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Development and Validation of a Rheumatoid Hand Functional Disability Scale That Assesses Functional Handicap

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ABSTRACT. ***Objective.*** To construct a functional disability scale for the rheumatoid hand and to determine if this scale also assesses functional handicap.

Methods. Outpatients and inpatients with rheumatoid arthritis (RA) according to the ACR criteria answered a set of questions on their daily hand activities. Intrarater and interrater reliability were examined. Criterion referenced validity, and convergent and divergent validities were investigated. Factor analysis followed by varimax rotation was performed. Spearman's (r_S) correlation coefficients between 2 quantitative variables were examined. The level of significance was $p < 0.05$.

Results. 96 patients with RA were recruited. The provisional scale had 41 questions. The elimination process left 18 hand activity questions with 6 levels of answers. The intrarater and interrater reliabilities of the scale were 0.97 and 0.96, respectively. Correlation of the scale's total score with visual analog scale (VAS) measure of functional handicap ($r_S = 0.78$) showed good criterion referenced validity. The scale had good convergence with Revel's Functional Index ($r_S = 0.91$) and a moderate relation to the Hand Functional Index (HFI) ($r_S = 0.58$). The scale had a moderate, fair, or no relation to age, morning stiffness, pain measures, and hand swelling. The scale had 3 main factors by factor analysis. An English translation of the scale was validated.

Conclusion. We have developed a practical functional disability scale for rheumatoid hands that also assesses functional handicap. It has 18 hand activity questions and has been validated in a French population. (*J Rheumatol 1996;***23:1167-72**)

Key Indexing Terms:
RHEUMATOID ARTHRITIS — OUTCOME ASSESSMENT — HAND
FUNCTIONAL DISABILITY SCALE — FUNCTIONAL HANDICAP

Quality of life and functional status have become increasingly important over the past decade[1,2], reflecting a growing expectation in society of a life without disability and handicap. Medical research suggests that disease can lead first to impairment and then disability, but that either can lead to handicap[3]. The rheumatologist is mostly concerned with reducing pain, fatigue (impairment), maintaining or improving ability to perform activities of daily living (disability), and maintaining or improving independence (handicap)[4]. Functional disability includes only those activities related to community living[5]; functional handicap is the disadvantage caused by this inability. Accurate assessment of functional disability and functional handicap is important for evaluating treatment and the progress of disease. It is also important for establishing strategies to maximize functional potential and promote well being.

Rheumatoid arthritis (RA) is a chronic disease, with episodes of remission and relapse that have a major effect on functional ability[6,7]. Persons with RA usually suffer its residual effects in their hands and upper extremities. While mortality is easily measured[8], disability and handicap are difficult to assess. One reason is that the degree of a person's handicap can vary according to needs or environment[9]. Although questionnaires are commonly used to assess general health, there is no single functional status questionnaire to assess outcome in all situations of rheumatic diseases[10].

Instruments such as the Arthritis Impact Measurement Scales[11,12], the Health Assessment Questionnaire[13], and Lee's functional index[14] include questions on hand activities for patients with rheumatic disease, but they were not developed to assess hand involvement in rheumatic disease. Three methods have been devised that mainly assess the impairment caused by RA of the hands. Treuhaft's method[15] measures the range of motion of hand joints and assesses deformities. MacBain's Hand Function Test[16] has 11 sub-

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tests that measure grip and pinch strength, and functional tasks. Clawson and Carthum's method[17] has 5 subtests that measure power, stability and unilateral–bilateral coordination. These tests are too complicated for routine use, since they require special equipment, trained personnel, or both.

We developed a practical instrument that can be routinely used to assess the functional disability due to the rheumatoid hand. The instrument was assessed to determine whether it could also give information on functional handicap. The term functional handicap is used to refer to the disadvantage related to activities of community living, but not those related to work roles or personal activities. The scale is based on questions about hand activities commonly performed in a person's daily environment; it is designed to assess the efficacy of local treatment and surgical intervention on the function of a rheumatoid hand.

MATERIALS AND METHODS

Patients. Out and inpatients aged 18–70 years with RA defined by the 1987 American College of Rheumatology criteria[18] for at least one year were recruited at the rheumatology unit of Hôpital Cochin. Patients were excluded on the basis of the following criteria: (1) severe psychiatric disorders (particularly psychosis and depression requiring a change in treatment in the last 30 days; (2) restricted hand motion due to skin lesions and Dupuytren's contracture; (3) neurological disorders of the upper limbs; (4) upper limb arthroplasty, amputation, or joint fusion; hand and wrist surgery or trauma within last 90 days; and (5) inability to speak French fluently.

Instrument development. The scale was constructed in 3 steps: (1) a list of hand activities was collected; (2) a provisional scale was tested; (3) the final scale was developed and its reliability and validity were checked.

List of hand activities. Hand activity questions were collected from published indices[11,14,16,19-26] and from an index used in our clinic[27] (Revel's Functional Index, RFI), which has 10 questions on hand activities. Questions requiring special equipment (e.g., cutting a soft plastic substance with a knife[17]) were eliminated. The remaining 37 questions were divided into 5 categories (in the kitchen, dressing, hygiene, in the office, and other) and given to 10 patients to assess the feasibility of the project. Patients were asked to add other daily activities they found difficult. As a result, 6 questions were modified to improve comprehension, and 4 questions were added. The resulting provisional scale comprised 41 questions; each item was scored on a 7 point Likert scale (0 = without difficulty; 1 = yes, with a little difficulty; 2 = yes, with some difficulty; 3 = yes, with much difficulty; 4 = nearly impossible to do; 5 = impossible; 6 = never done).

Testing the provisional scale. The questionnaire was administered to 102 patients by 2 independent rheumatologists who recorded the answers. Questions answered as "never done" by more than 5% of patients were eliminated. The questionnaire of any patient who was the only one to answer "never done" to an item was not included in the analysis. Responses were then analyzed statistically to select the questions for the final scale. The distribution of the answers was examined, intraclass correlation coefficient (ICC) was used to assess reliability, and factor analysis was performed. A question was eliminated if its answer distribution was badly skewed, if its intraclass correlation coefficient was ≤ 0.50, or if a question in the same factor group was redundant. The final version of the scale was examined for reliability, validity and factorial structure.

The final scale. The final scale of 18 items was tested on 96 patients (70 inpatients, 26 outpatients). Each item was scored on a 6 point Likert scale, as above except that "6 = never done" was dropped. Patients answered the questions based on their experience during the last month. Global raw scores were calculated (sum of scores of each item) and range from 0 to 90. In compliance with the standards published by the American Psychological Association[28], the following properties of the scale were assessed.

Reliability. Intrarater reliability: One of us (MTD) interviewed 25 inpatients twice at 24 h intervals (minimum 17; maximum 32.5). We chose 24 h to avoid variations in clinical status and patients' or interviewers' memory of previous answers. Interrater reliability: Two of us (MTD, SP) interviewed each of 66 inpatients not simultaneously but at 24 h intervals (minimum 15; maximum 31) and each of 2 outpatients at 3 h intervals (minimum 2.5; maximum 3.5). Since these intervals are too short to observe clinical status changes, this experiment is similar to a simultaneous rating of each patient by 2 clinicians. All patients selected for intra and interrater reliability were chosen at random from the initial pool of 96 patients.

Validity. Face validity: The interviewers asked each patient if the questions were comprehensible or not. Content validity: According to their clinical experience, the authors considered that the patients' daily environment contained 5 subsets (in the kitchen, dressing, hygiene, in the office, and other). Criterion referenced validity was assessed using the visual analog scale for functional handicap (VAS Hd) as a gold standard to determine the relation between the global score of our scale and the functional handicap perceived by the patients. The VAS Hd (0–100 mm) ranges from 0 (no handicap) to 100 (maximum handicap). The question with VAS Hd was, "During the last month and considering your needs for daily life, what is your handicap level due to hand involvement?" Functional handicap was explained to each patient as the disadvantage induced by rheumatoid hand in activities of daily life. Patients estimated VAS Hd only after interviewers were sure the concept of functional handicap was thoroughly understood. Construct validity was investigated in 3 ways: (1) Convergent validity was assessed by correlating global scale score with variables that should have converging relationship. These variables were the total score of the RFI and the total score of the first 9 questions (Hand Functional Index, HFI)[29] of the Keitel Functional Test[30]. (2) Divergent validity was assessed by the correlation of the global scale score with variables known to have a moderate or no relation with functional disability [age, disease duration (months), total score of swelling (S: 0 = none, 1 = probable swelling, 2 = definite swelling, 3 = tense swelling), total score of tenderness as the Ritchie articular index[31] (T: 0 = no tenderness, 1 = tender, 2 = tender with a wince response, 3 = tender with a wince and withdrawal response), morning stiffness (min), the VAS of pain[32] in hands and wrists (VAS PH), and VAS of pain in elbows, shoulders, and neck (VAS PESN) in the last week]. Joints examined on each hand were wrist (radiocarpal, intercarpal, and carpometacarpal as one unit), metacarpophalangeal (5 units), interphalangeal of the thumb, peripheral interphalangeal and distal interphalangeal of fingers (8 units). Operations (0 = no operation, 1 = synovectomy, 2 = decompression of nerves, 3 = tendon repair, 4 = others) on the hands and wrists were noted. (3) Factor analysis was performed as described below in statistical analysis to explore the factorial structure of our construct.

Statistical analysis. Statgraphics Plus Version 7[33] software was used for all statistical analyses. Quantitative variables were described using means, standard deviations (SD), minimum and maximum values, quartiles, and confidence intervals. Qualitative variables were described using proportion and percentage. The nonparametric Spearman rank correlation coefficient (r_S) was used to assess the correlation between 2 quantitative variables. Pearson's coefficient could not be used with confidence, because the sampled populations did not have bivariate normal distribution. Spearman coefficient values were interpreted as excellent relationship > 0.91; good 0.90–0.71; moderate 0.70–0.51; fair 0.50–0.31; and little or none ≤ 0.30[14]. Intra and interrater reliability were assessed using ICC under their corresponding random effect models. After estimating the components of total variance by analysis of variance, the ICC was calculated as usual[35]. Factor analysis was performed using the principal component analysis to extract factors. The retained factors had eigenvalues > 1. Independent factors were obtained using the varimax rotation method. The level of significance in all tests was $p < 0.05$.

English translation of the scale. Questions were translated into English by the back-translation method for English speakers: Questions were translated from French to English by 2 rheumatologists and were translated back

Table 5. Varimax rotated factor matrix. The highest loading of each item is underlined.

Question	Factor 1	Factor 2	Factor 3
1	0.18756	0.74895	0.30684
2	0.54880	0.43315	0.21893
3	0.70595	0.27268	0.27820
4	0.45707	0.63226	0.08506
5	0.70949	0.08764	0.30435
6	0.59008	0.27256	0.48683
7	0.14530	0.85555	0.23991
8	0.43638	0.60085	0.33610
9	0.34041	0.65232	0.21943
10	0.37170	0.72090	0.14925
11	0.58963	0.27246	0.35373
12	0.51961	0.35159	0.16190
13	0.19247	0.27239	0.82983
14	0.30294	0.34236	0.72211
15	0.69947	0.34392	0.11528
16	0.21166	0.10768	0.76891
17	0.50193	0.28229	0.53998
18	0.73942	0.29062	0.16914

authors found that the English questions were comparable to the French questions (Table 6) and were suitable for use in international trials.

DISCUSSION

Clinicians need reliable, validated scales for assessing functional disability and functional handicap to measure clinical evolution and patients' limitations before they can propose or evaluate treatment. Studies indicate that simple indices are superior to complex indices[36,37]. We have therefore developed a scale to assess functional disability caused by rheumatoid hand. Questions and answers about patients' ability to function without assistive devices show patients' perception of difficulty levels. We therefore measured the "absolute functional disability," which allows the disabilities of patients to be compared. According to Kirshner and Guyatt[38], the development of a scale should include 6 steps: selection of item pool, item scaling, item reduction, reliability, validity, and responsiveness. We followed this order, and

Table 6. French and English versions of the scale.

Les reponses aux questions (Answers to the questions):
0 = Oui, sans difficulté (Yes, without difficulty);
1 = Possible, avec très peu difficulté (Yes, with a little difficulty);
2 = Possible, avec quelque difficulté (Yes, with some difficulty);
3 = Possible, avec beaucoup difficulté (Yes, with much difficulty);
4 = Presque impossible (Nearly impossible to do);
5 = Impossible (Impossible).

Veuillez repondre aux questions ci-dessous, sans appareillage adapté:
(Answer the following questions regarding your ability without the help of any assistive device:)

C1 — A La Cuisine (In The Kitchen)
1. Pouvez-vous tenir un bol? (Can you hold a bowl?)
2. Pouvez-vous saisir une bouteille pleine et la lever? (Can you seize a full bottle and raise it?)
3. Pouvez-vous tenir un plat plein? (Can you hold a plate full of food?)
4. Pouvez-vous verser le liquide de la bouteille dans un verre? (Can you pour liquid from a bottle into a glass?)
5. Pouvez-vous dévisser le couvercle d'un pot déjà ouvert une fois? (Can you unscrew the lid from a jar opened before?)
6. Pouvez-vous couper de la viande avec un couteau? (Can you cut meat with a knife?)
7. Pouvez-vous piquer efficacement avec une fourchette? (Can you prick things well with a fork?)
8. Pouvez-vous peler des fruits? (Can you peel fruit?)

C2 — Habillage (Dressing)
9. Pouvez-vous boutonner votre chemise? (Can you button your shirt?)
10. Pouvez-vous ouvrir puis fermer les fermetures éclair? (Can you open and close a zipper?)

C3 — Toilette (Hygiene)
11. Pouvez-vous presser un tube de dentifrice plein? (Can you squeeze a new tube of toothpaste?)
12. Pouvez-vous tenir votre brosse à dent efficacement? (Can you hold a toothbrush efficiently?)

C4 — Au Bureau (In The Office)
13. Pouvez-vous écrire une phrase courte avec un crayon ou un stylo ordinaire? (Can you write a short sentence with a pencil or ordinary pen?)
14. Pouvez-vous écrire une lettre avec un crayon ou un stylo ordinaire? (Can you write a letter with a pencil or ordinary pen?)

C5 — Divers (Other)
15. Pouvez-vous tourner une poignée de porte ronde? (Can you turn a round door knob?)
16. Pouvez-vous utiliser des ciseaux pour couper un morceau de papier? (Can you cut a piece of paper with scissors?)
17. Pouvez-vous saisir les pièces de monnaie sur une table? (Can you pick up coins from a table top?)
18. Pouvez-vous tourner une clé dans la serrure? (Can you turn a key in a lock?)

into French by 2 nonphysician Americans living in France and involved in medical editing. The back-translations were then compared with the original questionnaire and any discrepancies documented. Two experts on the questions reviewed the back-translation.

RESULTS

Demographic and clinical data. The performance of the scale was assessed using 96 patients (17 men, 79 women). Table 1 shows demographic and clinical characteristics of patients. Table 2 shows the scores for our scale, the RFI, HFI, VAS Hd, and the disease activity measurements.

Reliability. The intrarater reliability for 25 inpatients was 0.97; interrater reliability for 68 patients (66 inpatients, 2 outpatients) was 0.96.

Validity. Face and content validity: All questions were well understood and acceptable. Each item corresponded to a subset and each subset was represented by several questions. Because patients helped produce the items and because a range of content areas had been covered, we judged that the scale had good face and content validity based on our clinical experience.

Criterion referenced validity: The scale was well correlated with VAS Hd (r_S: 0.7757, $p < 0.0001$).

Construct validity: Table 3 shows the results of the convergent and divergent validity. Our scale had good convergent validity with RFI and HFI and had only a moderate, fair, or no correlation with age, pain measures (VAS-PESN, VAS-PH, and tenderness), morning stiffness, disease duration, and hand joint swelling.

Factor analysis (Table 4) extracted 3 factors with eigenvalues > 1, which accounted for 64.1% of the total variance. Table 5 shows the loading of each question after varimax rotation on the 3 factors. The first factor represents activities requiring force and rotational motions (Questions 2, 3, 5, 6, 11, 12, 15, 18), the 2nd factor represents activities requiring dexterity and precision (Questions 1, 4, 7, 8, 9, 10), the 3rd factor represents dynamic activities requiring flexibility of the first 3 fingers (Questions 13, 14, 16, 17).

English translation of the scale. Changes required by cultural differences had no effect on the meaning of items. The

Table 1. Demographic and clinical characteristics of the 96 participants.

Variable			
Age, yrs (SD; range)	51.2 (13.2; 22–70)		
Sex, % female	82.3		
Disease duration, mo (SD; range)	115.7 (108.7; 13–471)		
Inpatient group (%)	72.9		
Race (%)			
Caucasian	93.75		
Black	5.21		
Asian	1.04		
Right handed (%)	92.71		
Operations*			
Right hand (%)	4.2	0	1.0
Left hand (%)	4.2	0	2.1
Right wrist (%)	9.4	2.1	2.1
Left wrist (%)	5.2	1.0	2.1

* Synovectomy, nerve decompression, or other.

Table 3. Construct validity of the scale (correlation coefficient with other variables).

	Spearman (r_S)	p
Convergent validity		
RFI	0.9075	<0.0001
HFI	0.5805	<0.0001
Divergent validity		
Age	0.3852	0.0002
Disease duration	0.2309	0.0244
Morning stiffness	0.4139	0.0001
VAS-PESN	0.4806	<0.0001
VAS-PH	0.5264	<0.0001
Tenderness	0.5113	<0.0001
Swelling	0.1215	0.2361

Table 4. Factors in factor analysis.

Factor	Eigenvalue	% Variance	Cumulative %
F1	9.18306	51	51
F2	1.28651	7.1	58.1
F3	1.0799	6	64.1
F4	0.86121	4.8	68.9

Table 2. Patient (n = 96) scores.

	Mean	SD	Min	Max	Quartiles		95% CI for Mean	
					Lower	Upper	Lower	Upper
Scale (range 0–90)	17.17	15.00	0	58	4.50	25.00	14.13	20.21
VAS-Hd (mm)	35.91	24.95	0	90	11.00	57.50	30.85	40.96
RFI (range 0–20)	4.31	3.63	0	14	1.00	7.00	3.58	5.05
HFI (range 4–42)	19.15	9.74	4	41	11.50	26.00	17.17	21.12
Morning stiffness (min)	79.22	105.03	0	360	0.00	120.00	57.93	100.51
VAS-PESN (mm)	41.35	30.81	0	98	15.50	68.00	35.11	47.60
VAS-PH (mm)	49.80	29.68	0	98	27.50	72.00	43.79	55.81
Tenderness (range 0–90)	11.00	9.82	0	40	3.00	18.00	9.01	12.99
Swelling (range 0–90)	12.71	8.19	0	36	6.00	17.00	11.05	14.37

Min = minimum; Max = maximum.

the responsiveness of the scale is currently under investigation.

The questionnaire was administered by the interviewers (rheumatologists). This approach allowed additional explanations to patients about the meaning of functional handicap and thus helped avoid missing questions.

Poor hand function in older people has been pointed out in earlier studies[21,39]. The question of geriatric degeneration of joints and muscles was avoided by excluding all patients over 70 years old. This might explain the fair correlation between age and functional disability in our results.

It is unlikely that the high intrarater and interrater reliability could be due to the short interval between the 2 tests. When they filled out the questionnaires, which had 41 questions with 7 levels of answers, patients remembered some questions but did not remember previous answers.

The practical advantages of this scale are clarity, comprehensiveness, simplicity, and a minimum requirement of professional time and money. It takes about 3 ± 1 min to answer, and the 6 levels of answers result in a more sensitive grading of functional disability[40].

Because there is no gold standard to assess functional disability[41], we assessed construct validity. Our scale had good correlation with RFI and moderate correlation with HFI. RFI, which assesses functional disability, was modified from Lee's functional index. These results suggested that our scale has excellent correlation with other functional disability scales. The reason for the lower correlation between our scale's global score and HFI compared with RFI is that HFI also assesses functional impairment. Hakala, *et al* showed moderate correlation between a functional disability questionnaire (AIMS dexterity questions) and HFI[42].

These results confirm that disease activity measures have fair or little correlation with health status instruments[43,44]. Our measurements of joint tenderness (articular index and VAS pain) and morning stiffness of the hands were moderately related to functional disability, while hand swelling was not significantly correlated with functional disability. As reported, RA develops rapidly in the first years of disease and then more slowly[45]. This may explain the slight relationship between disease duration and functional disability seen in our study.

Three factors were extracted by factor analysis. The first was activities requiring force and rotation. Such activities seem to be the most important type of disability for our patients. The second factor was activities requiring dexterity and precision. Such activities are based less on moderate movements than on hand coordination. The last factor was dynamic activities, primarily based on pinching and performed with the first 2 or 3 fingers of the dominant hand. In factor analysis after orthogonal rotation, the items of the scale are grouped in factors according to values of their correlation coefficients. Thus, for the items in the same factor group, the intercorrelations are very high and correlations with items from other factors are low. On the other hand, the grouping of items used for development of the scale was stratified *a priori* in subsets containing the item corresponding to each activity based on clinical observation, not statistical correlations. Thus, an apparent discrepancy results in the manner of grouping items: Development is based on clinical and factor analysis is based on correlation coefficient only. After factor analysis, as in earlier studies[46,47], items are grouped according to the kind of movement required.

The patients modified and simplified some of the activities. For instance, we thought that the activity tested in Item 4 was more difficult than the activity in Item 2, with Item 4 testing force and precision, and item 2 testing only force. Patients performed the Item 4 activity by pouring the liquid from a bottle into a glass without raising the bottle, thus avoiding the movement requiring force. It is not surprising that Questions 2 and 4 appear in different factor analysis groups and the scores for Question 2 were higher than for Question 4.

The VAS of functional handicap (VAS Hd) was used as a gold standard to determine whether our scale also assessed functional handicap. The VAS Hd was chosen as a gold standard because it was used successfully by Lequesne, *et al*[48] and because patients or their peer group are the only people who can make decisions about their functional handicap[49] (patient perceived handicap). As the correlation between our scale score and the gold standard is high, the global score of the scale may also reflect the functional handicap perceived by the patient. Although VAS Hd can assess the overall functional handicap, it cannot give detailed information. Our scale has one advantage over VAS Hd in that it indicates the kind of activities and factors that result in functional handicap.

In conclusion, we developed a practical scale that assesses functional disability due to rheumatoid hand. It also gives information about functional handicap. Our questionnaire had very good intrarater and interrater reliability, and was validated in a French population. The English translation of the scale has also been validated. The sensitivity of the scale to clinical changes and local treatment are under investigation. Although the scale was developed to assess rheumatoid hands, further studies will be done to determine its usefulness for assessing other rheumatic diseases of the hand.

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