# Visual Analog Scales in Formats Other than a 10 Centimeter Horizontal Line to Assess Pain and Other Clinical Data

THEODORE PINCUS, MARTIN BERGMAN, TUULIKKI SOKKA, JILL ROTH, CHRISTOPHER SWEARINGEN, and YUSUF YAZICI

***ABSTRACT.*** ***Objective.*** To analyze visual analog scales (VAS) for pain and patient global estimate on a Multidimensional Health Assessment Questionnaire (MDHAQ) in formats other than a traditional 10 cm horizontal line, designed to facilitate scoring on MDHAQ in usual clinical care.

***Methods***. The MDHAQ with VAS for pain and global estimate was completed by each patient at each visit. VAS formats other than a traditional (unnumbered) 10 cm horizontal line based on 21 circles at 0.5 intervals were analyzed. Formats included unnumbered, symbol at the 11th circle, numbers and/or squares (instead of circles) at selected intermittent scores, and numbers at each circle. Analyses were performed to study the time to score MDHAQ with different VAS formats, possible "clustering" of responses in any format, particularly with intermittent numbers and/or symbols, and test-retest reliability of various formats.

***Results.*** The median time to score MDHAQ with a 10 cm line VAS was 15.6 seconds, compared to 7.4 seconds for the 21 numbered circle VAS. No other format was scored in fewer seconds. Clustering was seen for scores of VAS formats with intermittent numbers or symbols, which rendered them unsuitable for use. No clustering was seen for the 21 numbered circle VAS format, for which test-retest agreement was significant, and similar to the 10 cm line VAS format.

***Conclusion.*** A 21 numbered circle VAS may be a desirable alternative to a 10 cm horizontal line, yielding similar results and requiring less than half the time to score. (First Release June 15 2008; J Rheumatol 2008;35:1550–8)

*Key Indexing Terms:*
VISUAL ANALOG SCALES
PATIENT GLOBAL STATUS
PAIN
RHEUMATOID ARTHRITIS

Measurement of pain on a visual analog scale (VAS) was established as a valuable quantitative clinical assessment in the 1970s by Huskisson and colleagues[1,2]. The VAS format has been extended to assess patient global estimate of status, fatigue, functional status[3-5], and other patient problems[6], as well as to a physician/assessor estimate of global status. Two VAS scores for pain and patient estimate of global status are included in the American College of Rheumatology (ACR) Core Data Set[7,8], and are found on the Health Assessment Questionnaire (HAQ)[3] and its multidimensional version (MDHAQ)[4,9].

Pain and patient global estimate VAS scores are included in all rheumatoid arthritis (RA) clinical trials and most clinical research. However, pain and global status VAS have not been assessed quantitatively at the majority of visits in usual care, as patient questionnaires are not completed at most visits to rheumatologists[10]. One potential reason involves the time required to use a ruler to measure the distance from the left border of a traditional 10 cm line VAS. Further, the length of a 10 cm VAS may be distorted in printing and photocopying, and some patients have difficulty with a 10 cm line VAS[11]. A VAS of 21 squares or circles in 0.5 unit increments can be scored quickly without a ruler, overcoming these limitations.

Early reports indicated that a 10 cm horizontal line without numbering provided an optimal format for a pain VAS, compared to vertical, numbered, and other formats designed to facilitate scoring[1,2,12]. Therefore, formal studies appeared necessary to compare results using other formats to the traditional 10 cm horizontal line. This report presents comparisons of the 10 cm horizontal line VAS to other VAS formats, including 21 circles at 0.5 intervals, unnumbered or num-

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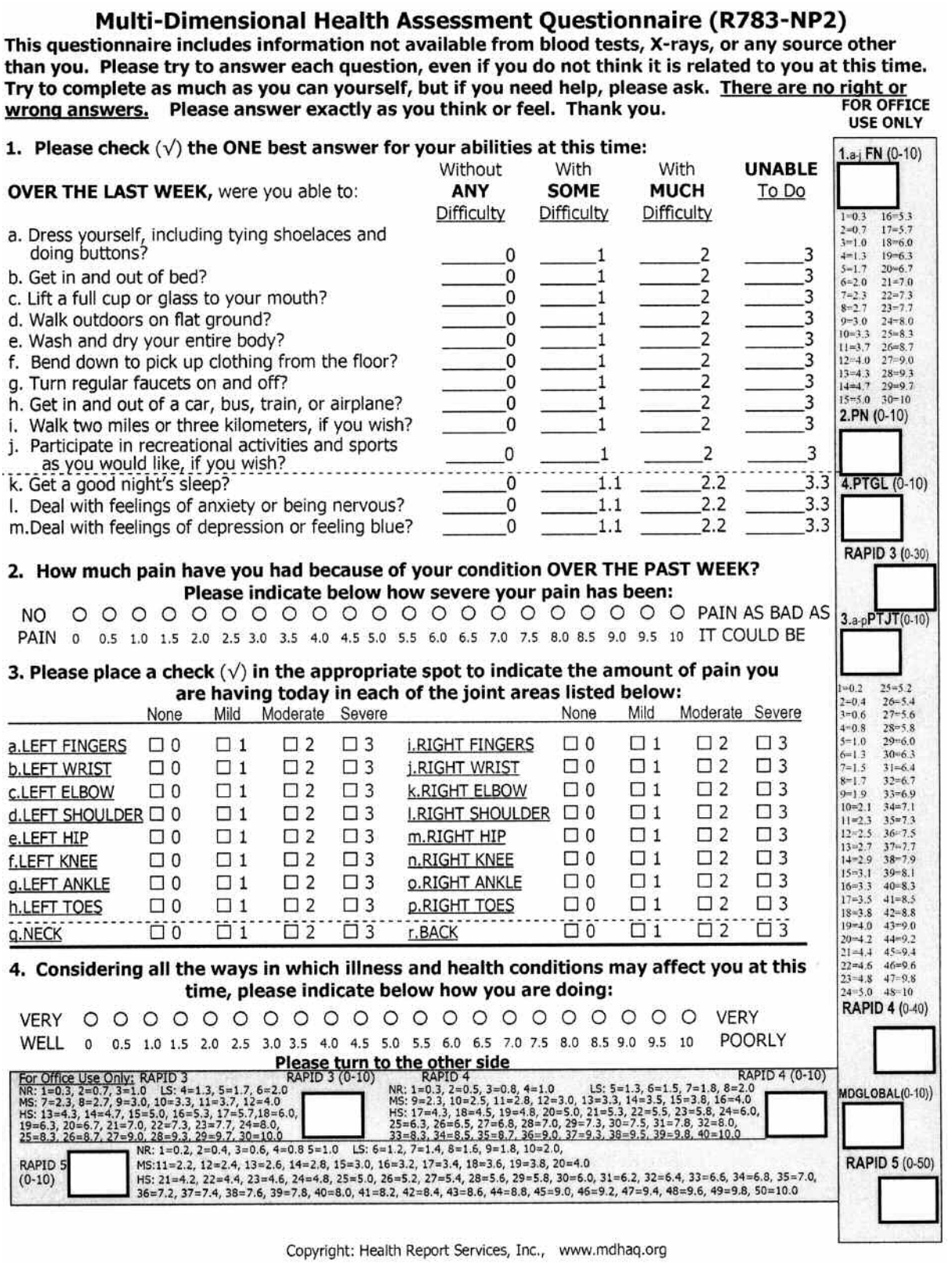

## Multi-Dimensional Health Assessment Questionnaire (R783-NP2)

**This questionnaire includes information not available from blood tests, X-rays, or any source other than you. Please try to answer each question, even if you do not think it is related to you at this time. Try to complete as much as you can yourself, but if you need help, please ask. There are no right or wrong answers. Please answer exactly as you think or feel. Thank you.**

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**1. Please check (√) the ONE best answer for your abilities at this time:**

| **OVER THE LAST WEEK,** were you able to: | Without **ANY** Difficulty | With **SOME** Difficulty | With **MUCH** Difficulty | **UNABLE** To Do |
|---|---|---|---|---|
| a. Dress yourself, including tying shoelaces and doing buttons? | 0 | 1 | 2 | 3 |
| b. Get in and out of bed? | 0 | 1 | 2 | 3 |
| c. Lift a full cup or glass to your mouth? | 0 | 1 | 2 | 3 |
| d. Walk outdoors on flat ground? | 0 | 1 | 2 | 3 |
| e. Wash and dry your entire body? | 0 | 1 | 2 | 3 |
| f. Bend down to pick up clothing from the floor? | 0 | 1 | 2 | 3 |
| g. Turn regular faucets on and off? | 0 | 1 | 2 | 3 |
| h. Get in and out of a car, bus, train, or airplane? | 0 | 1 | 2 | 3 |
| i. Walk two miles or three kilometers, if you wish? | 0 | 1 | 2 | 3 |
| j. Participate in recreational activities and sports as you would like, if you wish? | 0 | 1 | 2 | 3 |
| k. Get a good night's sleep? | 0 | 1.1 | 2.2 | 3.3 |
| l. Deal with feelings of anxiety or being nervous? | 0 | 1.1 | 2.2 | 3.3 |
| m. Deal with feelings of depression or feeling blue? | 0 | 1.1 | 2.2 | 3.3 |

**2. How much pain have you had because of your condition OVER THE PAST WEEK?**
**Please indicate below how severe your pain has been:**

NO PAIN 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10 PAIN AS BAD AS IT COULD BE

**3. Please place a check (√) in the appropriate spot to indicate the amount of pain you are having today in each of the joint areas listed below:**

| | None | Mild | Moderate | Severe | | None | Mild | Moderate | Severe |
|---|---|---|---|---|---|---|---|---|---|
| a.LEFT FINGERS | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | i.RIGHT FINGERS | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| b.LEFT WRIST | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | j.RIGHT WRIST | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| c.LEFT ELBOW | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | k.RIGHT ELBOW | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| d.LEFT SHOULDER | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | l.RIGHT SHOULDER | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| e.LEFT HIP | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | m.RIGHT HIP | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| f.LEFT KNEE | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | n.RIGHT KNEE | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| g.LEFT ANKLE | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | o.RIGHT ANKLE | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| h.LEFT TOES | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | p.RIGHT TOES | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |
| q.NECK | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | r.BACK | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 |

**4. Considering all the ways in which illness and health conditions may affect you at this time, please indicate below how you are doing:**

VERY WELL 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10 VERY POORLY

**Please turn to the other side**

For Office Use Only: RAPID 3 (0-10)
NR: 1=0.3, 2=0.7, 3=1.0 LS: 4=1.3, 5=1.7, 6=2.0
MS: 7=2.3, 8=2.7, 9=3.0, 10=3.3, 11=3.7, 12=4.0
HS: 13=4.3, 14=4.7, 15=5.0, 16=5.3, 17=5.7,18=6.0, 19=6.3, 20=6.7, 21=7.0, 22=7.3, 23=7.7, 24=8.0, 25=8.3, 26=8.7, 27=9.0, 28=9.3, 29=9.7, 30=10.0

RAPID 4 (0-10)
NR: 1=0.3, 2=0.5, 3=0.8, 4=1.0 LS: 5=1.3, 6=1.5, 7=1.8, 8=2.0
MS: 9=2.3, 10=2.5, 11=2.8, 12=3.0, 13=3.3, 14=3.5, 15=3.8, 16=4.0
HS: 17=4.3, 18=4.5, 19=4.8, 20=5.0, 21=5.3, 22=5.5, 23=5.8, 24=6.0, 25=6.3, 26=6.5, 27=6.8, 28=7.0, 29=7.3, 30=7.5, 31=7.8, 32=8.0, 33=8.3, 34=8.5, 35=8.7, 36=9.0, 37=9.3, 38=9.5, 39=9.8, 40=10.0

RAPID 5 (0-10)
NR: 1=0.2, 2=0.4, 3=0.6, 4=0.8 5=1.0 LS: 6=1.2, 7=1.4, 8=1.6, 9=1.8, 10=2.0,
MS:11=2.2, 12=2.4, 13=2.6, 14=2.8, 15=3.0, 16=3.2, 17=3.4, 18=3.6, 19=3.8, 20=4.0
HS: 21=4.2, 22=4.4, 23=4.6, 24=4.8, 25=5.0, 26=5.2, 27=5.4, 28=5.6, 29=5.8, 30=6.0, 31=6.2, 32=6.4, 33=6.6, 34=6.8, 35=7.0, 36=7.2, 37=7.4, 38=7.6, 39=7.8, 40=8.0, 41=8.2, 42=8.4, 43=8.6, 44=8.8, 45=9.0, 46=9.2, 47=9.4, 48=9.6, 49=9.8, 50=10.0

1.a-j FN (0-10)
1=0.3 16=5.3
2=0.7 17=5.7
3=1.0 18=6.0
4=1.3 19=6.3
5=1.7 20=6.7
6=2.0 21=7.0
7=2.3 22=7.3
8=2.7 23=7.7
9=3.0 24=8.0
10=3.3 25=8.3
11=3.7 26=8.7
12=4.0 27=9.0
13=4.3 28=9.3
14=4.7 29=9.7
15=5.0 30=10
2.PN (0-10)
4.PTGL (0-10)
RAPID 3 (0-30)
3.a-pPTJT(0-10)
1=0.2 25=5.2
2=0.4 26=5.4
3=0.6 27=5.6
4=0.8 28=5.8
5=1.0 29=6.0
6=1.3 30=6.3
7=1.5 31=6.4
8=1.7 32=6.7
9=1.9 33=6.9
10=2.1 34=7.1
11=2.3 35=7.3
12=2.5 36=7.5
13=2.7 37=7.7
14=2.9 38=7.9
15=3.1 39=8.1
16=3.3 40=8.3
17=3.5 41=8.5
18=3.8 42=8.8
19=4.0 43=9.0
20=4.2 44=9.2
21=4.4 45=9.4
22=4.6 46=9.6
23=4.8 47=9.8
24=5.0 48=10
RAPID 4 (0-40)
MDGLOBAL(0-10))
RAPID 5 (0-50)

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*Figure 1.* Multidimensional Health Assessment Questionnaire (MDHAQ). The front page includes 10 activities for function and 2 visual analog scales (VAS) for pain and patient global estimate of status, and a self-report joint count from a Rheumatoid Arthritis Disease Activity Index (RADAI). Scoring templates for these measures are available on the right side. The reverse side (not shown) includes a review of systems, fatigue VAS, demographic data, and recent medical history. Copyright© Health Report Services, Hastings-on-Hudson, NY, USA.

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bered, and 21 symbols with symbols at strategic points to facilitate scoring.

## MATERIALS AND METHODS

*Patients and clinical settings.* Each patient (with any diagnosis) completes a version of a MDHAQ[4,9] at the 3 rheumatology clinical care settings in this study (MB, Taylor Hospital; TP, Vanderbilt University, Nashville, TN; YY, NYU Hospital for Joint Diseases). The study was approved by the local institutional review boards. Patients signed consent for results to be sent anonymously to a data center.

*MDHAQ.* The MDHAQ[4,9] (Figure 1) is a 2-sided, single-sheet instrument, derived from the standard HAQ[3], designed to facilitate timely scoring for usual clinical care. The MDHAQ is designed for the physician to review the data prior to seeing the patient, to enhance the focus of the patient and rheumatologist on patient concerns at the visit. MDHAQ scores are highly correlated with the standard HAQ[4,9], as might be expected, since 8 of the 10 activities are found on the HAQ[3]. Page 1 (Figure 1) includes 3 scales to assess 10 physical function items, pain, global status, as well as a self-report joint count from a RA disease activity index (RADAI)[13,14]. Scoring templates for these measures and boxes on the right to enter the scores are included.

Different VAS formats for pain and patient global estimate — the same format for both VAS — were included in different versions of the MDHAQ analyzed in the present study (Figure 2), as explained below. Page 2 (the reverse side — not shown) of the MDHAQ includes a review of systems symptom checklist, fatigue VAS, demographic data, and recent medical history. The RADAI self-report joint count and measures on Page 2 were not studied in this report.

*VAS formats.* VAS formats studied in this report (Figure 2) include: T-1, traditional unnumbered 10 cm horizontal line; T-2, 21 unnumbered circles spanning 10 cm with circles every 0.5 cm; T-3, 21 circles numbered below each circle in 0.5 cm increments; T-4, 21 circles with a symbol at the 11th circle indicating a score of 5/10, to facilitate scoring; T-5, 15 circles and 6 squares with numerical notations at 0, 2, 4, 6, 8, and 10, to facilitate scoring; T-6, 18 circles and 3 diamonds at points of 2.0, 4.0, 6.5, to provide a 4-point categorical scale allowing categorical classification of scores interpreted as "none" (< 1.5), "mild" (2.0–3.5), "moderate" (4.0–6.0), or "severe" (> 6.5); and T-7, 16 circles and 5 squares at positions 0, 2.5, 5.0, 7.5, 10, with a label at each symbol in 0.5 increments. Other formats with different numbers and symbols were studied, but were not more informative than the 7 presented in Figure 2 and are not included here.

Over a 6-month period, patients completed 2 MDHAQ at each visit, one before and the other at the end of the visit (generally within 1 hour of each other). Each visit included one MDHAQ with pain and global estimate VAS in the traditional 10 cm line format, and one MDHAQ with both VAS in a 21 symbol format, except in some studies of test-retest reliability, in which some patients completed 2 MDHAQ with the same 10 cm line or 21 circle format.

*Statistical analyses.* The data were entered into an Excel spreadsheet and transferred to Stata v9.2 for analyses of test-retest reliability (Stata, College Station, TX, USA). Three types of analyses are reported: (1) time required for a health professional to score a MDHAQ form with various formats of VAS for pain and global estimate using formats T-1 to T-7; (2) possible clustering of various VAS formats T-5 and T-7 compared to T-3; and (3) test-retest reliability for pain on a traditional 10 cm VAS (T-1); and 21 circles each numbered at 0.5 intervals (T-3).

*Time to score.* Because simple scoring of only 2 VAS might represent an artificial situation, the time to score the 3 patient self-report scales from the RA core data set (physical function, pain, and patient global estimate[15]) on page 1 of the MDHAQ was studied. The 10 activities for physical function on the MDHAQ were identical in all versions, and the 2 VAS for pain and global estimate were in various formats, T-1 to T-6 (T-7 was studied only for clustering — see below), with the 2 VAS in the same format. Scoring involved writing the 3 scores for physical function (FN), pain (PN), and patient global estimate (GL) in the box on the right side of page 1 (Figure 1). Sets of 50 MDHAQ with each VAS format were photocopied with attention to the need for a 10 cm line, so that each of the 3 rheumatologists would score identical questionnaires including VAS formats T-1 to T-6. The 50 MDHAQ were scored in groups of 10 and timed by an observer. The mean and median of the times to score the 5 groups of 10 MDHAQ were calculated. The total time required was divided by 10 to estimate the mean time required to score a simple MDHAQ in each studied format. The median of the 5 means was taken as the time required to score a single MDHAQ with a given VAS format. Further details concerning studies of the time required to score questionnaires are presented in a previous report[16].

*Analyses of clustering*. Formats with intermittent numbering and/or different symbols (squares or diamonds) at regular or intermittent values, rather than every circle being the same, and either unnumbered or numbered, were also developed, potentially to facilitate scoring in usual care. There was

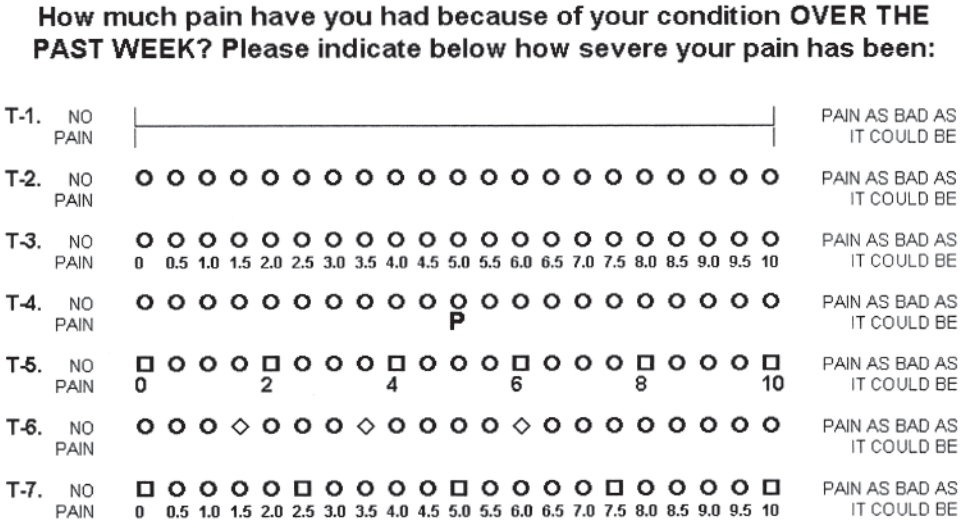


*Figure 2.* Seven visual analog scale (VAS) formats, including traditional 10 cm horizontal line and 6 alternative VAS formats designed to facilitate scoring in standard clinical care.

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concern, however, that use of intermittent numbers or different symbols might introduce "clustering," defined, as noted, as scores designated by 5% or more patients at positions with an intermittent number or different symbol compared to responses on a VAS with only circles. Formats reported here in studies of possible clustering included VAS versions T-5 and T-7 compared to T-3 (Figure 2); additional formats studied were not informative beyond the reported formats.

*Test-retest reliability*. MDHAQ versions with VAS in the traditional 10 cm line and the 21 numbered circle format, which was found to require the fewest seconds to score and not be affected by clustering of responses (see Results), were selected for studies of test-retest reliability. The 2 MDHAQ were completed within 1 hour, according to 4 different protocols: 10 cm line first and 21 circles second; 21 circles first and 10 cm line second; 10 cm line first and 10 cm line second; and 21 circles first and 21 circles second. Spearman rank-order correlations and intraclass correlations (ICC) were estimated as a measure of test-retest reliability. To assess the agreement between test and retest scores, the Bland-Altman[17] method was used. Mean differences between test and retest scores, its standard deviation (SD), 95% confidence interval around the difference between the test and retest values, and scatterplot graphs were computed according to this method. The smallest detectable difference (SDD) was also calculated, which is defined as 1.96 times the SD of the difference between VAS scores. The percentages of retest responses within 0.5, 1, and 2 units of the test responses were calculated as an indication of scale agreement.

## RESULTS

*Time to score MDHAQ with different VAS formats.* The median time for the 3 rheumatologists to score a traditional 10 cm MDHAQ with a ruler (T-1) was 15.6 seconds (Table 1), compared to 10.4 seconds for 21 unnumbered circles (T-2), and 7.4 seconds for 21 numbered circles (T-3), a little less than half the time required to score with a ruler. A format in which a mark was available only at the midpoint of the VAS (T-4) required a median time of 8.6 seconds, 1.2 seconds longer than with all circles numbered. A VAS with squares at 0, 2, 4, 6, 8, 10, and circles at all other scores (T-5) required a median of 10.2 seconds, similar to the 10.4 seconds for 21 unnumbered circles. A VAS with diamonds (T-6) at positions 2.0, 4.0, and 6.5 required a median of 8.3 seconds (Table 1). (Format T-7 was not studied formally for time to score.)

*Clustering of scores in certain formats with different symbols.* Data from 387 patients were studied for clustering, including 119 patients who completed format T-3, 207 who completed format T-5, and 206 who completed format T-7 (some patients completed 2 of these formats (Table 2). In format T-5, with numbered squares at scores of 2, 4, 6, 8, and 10, 10.1% of patients scored 2.0, 10.6% scored 4.0, 9.2% scored 6.0, and 13.0% scored 8.0, compared to 5.9%, 3.4%, 0.8%, and 5.9%, respectively, on format T-3 with circles for these scores. In format T-7, which included numbers for all scores, but squares at 2.5, 5, 7.5, and 10, 12.1% of patients scored 2.5 and 17.0% scored 7.5, compared to 3.4% and 4.2% in format T-3, in which all scores were circles. These data, as well as studies with other formats (data not shown), indicate that labeling of intermittent numerical rating values and/or different intermittent symbols from circles, designed to facilitate scoring, were affected by "clustering," i.e., a higher proportion of patients marked these compared to plain circles (Table 2).

*Test-retest reliability.* Data from 606 paired questionnaires

*Table 2.* Analysis of clustering in different formats of visual analog scale.

| Position of Symbol | Format T-3, N = 119 | Format T-5, N = 207 | Format T-7, N = 206 |
|---|---|---|---|
| 0.0 | 5.0 | 8.7 (S) | 10.7 (S) |
| 0.5 | 13.4 | 3.4 | 2.4 |
| 1.0 | 10.1 | 3.9 | 2.9 |
| 1.5 | 3.4 | 3.4 | 2.9 |
| 2.0 | 5.9 | 10.1 (S) | 3.4 |
| 2.5 | 3.4 | 1.0 | 12.1 (S) |
| 3.0 | 4.2 | 4.3 | 1.5 |
| 3.5 | 8.4 | 1.0 | 3.4 |
| 4.0 | 3.4 | 10.6 (S) | 2.4 |
| 4.5 | 5.9 | 0.5 | 4.9 |
| 5.0 | 5.9 | 10.6 | 15.5 (S) |
| 5.5 | 0.0 | 1.0 | 0.5 |
| 6.0 | 0.8 | 9.2 (S) | 3.9 |
| 6.5 | 5.0 | 2.9 | 1.0 |
| 7.0 | 4.2 | 5.3 | 2.4 |
| 7.5 | 4.2 | 2.4 | 17.0 (S) |
| 8.0 | 5.9 | 13.0 (S) | 2.4 |
| 8.5 | 2.5 | 2.4 | 1.5 |
| 9.0 | 4.2 | 0.5 | 1.9 |
| 9.5 | 3.4 | 1.0 | 0.0 |
| 10.0 | 0.8 | 4.8 (S) | 7.3 (S) |
| Total | 100% | 100% | 100% |

S: Square instead of circles to facilitate scoring.

*Table 1.* Time to score MDHAQ function, pain, and patient global with various visual analog scale formats.

| Format | Rheumatologist 1, Median | Rheumatologist 2, Median | Rheumatologist 3, Median | Rheumatologist 1, 2, 3, Median |
|---|---|---|---|---|
| T-1, traditional 10 cm VAS | 18.9 | 16.8 | 11.9 | 15.6 |
| T-2, 21 circles, no numbers | 9.6 | 12.2 | 8.7 | 10.4 |
| T-3, 21 circles, numbered at all scores | 7.4 | 8.5 | 6.4 | 7.4 |
| T-4, VAS circles, mark at 5.0 | 8.2 | 10.8 | 7.2 | 8.6 |
| T-5, 21 symbols — 15 circles with 6 squares and numbers at 0, 2, 4, 6, 8, 10 | 11.1 | 10.2 | 8.4 | 10.2 |
| T-6, 21 symbols — 18 circles with 3 diamonds at scores of 2.0, 4.0 and 6.5 to define categorical scale | 8.2 | 12.4 | 7.8 | 8.3 |

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were assessed for test-retest reliability, including 130 pairs of the 10 cm line format followed by the 21 circle format, 125 pairs of the 21 circle format followed by the 10 cm line format, 264 pairs of the 10 cm line format followed by another 10 cm line, and 87 pairs of the 21 circle format followed by another 21 circles. Correlation coefficients for test-retest reliability ranged from 0.83 to 0.94 ($p < 0.001$) (Figure 3) for the pain VAS, and 0.84 to 0.94 ($p < 0.001$) (Figure 4) for the global estimate VAS. The ICC was virtually identical to the Spearman correlation coefficient, all greater than 0.8 ($p < 0.001$).

Levels of agreement for the pain VAS were within 0.5 units for 49%–77% of patients, within 1 unit for 71%–93% of patients, and within 2 units for 85%–97% for patients (Table 3). Levels of agreement for the global estimate VAS were within 0.5 units for 50%–77% of patients, within 1 unit for 70%–89% of patients, and within 2 units for 85%–94% of patients (Table 4). Highest levels of agreement were seen for 21 circles versus 21 circles, as might be expected with options for 21 scores rather than 101 with a 10 cm line.

Average differences were 0.016 for 10 cm line pain VAS compared to –0.017 for the 21 numbered circle pain VAS, and 0.24 for the 10 cm line global estimate VAS compared to 0.063 for the 21 numbered circle global VAS (Figure 5). Higher levels of differences were seen for comparisons of

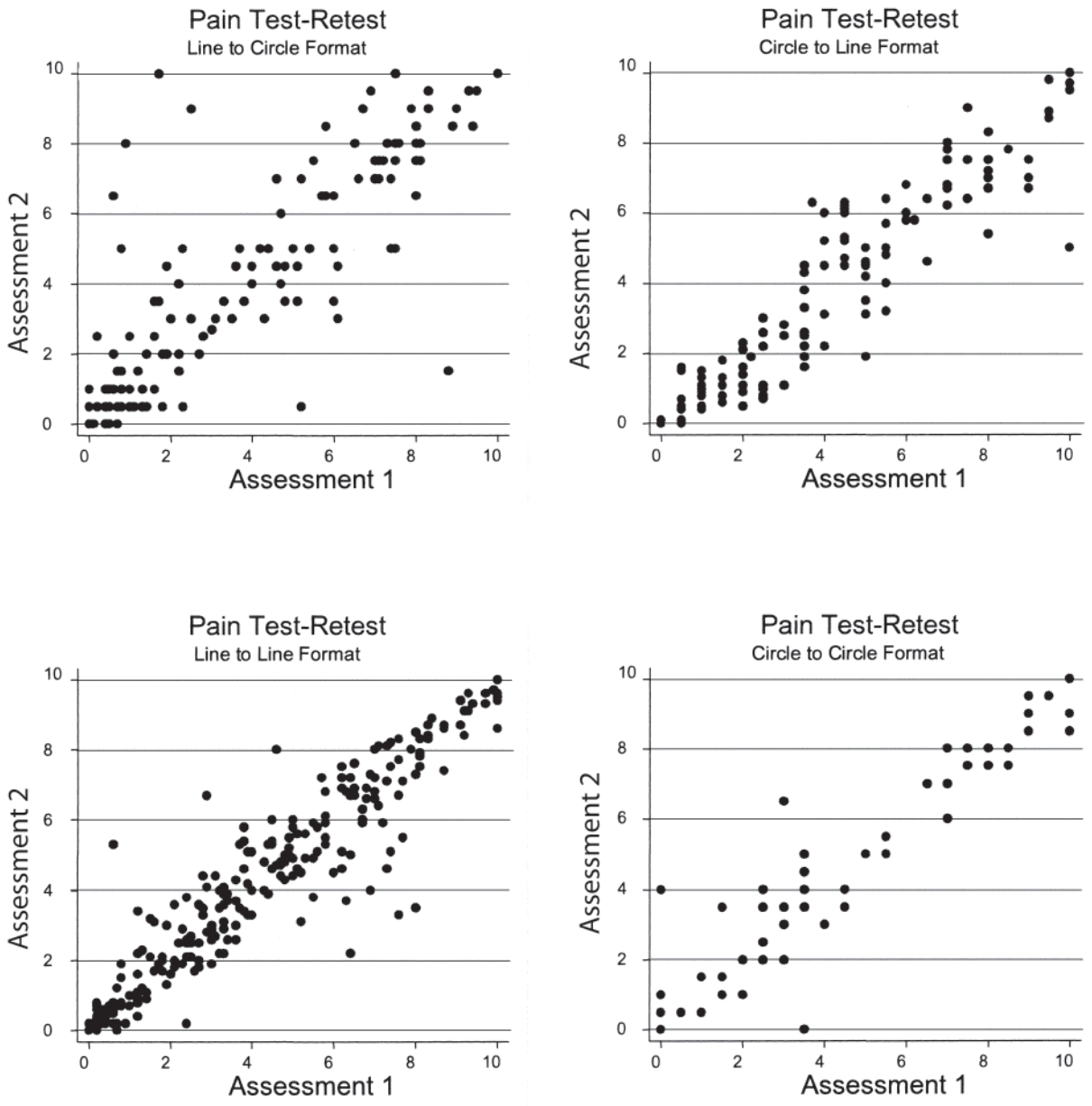


*Figure 3.* Test-retest results of patient self-report of scores for pain on a 10 cm visual analog scale (VAS) and using 21 circles numbered at 0.5 intervals.

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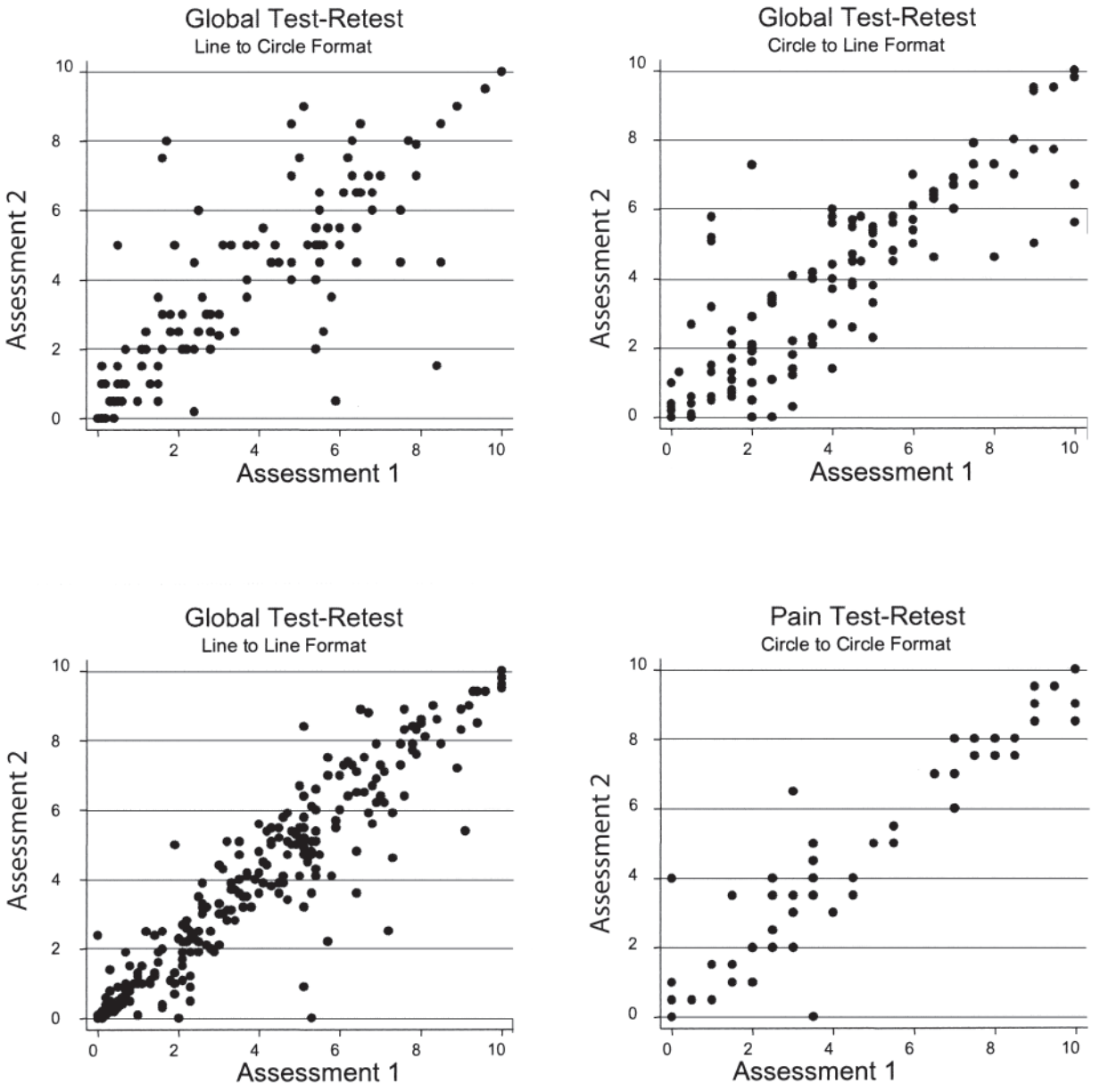


*Figure 4.* Test-retest results of patient self-report of scores for patient global estimate on a 10 cm visual analog scale (VAS) and using 21 circles numbered at 0.5 intervals.

line-to-circle and circle-to-line, although line-to-line and circle-to-circle comparisons were quite similar.

The SDD for the pain and global estimate VAS ranged from 1.77 to 3.54. The SDD was 1.92 for the 10 cm line pain VAS, 1.77 for the 21 numbered circle pain VAS, 1.98 for the 10 cm line global estimate VAS, and 2.09 for the 21 numbered circle global estimate VAS. Again, the SDD was higher for comparisons of line-to-circle and circle-to-line than for line-to-line or circle-to-circle VAS. Nonetheless, Spearman correlations, ICC, SDD, and limits of agreement were quite similar for the comparison of two 10 cm line VAS and two 21 circle VAS, completed by the same patients on the same day.

## DISCUSSION

These data indicate similar results for a pain VAS and patient global estimate VAS, whether the VAS format involved 21 circles or a classic 10 cm line. The 21 circle format presents at least 3 advantages compared to the 10 cm line format: (1) an assessor can score the VAS without a ruler, saving about half the time, or about 8 seconds to score the 2 VAS on the MDHAQ; (2) the need to reproduce an exact 10 cm line in printing or photocopying questionnaires is eliminated, averting the problem of minor distortion frequently seen in photocopying or printing; (3) patients appear to have a better understanding of how to respond to the 21 circles compared to a 10 cm line, for which some patients

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*Table 3.* Analysis of agreement between 2 formats of pain visual analog scales (VAS): 10 cm horizontal unmarked line and 21 circles numbered at 0.5 intervals.

| Format 1<br>Format 2<br>Pain VAS | 10 Cm Line<br>21 Numbered Circles<br>n = 130 | 21 Numbered Circles<br>10 Cm Line<br>n = 125 | 10 Cm Line<br>10 Cm Line<br>n = 264 | 21 Numbered Circles<br>21 Numbered Circles<br>n = 87 |
|---|---|---|---|---|
| Spearman correlation* | 0.83 | 0.94 | 0.94 | 0.96 |
| Intraclass correlation* | 0.83 | 0.93 | 0.94 | 0.96 |
| SDD** | 3.54 | 2.09 | 1.92 | 1.77 |
| Average difference | –0.33 | 0.33 | 0.02 | –0.02 |
| Standard deviation | 1.81 | 1.07 | 0.98 | 0.90 |
| 95% confidence interval | –3.87, 3.21 | –1.76, 2.42 | –1.90, 1.94 | –1.79, 1.75 |
| Difference ≤ 0.5 | 49% | 51% | 63% | 77% |
| Difference ≤ 1 | 71% | 73% | 84% | 92% |
| Difference ≤ 2 | 85% | 95% | 95% | 97% |

* All correlations significant at $p < 0.0001$. ** SDD: smallest detectable difference based upon Bland-Altman limits of agreement.

*Table 4.* Analysis of agreement between 2 formats of patient global estimate visual analog scales (VAS): 10 cm horizontal unmarked line and 21 circles numbered at 0.5 intervals.

| Format 1<br>Format 2<br>Pain VAS | 10 Cm Line<br>21 Numbered Circles<br>n = 130 | 21 Numbered Circles<br>10 Cm Line<br>n = 125 | 10 Cm Line<br>10 Cm Line<br>n = 264 | 21 Numbered Circles<br>21 Numbered Circles<br>n = 87 |
|---|---|---|---|---|
| Spearman correlation* | 0.84 | 0.87 | 0.92 | 0.94 |
| Intraclass correlation* | 0.80 | 0.87 | 0.93 | 0.94 |
| SDD** | 3.31 | 2.82 | 1.98 | 2.09 |
| Average difference | –0.24 | 0.16 | 0.02 | 0.06 |
| Standard deviation | 1.69 | 1.44 | 1.01 | 1.06 |
| 95% confidence interval | –3.54, 3.07 | –2.66, 2.97 | –1.96, 2.01 | –2.02, 2.15 |
| Difference ≤ 0.5 | 53% | 50% | 58% | 77% |
| Difference ≤ 1 | 72% | 70% | 80% | 89% |
| Difference ≤ 2 | 85% | 89% | 95% | 94% |

* All correlations significant at $p < 0.0001$. ** SDD: smallest detectable difference based upon Bland-Altman limits of agreement.

write words or even sentences on the line[11], increasing the burden on the health professional to interpret the data. All 3 features facilitate scoring in usual care.

The 10 cm horizontal line format provides 101 possible scores compared to 21 possible scores in the 21 circle format. However, this reduction in possible scores appears satisfactory, in part because of evidence that individuals cannot necessarily discriminate more than 21 levels of differences in pain or estimate of global status[18]. Correlation of the 21 numbered circle format to itself is at least as high as for the 10 cm line to itself, or the 10 cm line to 21 numbered circle VAS formats.

VAS formats with intermittent numbers or different symbols were introduced initially to facilitate scoring. However, intermittent numbers and/or different symbols not only did not reduce the time to score the VAS compared with a 21 numbered circle format (Table 1), but also were associated with clustering of responses (Table 2). Some level of clustering, which would be anticipated to reduce sensitivity to change in status, was seen with all formats involving intermittent numbers and/or different symbols.

The comparisons of lines to lines and circles to circles, indicating correlations of 0.8 or higher, are similar to data reported by Lassere, *et al*[19] and Kvien, *et al*[20]. In some senses, as recognized by Lassere, *et al*, the SDD level found would likely be regarded as larger than anticipated by rheumatologists. Nonetheless, the SDD of the VAS as a 10 cm line or as 21 circles were virtually indistinguishable. Further, the correlations, ICC, and SDD of the VAS in either format, as a percentage of maximum score, were more favorable than those associated with tender and swollen joint counts in both of these studies.

A logarithmic scale may have offered a possible advantage of calculating a change in score from, say, 4 to 2, as identical metric to a change from 8 to 4, rather than as being half as great on a numeric scale. A slight advantage was seen in studies of adalimumab clinical trials according to a categorical logarithmic scale, even compared to a continuous arithmetic scale[21]. However, the difference was relatively minor, and would not appear to justify complexities in interpretation of logarithmic scale data in usual clinical care.

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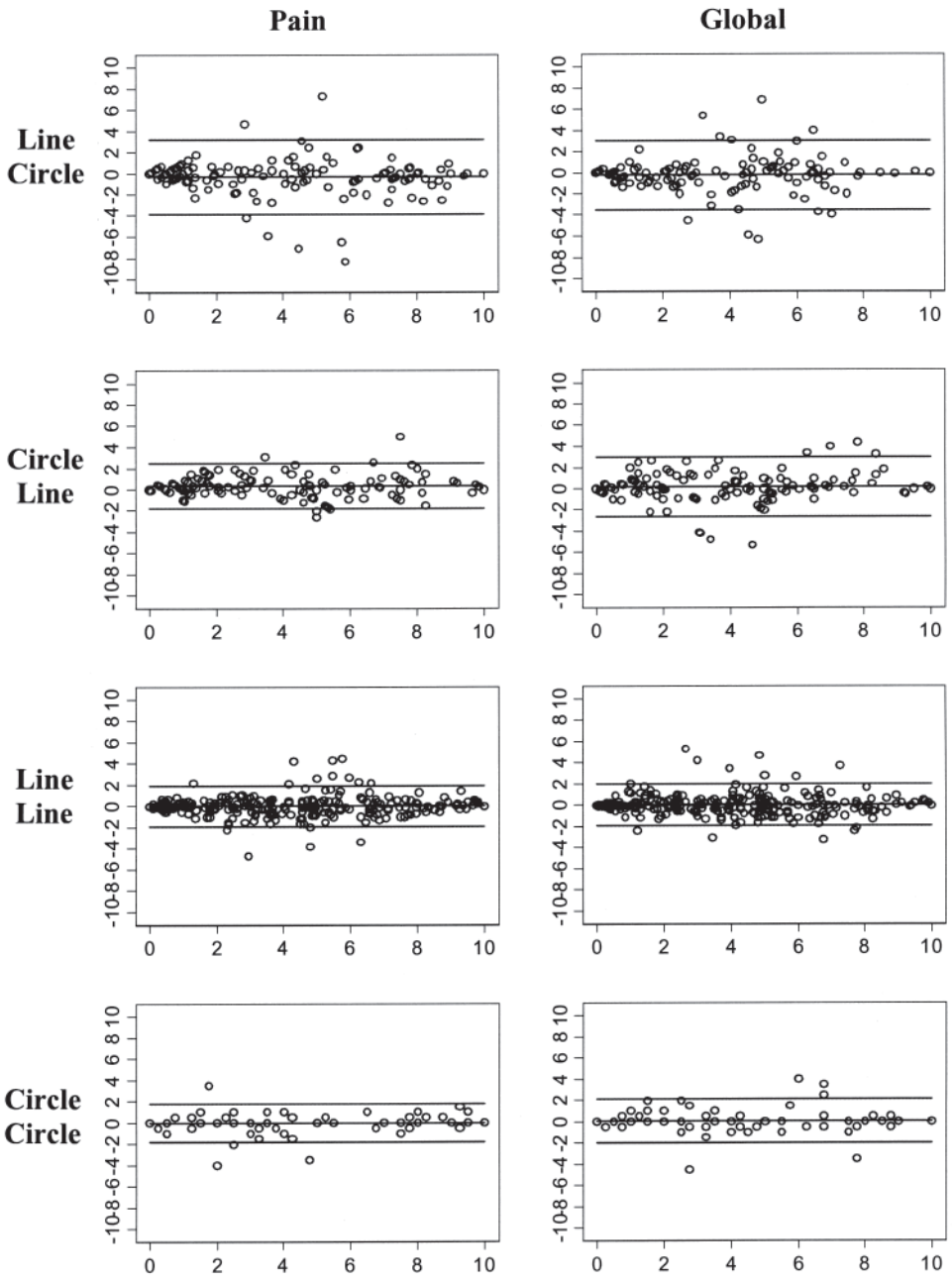


*Figure 5.* 95% Confidence bands around the scatterplot of test-retest differences.

Further, there was no saving in time to score the MDHAQ with categorical logarithmic (or arithmetic) scales, and clustering was introduced with changes of symbols to facilitate recognizing categorical cutpoints. Therefore, the 21 numbered circle format with an arithmetic scale appears to offer the optimal alternative to a 10 cm horizontal line.

It is possible to recognize and monitor clinical problems such as pain, global estimates, and fatigue qualitatively, rather than quantitatively. However, availability of quantitative data can add useful information and precision in patient care. In RA, it is now documented in FinRACO[22,23], TICORA[24], BeST[25,26], and CAMERA[27] that intense quantitative monitoring of RA activity with a target of remission is associated with more rapid improvement and better outcomes than usual *gestalt* clinical care. Most visits to most rheumatologists do not include a formal quantitative joint count[28], but rather a careful nonquantitative joint examination. Simplified VAS scoring and a Routine Assessment of Patient Index Data (RAPID) score[29,30] may enhance the capacity of rheumatologists to introduce quantitative assessment and monitoring of patients in usual clinical care.

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## REFERENCES

1. Huskisson EC. Measurement of pain. Lancet 1974;2:1127-31.
2. Huskisson EC. Measurement of pain. J Rheumatol 1982;9:768-9.
3. Fries JF, Spitz P, Kraines RG, Holman HR. Measurement of patient outcome in arthritis. Arthritis Rheum 1980;23:137-45.
4. Pincus T, Swearingen C, Wolfe F. Toward a Multidimensional Health Assessment Questionnaire (MDHAQ): Assessment of advanced activities of daily living and psychological status in the patient friendly health assessment questionnaire format. Arthritis Rheum 1999;42:2220-30.
5. Wolfe F, Michaud K, Pincus T. Preliminary evaluation of a visual analog function scale for use in rheumatoid arthritis. J Rheumatol 2005;32:1261-6.
6. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: A health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol 1988;15:1833-40.
7. Felson DT, Anderson JJ, Boers M, et al. The American College of Rheumatology preliminary core set of disease activity measures for rheumatoid arthritis clinical trials. Arthritis Rheum 1993;36:729-40.
8. Tugwell P, Boers M. OMERACT Committee. Proceedings of the OMERACT Conferences on outcome measures in rheumatoid arthritis clinical trials, Maastrict, Netherlands. J Rheumatol 1993;20:527-91.
9. Pincus T, Sokka T, Kautiainen H. Further development of a physical function scale on a multidimensional Health Assessment Questionnaire for standard care of patients with rheumatic diseases. J Rheumatol 2005;32:1432-9.
10. Wolfe F, Pincus T, Thompson AK, Doyle J. The assessment of rheumatoid arthritis and the acceptability of self-report questionnaires in clinical practice. Arthritis Care Res 2003;49:59-63.
11. Callahan LF, Brooks RH, Summey JA, Pincus T. Quantitative pain assessment for routine care of rheumatoid arthritis patients, using a pain scale based on activities of daily living and a visual analogue pain scale. Arthritis Rheum 1987;30:630-6.
12. Huskisson EC. Visual analogue scales. In: Melzack R, editor. Pain measurement and assessment. New York: Raven Press; 1983:33-7.
13. Mason JH, Anderson JJ, Meenan RF, Haralson KM, Lewis-Stevens D, Kaine JL. The Rapid Assessment of Disease Activity in Rheumatology (RADAR) questionnaire: validity and sensitivity to change of a patient self-report measure of joint count and clinical status. Arthritis Rheum 1992;35:156-62.
14. Stucki G, Liang MH, Stucki S, Brühlmann P, Michel BA. A self-administered Rheumatoid Arthritis Disease Activity Index (RADAI) for epidemiologic research. Arthritis Rheum 1995;38:795-8.
15. Felson DT. Choosing a core set of disease activity measures for rheumatoid arthritis clinical trials. J Rheumatol 1993;20:531-4.
16. Yazici Y, Bergman M, Pincus T. Time to score various measures to assess rheumatoid arthritis. J Rheumatol 2008;35:603-9; Epub Mar 1.
17. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986;i:307-10.
18. Jensen MP, Turner JA, Romano JM. What is the maximum number of levels needed in pain intensity measurement? Pain 1994;58:387-92.
19. Lassere MND, van der Heijde D, Johnson KR, Boers M, Edmonds J. Reliability of measures of disease activity and disease damage in rheumatoid arthritis: Implications for smallest detectable difference, minimal clinically important difference, and analysis of treatment effects in randomized controlled trials. J Rheumatol 2001;28:892-903.
20. Kvien TK, Mowinckel P, Heiberg T, et al. Performance of health status measures with a pen based personal digital assistant. Ann Rheum Dis 2005;64:1480-4.
21. Pincus T, Amara I, Koch GG. Continuous indices of Core Data Set measures in rheumatoid arthritis clinical trials: lower responses to placebo than seen with categorical responses with the American College of Rheumatology 20% criteria. Arthritis Rheum 2005;52:1031-6.
22. Mottonen T, Hannonen P, Leirisalo-Repo M, et al. Comparison of combination therapy with single-drug therapy in early rheumatoid arthritis: A randomised trial. FIN-RACo Trial Group. Lancet 1999;353:1568-73.
23. Puolakka K, Kautiainen H, Mottonen T, et al. Impact of initial aggressive drug treatment with a combination of disease-modifying antirheumatic drugs on the development of work disability in early rheumatoid arthritis. A five-year randomized followup trial. Arthritis Rheum 2004;50:55-62.
24. Grigor C, Capell H, Stirling A, et al. Effect of a treatment strategy of tight control for rheumatoid arthritis (the TICORA study): a single-blind randomised controlled trial. Lancet 2004;364:263-9.
25. Goekoop-Ruiterman YPM, de Vries-Bouwstra JK, Allaart CF, et al. Clinical and radiographic outcomes of four different treatment strategies in patients with early rheumatoid arthritis (the BeSt study): a randomized, controlled trial. Arthritis Rheum 2005;52:3381-90.
26. Goekoop-Ruiterman YPM, de Vries-Bouwstra JK, Allaart CF, et al. Comparison of treatment strategies in early rheumatoid arthritis: a randomized trial. Ann Intern Med 2007;146:406-15.
27. Verstappen SMM, Jacobs JWG, van der Veen MJ, et al. Intensive treatment with methotrexate in early rheumatoid arthritis: aiming for remission. Computer Assisted Management in Early Rheumatoid Arthritis (CAMERA, an open-label strategy trial). Ann Rheum Dis 2007;66:1443-9.
28. Pincus T, Segurado OG. Most visits of most patients with rheumatoid arthritis to most rheumatologists do not include a formal quantitative joint count. Ann Rheum Dis 2006;65:820-2.
29. Pincus T, Bergman MJ, Yazici Y, Hines P, Raghupathi K, Maclean R. An index of only patient-reported outcome measures, Routine Assessment of Patient Index Data 3 (RAPID3), in two abatacept clinical trials: similar results to disease activity score (DAS28) and other RAPID indices that include physician-reported measures. Rheumatology Oxford 2008;47:345-9.
30. Pincus T, Yazici Y, Bergman M, Maclean R, Harrington T. A proposed continuous quality improvement approach to assessment and management of patients with rheumatoid arthritis without formal joint counts, based on quantitative Routine Assessment of Patient Index Data (RAPID) scores on a Multidimensional Health Assessment Questionnaire (MDHAQ). Best Pract Res Clin Rheumatol 2007;21:789-804.

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