The Short Arthritis Assessment Scale: A Brief Assessment Questionnaire for Rapid Evaluation of Arthritis Severity in Research and Clinical Practice

FREDERICK WOLFE, KALEB MICHAUD, KRISTJIAN KAHLER, and MOHAMED OMAR

ABSTRACT. ***Objective.*** To develop a short, 4-item arthritis severity questionnaire that is simple to score, clinically useful and meaningful, and suitable for use in primary care, where osteoarthritis (OA) is the primary prevalent arthritis illness.

Methods. Data and items from the Medical Outcomes Study Short Form 36 (SF-36), the Western Ontario McMaster Osteoarthritis Index (WOMAC©), and visual analog scales (VAS) for pain and patient global severity were studied in 16,519 patients with arthritis. The Short Arthritis Assessment Scale (SAS) was developed by performing multivariable analyses that involved individually adding/subtracting items in differing regression models. The candidate items and scales were then studied by Rasch analysis, and tested for effect size, sensitivity to change, and reliability. The resultant scale was validated using data from a recent OA clinical trial.

Results. The VAS pain and VAS global severity scales and 2 items from the WOMAC in the VAS format, difficulty going down stairs and difficulty shopping, were found to be the best predictors of change in health status. The 4-item SAS was reliable (Cronbach's alpha = 0.87), demonstrated good test-retest reliability (Lin's concordance coefficient = 0.85), was unidimensional, and was strongly correlated with other important clinical measures, indicating good construct validity. Using data from a recent randomized clinical trial in OA, the SAS performed better than the WOMAC pain scale and the SF-36 physical component score in detecting change, and at least as well as the clinical trial VAS pain scale.

Conclusion. The SAS is a 4-item arthritis severity questionnaire that can be easily administered in primary care for patients with OA, but is suitable for use across all arthritis illnesses. Scoring is simple, requiring only the addition of four 10-point scales, and interpretation is straightforward. The SAS may have a role in rapid assessment of the arthritis patient in primary care practice. (J Rheumatol 2004;31:2472–9)

Key Indexing Terms:
OSTEOARTHRITIS SHORT ARTHRITIS ASSESSMENT SCALE QUESTIONNAIRE

Many questionnaires are available to evaluate arthritis severity in rheumatic disease research[1-12]. Many are either long or detailed, and are designed almost exclusively for use in research settings, for example, the Western Ontario McMaster Osteoarthritis Index (WOMAC®)[4]. Other questionnaires are shorter and can be used in the clinic, but focus on single areas, as for example the Health Assessment Questionnaire (HAQ)[6] disability index, which evaluates function only. Although arthritis care is provided mainly by primary care physicians, almost none of these physicians has regularly adapted or used any arthritis questionnaires in routine clinical practice. Nor is there a simple questionnaire assessment tool available.

Several decades of experience with questionnaires in rheumatology and primary care practice suggest essential characteristics of arthritis questionnaires that can be used in the clinical setting[3,13]. These include the following features: questionnaires must be short and easy to score; results must be immediately intuitive; questionnaires must be useful across many arthritis illnesses; and finally, questionnaires must be valid, reliable, and sensitive to change. That is, they must be useful to primary care clinicians, adding important knowledge to the medical care of their patients.

We describe the development of the Short Arthritis Assessment Scale (SAS).

To be compatible with osteoarthritis (OA) clinical trial data that almost always include the WOMAC[4], we used that questionnaire and patient global severity and pain scales as an item bank for questionnaire development. We report here on the 4-item SAS questionnaire that can be administered and scored in seconds, and which is valid and reliable.

From the Arthritis Research Center Foundation, University of Kansas School of Medicine, Wichita, Kansas; and Novartis Pharmaceuticals Corp., East Hanover, NJ, USA.

F. Wolfe, MD; K. Michaud, BS, MS, Arthritis Research Center Foundation; K. Kahler, RPh, MSc; M. Omar, RPh, PhD, Novartis Pharmaceuticals Corporation.

Address reprint requests to Dr. F. Wolfe, National Data Bank for Rheumatic Diseases, Arthritis Research Center Foundation, 1035 N. Emporia, Suite 230, Wichita, KS 67214.
E-mail: fwolfe@arthritis-research.org

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MATERIALS AND METHODS

For questionnaire development and questionnaire items analysis, we made use of the National Data Bank for Rheumatic Diseases (NDB) data sets, as described[14-17]. Patients in the NDB complete mailed questionnaires biannually. The analyses for development of the SAS questionnaire were restricted to 16,519 patients who had completed the standard NDB questionnaire items at 2 consecutive times, which include the WOMAC[4], the HAQ[6], the Medical Outcomes Study Short Form 36 (SF-36)[12], the Pain Visual Analog Scale (VAS), and the Global Severity VAS, among others. The variables are condition-independent, as they do not refer to a specific medical or arthritic disorder. The specific wording of the key study variables is given in Figure 1.

The VAS version of the WOMAC was used as a possible item source as it has been validated in patients with OA, and has been widely used in clinical research studies of OA.

By diagnosis, there were 3259 patients with OA of the knee or hip, 12,395 with rheumatoid arthritis (RA), and 865 with fibromyalgia (FM). Patients in the NDB are referred and diagnosed by United States rheumatologists.

Health status change was determined by the use of the SF-36 health questionnaire item: "Compared to 6 months ago, how would you rate your health in general now? The answers choices are: much better now than 6 months ago; somewhat better now than 6 months ago; about the same as 6 months ago; somewhat worse now than 6 months ago; much worse now than 6 months ago?" In rheumatology, concepts of analyses using transition questionnaires have been described by Stucki's group[18-21].

In preliminary analyses to assess sensitivity to change we used ordered logistic regression in which the SF-36 change score was regressed on each potential SAS item. As the results of ordered logit analyses are often difficult to understand, we simplified the analyses by omitting the middle category of the SF-36 questionnaire item ("About the same as 6 months ago") and created a dichotomous variable that measured any worsening (score 1) compared to any improvement (0).

To obtain a short 4-item questionnaire, we performed a number of multivariate analyses by individually adding items to the regression model that started with the pain variable and observing the results while other variables were added, considering statistical significance, clinical relevance, and colinearity. In logistic regression analyses the dependent variable was the SF-36 comparison item ("Compared to 6 months ago, how would you rate your health in general now?"), dichotomized as described above. The potential predictor variables were the change scores over 6 months for the WOMAC items and for the VAS pain and patient global scale.

Initial item selection for the SAS was aided by the determination of effect size. The effect size is a method to assess standardized change[22]. It represents the difference between a score at time 2 minus the score at time 1 divided by the standard deviation. In the analyses of these data we used the pooled standard deviation of the item at time 1 and the item at time 2. Time 2 scores were the most recent values of the variables under study. Time 1 variables were the (lagged) item values from the previous assessment.

To assess construct validity, correlations between SAS and a series of clinical assessment scales were performed. Scales included the HAQ[6], the RA Disease Activity Index (RADAI)[23], the "feeling thermometer" VAS quality of life scale from the EuroQoL[24], VAS fatigue, and a 5-item Likert scale for health satisfaction. Test-retest reliability at 6 months was assessed with the concordance reliability coefficient for patients who did not report change over 6 months on the SF-36 comparison question or in the 2 consecutive HAQ scores[25].

The SAS is scored simply, by adding the results of the 4 VAS scales, each of which ranges from 0 to 10, yielding a SAS score of 0 to 40.

Cross-validation has been subjected to extensive experiments and found to be the best choice to get accurate estimates of prediction error[26,27]. We used this method to test ability of the 4 SAS variables to predict 6-month change in health status in a logistic model (better vs worse; Table 1). A 30% test sample was identified and set aside. Then 10-fold cross-validation was performed on the remaining 70%, using a 90% training sample and a 10% validation sample to optimize parameters. The percentage correctly classified in the 10-fold validation was compared with the percentage correctly classified in the reserved test sample. Using this method the relative error (or the reduction in predictive ability) was found to be 1.3%.

Rasch analysis was used to assess item scalability and fit, and to explore unidimensionality. Correlation analyses used Pearson correlations. The significance level of all analyses was set at 0.05, and all tests were 2-tailed. Statistical computations were performed using Stata version 7.0[28] and Winsteps version 3.31 for Rasch analysis[29].

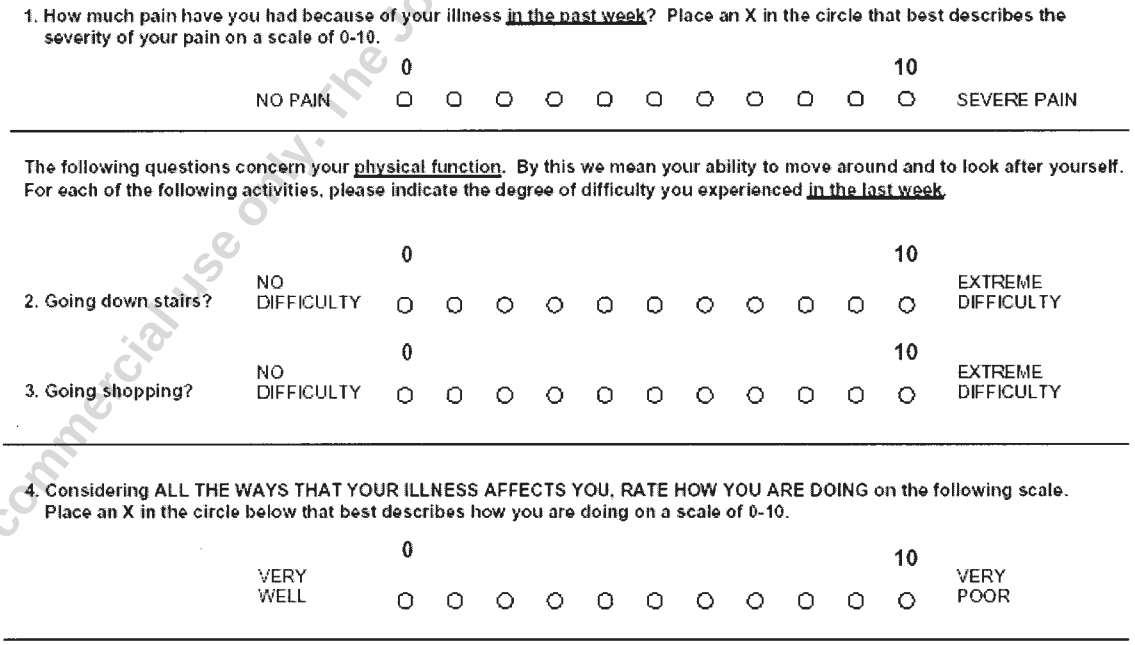

Figure 1. The Short Arthritis Assessment Scale (SAS) Questionnaire.

Table 1. Regression analysis of the predictive effect of changes in study variables on changes in health status in patients with OA. The odds ratio represents the increased risk of a change in SF-36 status associated with a one-unit change in the predictor variable.

Change Variable	Odds Ratio	SE	Z	p	95% CI
Multivariable model (OA)					
VAS global severity (0–10)	1.19	0.03	7.84	< 0.001	1.14–1.24
VAS pain (0–10)	1.16	0.02	7.32	< 0.001	1.11–1.20
Difficulty shopping (0–10)	1.08	0.01	6.36	< 0.001	1.05–1.10
Difficulty going down stairs (0–10)	1.04	0.01	3.53	< 0.001	1.02–1.06
SAS analysis*					
OA SAS (0–10)	1.70	0.05	16.91	< 0.001	1.60–1.80
RA SAS (0–10)	1.79	0.03	36.19	< 0.001	1.74–1.85
Fibromyalgia SAS (0–10)	1.71	0.09	9.78	< 0.001	1.53–1.90

* SAS items were rescaled to 0–10 from the original 0–40 scale for ease of comparison with the individual SAS variable components.

We then applied the SAS to the results of an unpublished randomized controlled trial (RCT) that assessed the safety and efficacy of 2 COX-2 inhibitors, one of which is an investigational compound. Data for this RCT are being submitted to regulatory authorities, and we were not permitted to identify the trial until its formal publication.

RESULTS

Demographic and clinical variables. Table 2 presents the demographic and clinical results for the study subjects. Patients in the study, including the OA patients studied separately, had evidence of active arthritis as shown by elevations of the HAQ, pain scales, global severity, SF-36, and WOMAC scales.

Item selection. To understand how the individual WOMAC items and VAS pain and VAS patient global performed, we calculated effect sizes for the difference between current values and those noted 6 months previously in patients who reported improvement on the SF-36 health comparison scale. Table 3 shows the effect sizes for the OA patients as well as the entire cohort. VAS pain and VAS patient global severity were the variables most associated with improvement in health status over 6 months. The 5 WOMAC pain scales did not perform as well as the VAS items, but performed better than the WOMAC function and stiffness scales. In the "all patients" group, composed mostly of the patients with RA, the 2 WOMAC stiffness items had the greatest effect sizes after the pain and patient global VAS scales. Overall, results for OA patients and the entire cohort were similar. Although we chose to present effect sizes for

Table 2. Demographic and disease status variables for patients with OA (n = 3259) and the entire cohort at last observation (n = 16,519).

Variable	Osteoarthritis Mean	Osteoarthritis SD	All Patients Mean	All Patients SD
Age (yrs)	65.74	11.5	60.91	13.16
Sex (% male)	18.1		21.25	
Education (yrs)	13.62	2.32	13.41	2.33
Education category (code)				
0–8 (%)	2.43		2.57	
8–11 (%)	6.19		8.00	
12 (%)	35.02		37.09	
13–15 (%)	27.13		26.23	
16 or > (%)	29.23		26.11	
Total income (US dollars)	42,789.79	27,414.78	44,300.47	28,418.26
WOMAC function (0–170)	59.05	42.95	53.11	42.90
WOMAC stiffness (0–20)	8.61	5.58	7.47	5.53
WOMAC pain (0–50)	18.33	12.71	16.19	12.66
HAQ (0–3)	1.02	0.66	1.09	0.72
Pain (0–10)	4.34	2.8	4.05	2.83
Fatigue (0–10)	4.48	2.98	4.53	2.97
Global severity (0-10)	3.67	2.56	3.58	2.57
VAS QOL scale (0–100)	65.97	21.65	65.61	22.08

QOL: quality of life.

Table 3. Relative sensitivity to change in health over the last 6 months as measured by effect sizes based on SF-36 global change. SF-36 criterion was improvement in health over the last 6 months. Items are ranked by SF-36 OA effect sizes.

Variable	OA patients (n = 3259)	All Patients (n = 16,519)	Selected in Final Model
Criterion	Effect size	Effect size	
VAS: pain	0.275	0.330	*
VAS: global severity	0.226	0.254	*
Pain: walking on a flat surface	0.215	0.183	
Pain: sitting or lying	0.199	0.195	
Pain: standing upright	0.191	0.181	
Pain: going up or down stairs	0.189	0.178	
Function: walking on a flat surface	0.174	0.161	
Function: going shopping	0.172	0.167	*
Stiffness: later in the day	0.172	0.217	
Function: arising from sitting	0.160	0.194	
Function: getting in/out of car	0.158	0.173	
Pain: at night while lying in bed	0.158	0.219	
Function: sitting	0.155	0.161	
Function: light domestic duties	0.151	0.152	
Function: descending stairs	0.144	0.157	*
Function: standing	0.144	0.148	
Stiffness: morning stiffness	0.141	0.233	
Function: ascending stairs	0.139	0.146	
Function: heavy domestic duties	0.134	0.144	
Function: rising from bed	0.133	0.189	
Function: lying in bed	0.126	0.164	
Function: getting on/off toilet	0.118	0.156	
Function: taking off socks/ stockings	0.113	0.165	
Function: bending to floor	0.110	0.129	
Function: getting in/out of bath	0.105	0.103	
Function: putting on socks/ stockings	0.098	0.157	

* Indicates items used in the Short Arthritis Assessment Scale (SAS).

patients who improved, because we were interested in improvement and because this is the more conservative method, we also calculated effect sizes for patients who worsened. As expected, effect sizes were slightly greater. For the 4 key variables the results were: pain 0.335, global 0.298, walk down stairs 0.179, and shopping 0.205.

The multivariable model in Table 3 shows the final selected model for the SAS questionnaire items in OA patients. The odds ratio represents the increased risk of a change in SF-36 status associated with a one-unit change in the predictor variable. Regression analysis results were similar in the RA and fibromyalgia groups, and groups are not shown separately. Although WOMAC pain scales had higher effect sizes than the WOMAC function items in the univariate analyses, once the VAS pain and global items were included in the model, the WOMAC pain-item change scores had little additional predictive power. Instead, the WOMAC function-item change scores "difficulty shopping" and "difficulty going down stairs" contributed significantly to the model, and were retained in the final 4-item questionnaire. We also estimated how well this model might be expected to perform in different samples by using 10-fold cross-validation, as described above. The overall error or misclassification rate, in classifying persons who improved compared with persons who worsened, was 1.3%.

SAS characteristics. The 4 scales (pain, global, difficulty with stairs, and difficulty with shopping) were added to form the SAS, yielding a score between 0 and 40, with a mean of 13.7 and a standard deviation of 9.7. As shown in the multivariable model of Table 1, for a one-unit change in the 0–10 predictor variables, VAS global severity change was shown to be the best predictor of change in global health, followed closely by VAS pain change. Less useful as predictors were changes in difficulty shopping and in difficulty going down stairs.

Table 1 also contains the result of the SAS in each of the 3 diagnostic groups. For ease of comparison with the individual items above, SAS was rescaled to 0–10. The SAS performed substantially better than the individual items, with odds ratios (OR) of 1.70 or greater. In addition, the scale performed equally well in the different diagnostic groups, and the OR did not differ among RA and OA patients (p = 0.221).

The distribution of SAS in OA is shown in Figure 2. The graph shows the relatively normal distribution of the SAS scores in OA as a result of the item selection process, indicating no floor or ceiling effects.

Factor analysis of the 4 variables of the SAS scale was performed, but only one factor had an eigenvalue greater than 1. The eigenvalue of the second factor was 0.08, indicating unidimensionality of the SAS scale. In addition, principal component analysis of standardized residuals was performed as a part of Rasch analysis. Within the residuals, a bidimensional pattern could be seen that was composed of pain and global severity versus the 2 functional items. However, this factor contributed only slightly to the overall measure, indicating that a second dimension was not important within the Rasch model. Finally, the Rasch analysis indicated no nonfitting items, a unidimensional scale, and a separation score of 2.4. Thus SAS fits the Rasch model and has adequate scale length and discrimination.

Classical scale reliability was assessed with Cronbach's alpha. When SAS was used in all patients the inter-item correlation was 0.63 and alpha reliability was 0.87. When the scale was used in OA patients only, the inter-item correlation was 0.64 and alpha reliability was 0.88. Test-retest reliability using a 6-month interval was measured with Lin's concordance coefficient[25]. First, reliability was assessed in patients whose HAQ disability score had not changed in 2 consecutive assessments 6 months apart. The reliability coefficient ranged from 0.88 to 0.95 for the 3 medical diagnostic groups, and overall was 0.90. In addition, we also

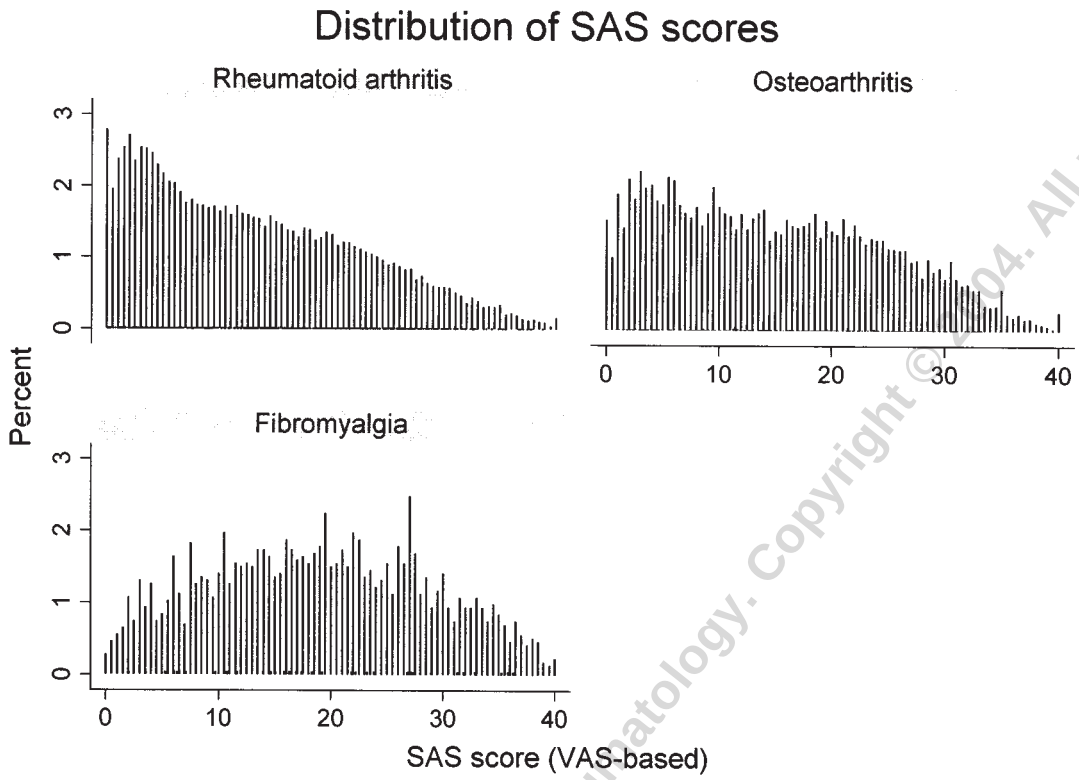

Figure 2. Distribution of the Short Arthritis Assessment Scale (SAS) scores in patients with RA, OA, and fibromyalgia.

assessed reliability in patients who reported no change in their overall health in the last 6 months using the SF-36 scale. The reliability coefficient ranged from 0.85 to 0.86, and overall was 0.85. The first reliability measurement uses measured health status whereas the SF-36 measure uses a reported global health statement.

To examine construct validity, Pearson correlation coefficients were calculated between the SAS and important clinical variables for the entire patient population and for the OA patients separately. Even though only 2 WOMAC function items were included in SAS, very high correlation was seen with WOMAC function (0.92). In addition, SAS was significantly and importantly correlated with all clinical variables, including SF-36, HAQ, WOMAC, RADAI, health satisfaction, and other VAS scales, as shown in Table 4.

To give clinical interpretation to the values of SAS, SAS was examined at a number of cutpoints, and cutpoints that best separated the scale into mild, moderate, severe, and very severe were identified, as shown in Tables 5a and 5b. Selected cutpoints were based on generally accepted values for severity. By reference to the means of the clinical variables presented at the various cutpoints, the meaning and relative significance of the SAS categories can be determined. For example, a SAS score > 25 was associated with a mean score of 1.91 for HAQ and 118 for WOMAC function, or very severe arthritis.

We then applied the SAS to the results of a randomized controlled trial that assessed the safety and efficacy of 2 COX-2 inhibitors. The characteristics of patients participating in the clinical trial at the treatment start were as follows: age 64.2 years (SD 10.4), sex 69% female, body mass index 29.8 (5.7), joint pain 6.5 (1.4; range 0–10), patient global 6.3 (1.7; range 0–10), SF-36 physical component summary score 31.8 (8.0), and SF-36 physical component summary

Table 4. Correlations between SAS and important rheumatic disease clinical and demographic variables.

Variable	All Patients	OA Patients
SF-36 physical component scale	–0.75	–0.75
SF-36 component function scale	–0.66	–0.65
HAQ	0.76	0.76
RADAI	0.84	0.83
Satisfaction with health	0.65	0.63
VAS global severity	0.83	0.81
VAS pain	0.85	0.84
WOMAC function	0.92	0.92
WOMAC pain	0.87	0.86
WOMAC stiffness	0.76	0.75
VAS fatigue	0.69	0.69
VAS QOL scale	–0.61	–0.59
Education level	–0.21	–0.24
Age	0.03	–0.04
Sex (male)	–0.08	–0.09
Total income	–0.30	–0.30
Total direct medical costs	0.20	0.24

Table 5A. Mean disease status and severity measure by SAS grouping for all patients at last observation (n = 16,519).

Variable	SAS	SAS	SAS	SAS
Group cutpoints	≤ 7	> 7, ≤ 15	> 15, ≤ 25	> 25, ≤ 40
Classification	Mild	Moderate	Severe	Very severe
N	5034	4239	4426	2811
SAS (0–40)	3.33	11.17	20.00	30.43
VAS QOL (0–100)	81.71	67.92	58.06	44.91
RADAI (0–10)	1.57	3.31	4.81	6.49
HAQ (0–3)	0.42	0.99	1.44	1.91
VAS global severity (0–10)	1.04	3.25	4.69	6.88
VAS pain (0–10)	1.25	3.44	5.53	7.70
VAS fatigue (0–10)	2.04	4.14	5.90	7.45
WOMAC function (0-170)	10.80	37.36	75.35	118.16
WOMAC pain (0–50)	4.16	12.30	22.56	33.81
WOMAC stiffness (0–20)	2.66	6.28	10.07	13.86
SF-36 physical component scale	41.62	32.11	26.23	21.12
SF-36 mental component scale	53.55	45.01	37.04	28.06
Total income ($US)	54,737.01	45,857.73	38,754.65	31,819.78
Total direct medical costs per 6 month ($US)	2798.61	3628.35	4245.17	5063.08

Table 5B. Disease status and severity measure by SAS grouping for patients with OA at last observation (n = 3259).

Variable	SAS	SAS	SAS	SAS
Group cutpoints	≤ 7	> 7, ≤ 15	> 15, ≤ 25	> 25, ≤ 40
SAS classification	Mild	Moderate	Severe	Very severe
N	840	810	965	646
SAS (0–40)	3.56	11.31	20.21	30.37
VAS QOL (0–100)	82.30	69.86	60.79	47.52
RADAI (0–10)	1.64	3.30	4.74	6.42
HAQ (0–3)	0.38	0.83	1.27	1.73
VAS global severity (0–10)	1.01	3.03	4.54	6.69
VAS pain (0–10)	1.35	3.48	5.43	7.71
VAS fatigue (0–10)	1.82	3.71	5.58	7.27
WOMAC function (0-170)	12.35	39.35	77.31	117.76
WOMAC pain (0–50)	5.01	13.38	23.50	34.21
WOMAC stiffness (0–20)	3.24	6.98	10.84	14.32
SF-36 physical component scale	41.37	32.79	27.02	21.45
SF-36 mental component scale	54.01	46.37	38.40	28.94
Total income ($US)	53,851.26	45,380.43	38,658.40	31,518.01
Total direct medical costs per 6 month ($US)	1648.99	2655.23	3188.97	4092.37

score 38.8 (11.9). Individual (0–10) VAS scales for patient global and pain were available in this trial, as were categorical scales (0–4) for the individual WOMAC items. To make the scales comparable to the SAS, the categorical values of 0, 1, 2, 3, and 4 of the WOMAC that was used in the COX-inhibitor study, the items were rescored to 1, 3, 5, 7, and 9, and the SAS was calculated using these values. To test statistical significance the signed-rank nonparametric test was used, given the essentially ordinal scaling of the WOMAC items, but t-tests were performed, as well. As shown in Table 6, analyses of the changes in the RCT indicated that SAS and VAS pain performed equally well, and were the best measures. Compared to SAS, the WOMAC pain scale and the SF-36 physical component score were less effective in detecting change in the clinical trial.

DISCUSSION

Many scales are available to evaluate arthritis. There is a need for a brief scale to assess arthritis severity in primary care. The scale needs to be simple and easy to administer and score. The SAS consists of 4 visual analog scales (Figure 1). The result can be added together by the clinician. Scores below 7 show minimal involvement, and scores cutting at 15 and 25 show increasing severity. It should take less than a minute to complete the SAS, and scoring by the clinician should only occupy a few seconds: all that is necessary is for the clinician to sum the scores from the 4 VAS scales.

The SAS is internally reliable, has high levels of construct validity, and is as sensitive as any measure used in a clinical trial. In addition, although designed for OA, it can

Table 6. Comparative effectiveness of 5 measures in detecting improvement among patients receiving 2 COX-2 inhibitors in a randomized controlled trial. Data are from a separate data set from an RCT.

Measure	Effect Size	Z (Sign Rank Test)	T (t-test)
SAS	1.382	22.876	34.69
VAS pain	1.588	22.570	34.86
VAS patient global	1.346	21.531	30.82
WOMAC pain	0.972	19.932	25.35
SF-36 physical component score	0.747	17.075	20.53

be used across rheumatic illnesses. Thus, the clinician does not have to decide whether the patient has OA or any other kind of arthritis.

The performance of the SAS in an RCT was as good as but not better than a single pain scale. However, patients in the clinical trial were selected for inclusion only by their pain score at baseline, rather than pain and functional status. In the clinic, however, pain and function are important. Although SAS performed well in the RCT, from the analyses in the NDB data sets, SAS appears to perform better in clinical practice where there is a more uniform distribution of pain and function scores, and where status rather than flare is the key measurement.

Pain and global severity, here as in most other studies, explain most of the variance in the SAS global health scale. Although the 2 functional questions used in the SAS are also strongly influenced by pain, they were still contributors to the overall multivariable model (Table 1), indicating that specific functional activities are also important, although not as important as pain.

The 4 items of the SAS are consistent with the World Health Organization (WHO) International Classification of Function, Disability and Health (ICF)[30]. Pain is arguably the most important category of the bodily function component of the ICF. Climbing stairs is one of the most important activities that is limited in patients with musculoskeletal conditions, and shopping is the most important participation activity. Global severity covers the entire spectrum of activities, including those not specifically addressed by the other scale items. The SAS scale, then, may be thought of as representing a comprehensive view of functioning. In a recent project to develop ICF core sets[31] for chronic disease conditions, including RA, OA, and chronic widespread pain, the SAS items were among the most important items selected into the core sets.

In summary, we have described a simple, valid, and reliable arthritis severity scale that is suitable for use in primary care and also in randomized controlled trials.

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