha coefficient of the 11 items used for calculating QuickDASH-DS was 0.899 and ranged 0.884-0.902 with each item deleted one by one. Alpha coefficients for the four items in DASH-W and DASH-SM were also high (0.942 and 0.968, respectively). When alpha was recalculated with items deleted one by one, the ranges were 0.906-0.945 and 0.941-0.985, respectively. No item was found to change the internal consistency substantially.

Structural validity

A principal component analysis was performed to check the unidimensionality of the DASH-DS. The first factor had an eigenvalue (*i.e.*, amount of variation in the total sample accompanied to that latent background parameter con-

sidered to be measured by our items) of 15.5, which contained 51.8 % of the total variance of the DASH-DS scores of the patients. The unidimensionality was found to be strong due to a substantial difference between the first and second factors (eigenvalue 2.5). The first factor loadings for each item (correlation of the item with the factor score) were higher than 0.4 (range: 0.43-0.87). As one factor solution was used finally, no rotation was necessary. The unidimensionality of QuickDASH-DS components were also confirmed by principal component analysis. The first factor had an eigenvalue of 5.7, which contained 51.7% of the total variance of patients' QuickDASH-DS scores. The unidimensionality was found to be strong as a result of a substantial difference between the first and second factors (eigenvalue 1.5). The first factor loading for each item was higher than 0.4 (range: 0.45-0.86). The unidimensionality of DASH-W was confirmed by the same approach. The eigenvalue for first factor was 3.4, which explained 85.7% of the total variance of the DASH-W items.

In addition, the unidimensionality of the DASH-DS and the DASH-W (34 items)

was also confirmed by principal component analysis. The eigenvalue of the first factor was 18.8, which explained the 55.2% of the total variance of the combined score of the patients. All combined items showed the correlation with the first factor of at least 0.6 (range 0.60-0.88). The unidimensionality of DASH-SM was also confirmed on the available data of 8 responder patients. The eigenvalue for first factor was 3.7, which explained the 92.5% of the total variance of the DASH-SM items.

Concurrent validity

The Spearman correlation coefficient between all the DASH scores and HAQ-DI with SF-36 dimensions, SSc-HAQ (the HAQ-DI and the 5 VAS), HAI of the right hand and the MSS scores can be seen in Table III.

Discriminant validity

There was no significant difference between groups of lcSSc and dcSSc patients neither in DASH scores, nor in HAQ-DI, nor SSc-HAQ, nor Rodnan's skin score. On the contrary, patients with hand and/or shoulder contractures, or with symmetric tender or

Table III. Non parametric correlations between the scores of DASH and HAQ-DI questionnaires with dimensions of 36-item Short-Form Health Survey (SF-36), SSc-HAQ, Hand Anatomic Index (HAI), Medsger's severity scale's (MSS) joint/tendon and muscle scores in a group of 128 patients with systemic sclerosis.

Instrument	No.	Spearman's correlation coefficients			
		DASH-DS	DASH-W	QuickDASH-DS	HAQ-DI
DASH-DS	128	–	0.74	0.98	0.86
DASH-W	48	0.74	–	0.74	0.61
DASH-SM	8	0.71	0.71	0.71	0.64
QuickDASH-DS	128	0.98	0.74	–	0.83
SF-36 PF	128	-0.77	-0.66	-0.73	-0.69
SF-36 Role-Physical	128	-0.42	-0.59	-0.43	-0.31
SF-36 Role-Emotional	128	-0.27	-0.33	-0.26	-0.18
SF-36 Mental Health	128	-0.17	-0.31	-0.17	-0.16
VAS-Raynaud	128	0.39	0.41	0.40	0.34
VAS-skin ulcers	128	0.34	0.36	0.35	0.30
VAS-all-SSc-symptom	128	0.68	0.64	0.68	0.56
SSc-HAQ global score	128	0.88	0.70	0.86	0.94
HAI on the right hand	128	-0.37	-0.19	-0.38	-0.35
MSS Joint/tendon	128	0.23	0.12	0.27	0.27
MSS Muscle score	128	0.37	0.42	0.40	0.29

DASH: Disabilities of the arm, shoulder, and hand questionnaire; DASH-DS: Disability/symptom scale of DASH; DASH-W: Work module of DASH; DASH-SM: Sport/music module of DASH; HAQ-DI: Health Assessment Questionnaire Disability Index; SSc-HAQ: Modified HAQ for patients with SSc; SF-36-PF: Physical Functioning.

swollen joints had significantly higher DASH and QuickDASH scores compared to cases without these abnormalities (Table IV).

Sensitivity to change

Based on changes of the HAQ-DI as an anchor, the mean scores at baseline and mean changes at 12 months of the DASH and QuickDASH, and the dimensions of SF-36 can be seen in Table V. Results of the sensitivity to change, SRM, ES and RS values are also shown in Table V.

Discussion

The Hungarian adaptation of the DASH questionnaire was performed following a systematic approach. (25) Considering the original text, some questions needed adaptation to Hungarian conditions. Similarly to other cross-cultural adaptations in other languages (17-20) the DASH Hungarian Version required changes to the 18th and 19th items (recreational activities).

Patients took a similar amount of time to complete the DASH Hungarian Version compared with that needed to complete other versions (18-20). This indicates that the questionnaire was easy to understand. In the DASH-DS none of the patients left more than three items unanswered, and the unanswered question was mainly the one concerning sexual activity. Internal consistency of the DASH items remained high during trans-cultural adaptation similarly to patients with other diseases involving the upper extremities (18-21). Test-retest reliability (18-22) was considered good and excellent independent from the patients groups and trans-cultural adaptation examined.

The mean value of the DASH-DS scores of SSc patients was similar to that of patients with rheumatoid arthritis (22) and slightly poorer than that of patients with psoriatic arthritis (23).

Less than half of the patients with SSc completed the optional DASH-W and fewer patients filled out the DASH-SM, as in validation studies of Italian and Japanese versions (18, 20, 21). SSc is a severe progressive disease which causes very early disability at work and at playing sports or musical

Table IV. Comparison of Disabilities of the arm, shoulder, and hand questionnaire (DASH) scores in different subgroups of patients with systemic sclerosis.

	No.	Median, (quartiles)	No.	Median, (quartiles)	p-value*
	Patients without hand contracture		Patients with hand contracture		
DASH-DS	87	29.1 (14.1-45.8)	41	40.0 (23.0-62.0)	< 0.05
Quick-DASH-DS	87	34.0 (18.1-50.0)	41	47.7 (28.3-64.8)	< 0.01
DASH-W	37	25.0 (0.0-50)	11	25.0 (12.5-62.5)	NS
DASH-SM	4	15.6 (NA)	4	75.0 (NA)	NS
	Patients without shoulder contracture		Patients with shoulder contracture		
DASH-DS	107	29.1 (14.1-45.6)	21	48.3 (36.2-70.7)	< 0.001
Quick-DASH-DS	107	34.0 (18.1-50)	21	54.5 (34.0-71.6)	< 0.01
DASH-W	47	25.0 (12.6-50)	1	NA	–
DASH-SM	8	34.4 (6.3-75)	0	NA	–
	Patients without arthralgia/arthritis		Patients with symmetric tender and/or swollen joints		
DASH-DS	82	27.1 (11.7-34.6)	46	45.7 (30.1-59.6)	< 0.001
Quick-DASH-DS	82	27.2 (15.9-38.6)	46	50.0 (34.0-62.5)	< 0.001
DASH-W	32	25.0 (0.0-40.6)	16	46.9 (25.0-50.0)	< 0.05
DASH-SM	7	31.2 (0.0-75)	1	NA	–

*Mann-Whitney U-test

NA: insufficient amount of data for statistical reason; DASH-DS: Disability/symptom scale of DASH; DASH-W: Work module of DASH; DASH-SM: Sport/music module of DASH.

instruments. The patients who filled out the DASH-W had significantly better DASH-DS scores.

The range of our DASH measures was also displaced from the ceiling (15, 17, 18) in our SSc patients (Table II). Only one patient had a DASH-DS score at the top level (best score) and there was no score at the bottom level (worst score), which means that DASH-DS can detect improvement or worsening of the health status in most patients.

The subgroups of our SSc patients could not be differentiated by DASH scores or by the other functional or severity tests. The patients with dcSSc and with lcSSc can have a very different physical status, hence the mean scores of the functional tests were similar. Patients with symmetric painful or swollen joints in the upper limbs had significantly higher DASH-DS and QuickDASH-DS scores compared to cases without that abnormality (Table IV).

Patients with hand contractures had significantly higher DASH-DS and QuickDASH-DS scores than patients without (Table IV), though the correlation between the DASH-DS and the HAI was only moderate (Table III).

Patients with a lower (< 2) HAI (with severe hand contractures) could also be differentiated using the DASH-DS from patients with a higher (> 2) HAI. Similarly, patients with contractures of the shoulders had higher DASH-DS scores. We demonstrate that contractures of the hands and mainly contractures of the shoulders cause severe disability in patients with SSc (Table IV).

DASH-DS, QuickDASH-DS and DASH-W scores correlated with all subscales of the SF-36. As in other validation studies (19-20), we observed the strongest correlation with dimensions of physical function and body pain, and only a weak correlation with mental health. The PREE questionnaire is similar to the DASH. When PREE was administered in patients following elbow arthroplasties, also similar correlations were recognized (15). DASH-DS and QuickDASH-DS show equally strong correlations as the dimensions of the SF-36 as with the HAQ-DI.

With DASH-DS and QuickDASH-DS the HAQ-DI had the strongest correlation, as DASH is also a functional assessment questionnaire and is in addition useful for assessing upper limb function. The strong correlations of

Table V. Sensitivity to change of the Disabilities of the arm, shoulder, and hand questionnaire (DASH) scores and dimensions of Short form Health Survey (SF-36) in perceived HAQ-DI status over 12 months in a group of 76 patients with systemic sclerosis.

Scale	Poorer HAQ-DI (n=35)		No change in HAQ-DI (n=13)		Improved HAQ-DI (n=29)	
	statistics	95% CI		95% CI		95% CI
<i>DASH-Disability/symptom scale</i>						
Baseline mean score	32.7 (21.6)		25.4 (28.0)		37.0 (17.6)	
12 month change	7.8 (12.3)***	(3.6 to 12.0)	-1.5 (4.6)	(-4.4 to 1.5)	-3.3 (13.5)	(-8.4 to 1.9)
SRM	0.64	(0.58 to 0.69)	-0.32	(-0.51 to -0.13)	-0.24	(-0.32 to -0.17)
ES	0.36	(0.32 to 0.40)	-0.05	(-0.09 to -0.02)	-0.19	(-0.25 to -0.13)
RS	0.28				-0.12	
<i>DASH-Work Module</i>						
Baseline mean score	39.6 (23.6)		10.9 (15.6)		25.0 (24.5)	
12 month change -	3.1 (3.6) n=4	(-8.9 to 2.6)	2.5 (5.6) n=5	(-4.4 to 9.4)	0 (17.7) n=5	(-21.9 to 21.9)
SRM	-0.87	NA	0.45	NA	0.00	NA
ES	-0.13	NA	0.16	NA	0.00	NA
RS	-0.20				0.00	
<i>QuickDASH-Disability/symptom scale</i>						
Baseline mean score	36.2 (21.6)		28.6 (29.8)		39.3 (17.9)	
12 month change	7.5 (12.1)***	(3.3 to 11.7)	-1.7 (5.7)	(-5.3 to 2.0)	-3.9 (14.4)	(-9.4 to 1.5)
SRM	0.62	(0.56 to 0.68)	-0.29	(-0.48 to -0.11)	-0.27	(-0.35 to -0.20)
ES	0.35	(0.31 to 0.39)	-0.06	(-0.10 to -0.01)	-0.22	(-0.28 to -0.16)
RS	0.25				-0.13	
<i>SF-36-Physical Functioning</i>						
Baseline mean score	48.1 (24.9)		56.3 (30.9)		48.1 (20.5)	
12 month change	0.86 (23.5)	(-7.2 to 8.9)	3.8 (16.8)	(-6.9 to 14.4)	-0.5 (23.0)	(-9.3 to 8.2)
SRM	0.04	(-0.02 to 0.10)	0.22	(0.03 to 0.42)	-0.02	(-0.10 to 0.05)
ES	0.03	(-0.02 to 0.09)	0.12	(0.02 to 0.22)	-0.02	(-0.11 to 0.06)
RS	0.03				-0.02	
<i>SF-36-Role-Physical</i>						
Baseline mean score	30.0 (40.6)		58.3 (45.6)		29.3 (37.8)	
12 month change	6.43 (33.4)	(-15.9 to 17.3)	-6.3 (45.4)	(-35.1 to 22.6)	6.9 (45.2)	(-10.3 to 24.1)
SRM	0.19	(0.13 to 0.26)	-0.14	(-0.36 to 0.08)	0.15	(0.08 to 0.23)
ES	0.16	(0.11 to 0.21)	-0.14	(-0.35 to 0.08)	0.18	(0.09 to 0.28)
RS	0.14				0.15	

HAQ-DI: Health Assessment Questionnaire Disability Index; SF-36: Short form Health Survey questionnaire; SRM: standardized response mean; ES: effect size; RS: responsiveness statistic. Baseline and 12 month change: values are mean (standard deviation); 12 month change: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ tested with paired t -test. For estimation of confidence intervals (CI) see *Methods*. 95% CI for SRM values were estimated using bootstrap resamples. NA: insufficient data available for statistical reason.

the DASH with the HAQ-DI, and the physical dimensions of SF-36 show that the disability of the patients with SSc is mainly caused by the functional impairment of the upper limb. All VAS answers of the SSCHAQ indicated significant correlations with the DASH-DS and QuickDASH-DS, the strongest were seen in the answer to the question concerning how overall scleroderma problems had interfered with patient's activity during the last week. This indicates that the disability of the upper limbs has a very important role among the problems related to SSc. All VAS answers correlated with similar or stronger association with the DASH-DS and QuickDASH-DS than with the HAQ-DI. Using HAQ-DI as an anchor, the sensitivity to changes of DASH-DS and

QuickDASH-DS proved to be good in the group of patients with worsening disease, but did not show significant changes among patients with improving and unchanging status (Table V). Improvement of the patient's health in SSc could be due to components other than upper limb function when appropriate supportive therapeutic exercises and rehabilitation are performed. We think that further investigation is needed, using more anchors, to estimate appropriately the sensitivity to change of DASH in follow-up studies in SSc patients. These correlations confirm the value of the DASH Hungarian Version and demonstrate its psychometric properties in Hungarian patients with SSc. Mainly the DASH-DS and the QuickDASH-DS but also the DASH-W are able to

differentiate between the severity levels of functional impairment of patients with SSc and may provide valid clinical outcome measure in patients with this disabling disorder. The limitation of this present study is that patients with SSc do not represent the general population, though we have started DASH evaluation in patients with other connective tissue diseases (29). The other problem is that the DASH-SM could not be validated successfully because the response rate of the SSc patients was low. DASH-DS and QuickDASH-DS indicated similarly strong correlations with all dimensions of the SF-36, with all VAS questions of SSc-HAQ, as the HAQ-DI. We demonstrated that similarly to the HAQ-DI, the DASH-DS and

QuickDASH-DS are valid and sensitive functional measurement tools which are worth using for SSc patients when the main purpose is upper limb status follow-up. Scores of the shorter and simpler QuickDASH showed the same correlations as the DASH, so it seems to be equally valid, and as sensitive as the DASH. We emphasize that functional impairment of the upper limbs (which leads to very serious problems in everyday life) can be considered one of the main causes of disability related to SSc.

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References

- AKESSON A, FIORI G, KRIEG T, VAN DEN HOOGEN FH, SEIBOLD JR: Assessment of skin, joint, tendon and muscle involvement. *Clin Exp Rheumatol* 2003; 21 (Suppl. 29): S5-8.
- MEDSGER TA JR, BOMBARDIERI S, CZIRJÁK L, SCORZA R, DELLA ROSSA A, BENCIVELLI W: Assessment of disease severity and prognosis. *Clin Exp Rheumatol* 2003; 21 (Suppl. 29): S42-6.
- HUDAK PL, AMADIO PC, BOMBARDIER C: Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). The Upper Extremity Collaborative Group (UECG) *Am J Ind Med* 1996; 29: 602-8.
- DAVIS AM, BEATON DE, HUDAK P *et al.*: Measuring disability of the upper extremity: a rationale supporting the use of a regional outcome measure. *J Hand Ther* 1999; 12: 269-74.
- BOT SD, TERWEE CB, VAN DER WINDT DA, BOUTER LM, DEKKER J, DE VET HC: Clinimetric evaluation of shoulder disability questionnaires: a systematic review of the literature. *Ann Rheum Dis* 2004; 63: 335-41.
- BEATON DE, WRIGHT JG, KATZ JN: Upper Extremity Collaborative Group. Development of the QuickDASH: comparison of the three item-reduction approaches. *J Bone Surg (Am)* 2005; 87: 1038-46.
- SANDQVIST G, EKLUND M: Hand Mobility in Scleroderma (HAMIS) test: the reliability of a novel hand function test. *Arthritis Care Res* 2000; 13: 369-74.
- SANDQVIST G, EKLUND M: Validity of HAMIS: a test of hand mobility in scleroderma. *Arthritis Care Res* 2000; 13: 382-7.
- POOLE JL, GALLEGOS M, O'LINC S: Reliability and validity of the Arthritis Hand Function Test in adults with systemic sclerosis (scleroderma). *Arthritis Care Res* 2000; 13: 69-73.
- ROBERTS-THOMSON AJ, MASSY-WESTROPP N, SMITH MD, AHERN MJ, HIGHTON J, ROBERTS-THOMSON PJ: The use of the hand anatomic index to assess deformity and impaired function in systemic sclerosis. *Rheumatol Int* 2006; 26: 439-44.
- SILMAN A, AKESSON A, NEWMAN J *et al.*: Assessment of functional ability in patients with scleroderma: a proposed new disability assessment instrument. *J Rheumatol* 1998; 25: 79-83.
- RANNOU F, POIRAUDEAU S, BEREZNE A *et al.*: Assessing disability and quality of life in systemic sclerosis: construct validities of the Cochin Hand Function Scale, Health Assessment Questionnaire (HAQ), Systemic Sclerosis HAQ, and Medical Outcomes Study 36-Item Short Form Health Survey. *Arthritis Rheum* 2007; 57: 94-102.
- BROWER LM, POOLE JL: Reliability and validity of the Durouz Hand Index in persons with systemic sclerosis (scleroderma). *Arthritis Rheum* 2004; 51: 805-9.
- SMYTH AE, MACGREGOR AJ, MUKERJEE D, BROUGH GM, BLACK CM, DENTON CP: A cross-sectional comparison of three self-reported functional indices in scleroderma. *Rheumatology (Oxford)* 2003; 42: 732-8.
- JOHN M, ANGST F, PAP G, JUNGE A, MANNION AF: Cross-cultural adaptation, reliability and validity of the Patient Rated Elbow Evaluation (PREE) for German-speaking patients. *Clin Exp Rheumatol* 2007; 25: 195-205.
- HERVAS MT, NAVARRO COLLADO MJ, PEIRO S, RODRIGO PEREZ JL, LOPEZ MATEU P, MARTINEZ TELLO I: Spanish version of the DASH questionnaire. Cross-cultural adaptation, reliability, validity and responsiveness. *Med Clin (Barc)* 2006; 127: 441-7.
- OFFENBACHER M, EWERT T, SANGHA O, STUCKI G: Validation of a German version of the 'Disabilities of Arm, Shoulder and Hand' questionnaire (DASH-G). *Z Rheumatol* 2003; 62: 168-77.
- PADUA R, PADUA L, CECCARELLI E *et al.*: Italian version of the Disability of the Arm, Shoulder and Hand (DASH) questionnaire. Cross-cultural adaptation and validation. *J Hand Surg (Br)* 2003; 28: 179-86.
- ATROSHI I, GUMMESSON C, ANDERSSON B, DAHLGREN E, JOHANSSON A: The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: reliability and validity of the Swedish version evaluated in 176 patients. *Acta Orthop Scand* 2000; 71: 613-8.
- IMAEDA T, TOH S, NAKAO Y *et al.*: Validation of the Japanese Society for Surgery of the Hand version of the Disability of the Arm, Shoulder, and Hand questionnaire. *J Orthop Sci* 2005; 10: 353-9.
- IMAEDA T, TOH S, WADA T *et al.*: Version of the Quick Disability of the Arm, Shoulder, and Hand (QuickDASH-JSSH) questionnaire. *J Orthop Sci* 2006; 11: 248-53.
- ORFALE AG, ARAUJO PM, FERRAZ MB, NATOR J: Translation into Brazilian Portuguese, cultural adaptation and evaluation of the reliability of the Disabilities of the Arm, Shoulder and Hand Questionnaire. *Braz J Med Biol Res* 2005; 38: 293-302.
- NAVARIKAR A, GLADMAN DD, HUSTED JA, COOK RJ: Validity assessment of the disabilities of arm, shoulder, and hand questionnaire (DASH) for patients with psoriatic arthritis. *J Rheumatol* 1999; 26: 2191-4.
- LEROY EC, MEDSGER TA JR: Criteria for the classification of early sclerosis. *J Rheumatol* 2001; 28: 1573-6.
- BEATON DE, BOMBARDIER C, GUILLEMIN F, FERRAZ MB: Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine* 2000; 25: 3186-91.
- WARE JE JR, SHERBOURNE CD: The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992; 30: 473-83.
- POOLE JL, STEEN VD: The use of the Health Assessment Questionnaire (HAQ) to determine physical disability in systemic sclerosis. *Arthritis Care Res* 1991; 4: 27-31.
- STEEEN VD, MEDSGER TA JR: The value of the Health Assessment Questionnaire and special patient-generated scales to demonstrate change in systemic sclerosis patients over time. *Arthritis Rheum* 1997; 40: 1984-91.
- MORITA Y, MURO Y, SUGIURA K, TOMITA Y, TAMAKOSHI K: Results of the Health Assessment Questionnaire for Japanese patients with systemic sclerosis - measuring functional impairment in systemic sclerosis versus other connective tissue diseases. *Clin Exp Rheumatol* 2007; 25: 367-72.
- KAHALEH MB, SUTTANY GL, SMITH EA, HUFFSTUTTER JE, LOADHOLT CB, LEROY EC: A modified scleroderma skin scoring method. *Clin Exp Rheumatol* 1986; 4: 367-9.
- CZIRJÁK L, NAGY Z, ARINGER M, RIEMKASTEN G, MATUCCI-CERINIC M, FURST DE: on behalf of EUSTAR: The EUSTAR model for teaching and implementing the modified Rodnan skin score in systemic sclerosis. *Ann Rheum Dis* 2007; 66: 966-9.
- MCHORNEY CA, TARLOV AR: Individual-patient monitoring in practice: are available health status surveys adequate? *Qual Life Res* 1995; 4: 293-307.
- ALTMAN DG: Practical statistics for medical research. London, Chapman & Hall, 1991: 404.
- KHANNA D, FURST DE, HAYS RD *et al.*: Minimally important difference in diffuse systemic sclerosis: results from the D-penicillamine study. *Ann Rheum Dis* 2006; 65: 1325-9.
- MAHEU E, CADET C, MARTY M *et al.*: Reproducibility and sensitivity to change of various methods to measure joint space width in osteoarthritis of the hip: a double reading of three different radiographic views taken with a three-year interval. *Arthritis Res Ther* 2005; 7: R1375-85.
- TAAL E, RASKER JJ, RIEMSMA RP: Sensitivity to change of AIMS2 and AIMS2-SF components in comparison to M-HAQ and VAS-pain. *Ann Rheum Dis* 2004; 63: 1655-8.
- GAY RE, MADSON TJ, CIESLAK KR: Comparison of the Neck Disability Index and the Neck Bournemouth Questionnaire in a sample of patients with chronic uncomplicated neck pain. *J Manipulative Physiol Ther* 2007; 30: 259-62.
- KATZ JN, LARSON MG, PHILLIPS CB, FOSSEL AH, LIANG MH: Comparative measurement sensitivity of short and longer health status instruments. *Med Care* 1992; 30: 917-25.
- REVICKI DA, CELLA D, HAYS RD, SLOAN JA, LENDERKING WA, AARONSON NK: Responsiveness and minimal important differences for patient reported outcomes. *Health Qual Life Outcomes* 2006; 4: 70.