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Validation and Patient Acceptance of a Computer Touch Screen Version of the WOMAC 3.1 Osteoarthritis Index

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Abstract

Objectives: To validate the WOMAC 3.1 in a touch screen computer format, which applies each question as a cartoon, in writing and in speech (QUALITOUCH method). To assess patient acceptance of the computer touch screen version.

Methods: We applied the paper and the computer format of the WOMAC 3.1 in random order to 53 subjects with hip or knee OA. Mean age of subjects was 64 years (range: 45-83). 60% of subjects were male, 53% were 65 years or older and 53% used computers at home or at work. Agreement between formats was assessed with intra-class correlation coefficients (ICCs). Preferences were assessed with a supplementary questionnaire.

Results: ICCs between formats were 0.93 (95% CI [0.87;0.96]) for pain; 0.94 (95% CI [0.90;0.97]) for stiffness and 0.96 (95% CI [0.94;0.98]) for function. ICCs were similar in men and in women, in subjects with or without prior computer experience, and in subjects below or above age 65. 26% of subjects stated that the computer format was easier to use, while 8% preferred the paper format and 66% were undecided. Overall 53% of subjects preferred the computer format, while 9% preferred the paper format and 38% were undecided.

Conclusion: These data indicate that the computer format of the WOMAC 3.1 is reliable if compared to the paper format. Agreement between formats was independent of computer experience, age and gender. Thus, the computer format may help improve patient follow-up by meeting patients' preferences and providing immediate results.

Key words: WOMAC 3.1, osteoarthritis, patient acceptance, touch screen computer format

Introduction

The WOMAC (Western Ontario McMaster Universities Osteoarthritis Index) Osteoarthritis Index is the best validated and most widely used outcome measure in subjects with hip or knee osteoarthritis (OA)[1, 2]. It is a 24-item questionnaire focusing on pain, stiffness, and functional limitation[3].

The WOMAC Osteoarthritis Index has been used as the main outcome in evaluations of pharmacological[4] and surgical trials[5, 6], as well as observational studies[7, 8]. Several studies assessed its validity, reliability and responsiveness[4, 8-10]. The recently defined OARSI (OsteoArthritis Research Society International) response criteria for clinical trials are largely based on the WOMAC Osteoarthritis Index[11].

The WOMAC Osteoarthritis Index is usually applied in paper format. Only recently, computerized versions of the WOMAC Osteoarthritis Index are being developed[12, 13]. The advantages of computerized applications are direct data entry decreasing the chances of error in data transcription and the possibility of an immediate display of results[12]. In addition, the touch screen computerized format applies each question as a cartoon, in writing and in speech, which may be appreciated especially in senior subjects. However, patients' preferences and patients' acceptance of the touch screen computerized format of the WOMAC Osteoarthritis index has not been evaluated.

In this study we aim to validate the latest version of the instrument, which is the WOMAC 3.1, in a Likert Scale on a touch screen computer. In addition, we assess patients' preferences and acceptance of the touch screen computer format compared to the paper format, taking into account prior computer use, age and gender.

Methods

Subjects

The study included 53 eligible subjects with symptomatic OA at the hip or knee consecutively admitted to our rheumatology outpatient clinic (Kantonal Hospital Aarau, Switzerland). Subjects underwent a lower extremity clinical exam for signs of hip and knee OA. This included inspection, manual examination by palpation and functional examination of range of motion (deficits in flexion, extension and rotation, instability, joint laxity). To be enrolled into the study subjects had to have a positive clinical exam for knee or hip OA, as well as radiographic changes at the symptomatic joint consistent with OA. In addition, subjects had to be fluent in the German language. Subjects with symptomatic disease after total joint replacement were excluded. Patients' characteristics are displayed in **Table 1**.

Instruments

Subjects were invited to complete both the paper format and the touch screen computerized version of the WOMAC Osteoarthritis Index 3.1. They received either the paper format first or the touch screen computer format first based on random order. There was a 15 minute break between the two assessments.

The German paper format of the WOMAC Osteoarthritis Index used in this study was validated previously[14].

The computer touch screen format (QUALITOUCH method[12]) presents each question of the WOMAC Osteoarthritis Index as a cartoon, in writing and in speech on a 34.3 cm screen. The questions are answered by touching one of the 5 squares of the Likert scale on the screen (difficulties are ranked as follows: 0 = none, 1 = mild, 2 = moderate, 3 = severe, 4 = extreme). This may be done with a pen or by hand. Neither keyboard nor computer mouse are necessary. In addition to the Likert scale squares, there are 4 squares on the screen that the user could tap on: (1) help, (2) repeat, (3) back, (4) forward. With the forward option, it is possible to skip questions. The help function self activates if the screen is not touched for more than 15 seconds, guiding the user back to the question.

This data capturing method is called the QUALITOUCH method and has previously been validated for the WOMAC Osteoarthritis Index 3.0 numeric scale[12]. The validation study of the WOMAC 3.0 against the paper format yielded the following ICCs in patients with knee or hip OA: pain = 0.91; stiffness = 0.74; function = 0.94. However, the WOMAC 3.0 validation did not include any measures of patients' acceptance or prior computer use. In addition, no subgroup analyses by gender, age and prior computer experience were performed. Also, the WOMAC 3.1 uses a Likert scale, as oppose to the numeric rating scale used in the WOMAC 3.0 version. Overlapping in both validation studies is the QUALITOUCH method, which is the presentation of each question in writing, in speech and as a cartoon. The software for both versions of the WOMAC 3.0 and 3.1 (QUALITOUCH method) is available through the authors.

WOMAC subscales scores were transformed to a 0-100 scale: a WOMAC score of 100 indicates that the patient has no problems and a score of 0 indicates that the patient has extreme difficulty. In between, a score of 25 indicates that a patient has severe difficulty, 50 indicates moderate difficulty and 75 mild difficulties. Differences in

WOMAC functional scores of more than 10 points on the transformed 0-100 WOMAC scale are generally perceptible to patients[15]. Patients evaluated preoperatively before total joint replacement generally have WOMAC functional scores close to 50 or below[16]. We compared patient classification (0 = extreme difficulty, 1-24 score = very severe difficulty, 25-49 = severe difficulty, 50-74 = moderate difficulty, 75 – 99 = mild difficulties, 100 = no difficulties) between the paper and the touch screen computer formats for the function subscale.

After completing both formats of the WOMAC Osteoarthritis Index, subjects were asked to fill in a short multiple choice supplementary questionnaire (5 items are described in the results section and in **Figure 2** and **Table 3**) on previous computer use and preferences in regard to both formats.

Statistical Analyses

Random assignment of which tool (paper or computer) was applied first was performed in blocks of 5. In the calculation of each of the 3 subscale scores of the WOMAC, the range of the subscale score was transformed to a range from 0 to 100 points, with a score of 100 indicating no pain or dysfunction ($100 - (\text{actual raw score} \times 100 / \text{possible raw score range})$).

Descriptive statistics included the means and the standard deviation of the transformed WOMAC subscale scores. Paired t-tests were used to compare differences between the paper and the computer version. In addition individual differences between formats are displayed graphically in **Figure 1**. Individuals with differences of 10 points on the 0 to 100 scale between formats were considered discrepant on each subscale, following the suggestions of Ehrich and colleagues[15]. Agreement (reliability) was assessed with the intra-class correlation coefficient. Ease of use and preference among subjects who expressed a preference were compared with a 2-tailed comparison test against 0.5.

Data was analyzed using SAS version 8.1 and SPSS version 11.

Results

Table 1 displays characteristics of the study population. In total 53 subjects with symptomatic knee or hip OA were enrolled in the study. The age range was 45 to 83 years with a mean age of 64 years. Sixty percent of participants were male.

Every participant completed both formats of the WOMAC Osteoarthritis Index version 3.1. There were 0.55% of items missing on the computer format (7 items in 2 persons) and 0.31% of items missing on the paper format (4 items in 2 persons). The means and standard deviations (SD) of the WOMAC aggregate subscale scores are presented in **Table 2**. For all subscales, aggregate means were similar between the paper and the computer version. Based on the mean score difference by subscale, there was no significant difference between the paper and the computer version. Agreement, assessed by the intra-class correlation coefficient was very good for all three subscales: pain = 0.92, stiffness = 0.94 and function = 0.96. If persons with hip OA were excluded, ICCs were similar to the group that included all persons: pain = 0.91, stiffness = 0.93 and function = 0.96.

The difference between the two formats was plotted against the paper format as the gold standard in **Figure 1** to further illustrate the differences between formats by subscale in individuals. According to **Figure 1**, there was no systematic error in any of the subscales. For all three subscales, the majority of subjects showed no or minimal differences between the paper and the computer format, but when discrepancies occurred, they tended to be larger in the midrange of the scale. In total there were 10 persons that scored 10 points lower or higher in the computer format when compared to the paper format (pain = 3 persons, stiffness = 3 persons, function = 4 persons). None of these 10 persons were discrepant in more than one subscale and 7 out of the 10 were 65 years or older.

In the additional questionnaire on prior computer use and preferences, 53% of subjects stated that they used a computer previously either at work (28%) or at home (25%). Only 28% of all subjects used the internet.

If agreement between formats was assessed stratified by prior computer use, we found that the intra-class correlation coefficients (ICC) between the paper and the computer format were similar for subjects with and without computer experience. The ICCs for subjects with prior computer experience were as follows: pain subscale = 0.92 [95% CI: 0.82-0.96], stiffness subscale = 0.95 [95% CI: 0.88-0.98] and function subscale = 0.96 [95% CI: 0.91-0.98]. The ICCs for subjects without prior computer experience were as follows: pain subscale = 0.92 [95% CI: 0.81-0.96], stiffness subscale = 0.94 [95% CI: 0.86-0.97] and function subscale = 0.97 [95% CI: 0.92-0.98].

Fifty-three percent of the study sample were 65 years or older. If agreement between formats was assessed stratified by age, we found that the ICCs between the paper and the computer format were similar for subjects below age 65 and those aged 65 years or older. The ICCs for subjects aged < 64 years were as follows: pain subscale = 0.89 [95% CI: 0.76-0.95], stiffness subscale = 0.91 [95% CI: 0.79-0.96] and function subscale = 0.98 [95% CI: 0.95-0.99]. The ICCs for subjects 65 years or older were as follows: pain subscale = 0.95 [95% CI: 0.88-0.98], stiffness subscale = 0.97 [95% CI: 0.93-0.98] and function subscale = 0.95 [95% CI: 0.89-0.98].

Sixty percent of the study sample were men. If agreement between formats was assessed stratified by sex, we found that the ICCs between the paper and the computer format were similar for subjects women and men. The ICCs for men were as follows: pain subscale = 0.94 [95% CI: 0.88-0.97], stiffness subscale = 0.94 [95% CI: 0.88-0.97] and function subscale = 0.97 [95% CI: 0.94-0.99]. The ICCs for women were as follows: pain subscale = 0.87 [95% CI: 0.67-0.95], stiffness subscale = 0.94 [95% CI: 0.85-0.97] and function subscale = 0.94 [95% CI: 0.85-0.98].

If we applied clinical cut-offs for the aggregate function subscale, there were 0 subjects with extreme and very severe functional limitations (score of 0-24) in both formats, while there were 8 subjects with severe functional limitations (score of 25-49) in the paper format and 5 in the computer format. There were 22 subjects in the paper format and 24 subjects in the computer format with moderate functional limitations (score of 50-74), and 23 subjects in the paper format and 24 subjects in the computer format had mild functional limitations (75-99). None of the subjects had a function score of 100.

Figure 2 gives the results on 2 questions in the supplement questionnaire. For the item “ease of use”, subjects were asked the following question: “Which format was easier for you to use: the paper format, the computer format or both equally?” For the item “preference”, subjects were asked the following question: “Which format did you prefer: the paper format, the computer format or both equally?” We found that 66% of subjects stated that both formats are equally easy to use and 26% thought that the computer format was easiest to use. Only 8% of subjects felt that the paper format was easiest to use. The majority of subjects (53%) preferred the computer format over the paper format (9%) and 38% of subjects had no preference. In subjects who expressed a preference, there were approximately 3 times as many who found the computer format easier to use ($p = 0.02$) and approximately 5 times as many preferred the computer format over the paper format ($p < 0.01$).

We asked subjects more specifically about 3 features of the two formats as shown in **Table 3**. Ninety-four percent of subjects felt that the combination of cartoon, writing and voice of the computer format was informative and helpful, 2% were undecided and 4% were irritated. Sixty percent stated that it is informative and helpful that the computer format presents only one question at a time, while 40% had no preference. In regard to the paper format 49% felt that it was informative and helpful that it allows going forth and back between pages, while 51% had no preference.

Discussion

The touch screen computer format of the WOMAC Osteoarthritis Index was designed to facilitate patient assessment in clinical practice and research. In this study, we show that the touch screen computer format of the WOMAC Osteoarthritis Index 3.1. is a reliable assessment tool in patients with hip or knee OA if compared to the original paper format independent of prior computer experience, age and gender.

The ICCs for all three subscales (pain, stiffness and function) showed very good agreement for the total study sample, but also in subgroups with or without prior computer experience, and in subjects below age 65 and those aged 65 years or older, and in men and women. There were a small percentage of subjects with discrepant scores beyond 10 points on the 0-100 scale in each subscale (3 to 4 subjects of 53) considering the paper format as the gold standard. However, these subjects were only discrepant in one subscale and the mean aggregate scores by subscale differed minimally between formats (0.11 to 1.5 points on the 0-100 scale). Most subjects with discrepant scores of more than 10 points were 65 years and older. However, in subjects with discrepant scores, it cannot be determined whether the audiovisual presentation provides a score that is further from or closer to the “true” answer.

There were a few missing items for the computer format, which may be due to the software permitting questions to be left unanswered. While this is an important feature of personal choice, it may offer a chance of unintentionally missing a question. As suggested by Buxton and colleagues unintentional non-response may be avoided by having skipped items be presented a second time [17].

If clinical cut-offs for functional status were applied to both formats, there was very good agreement in levels of functional difficulties. Both formats classified the same subjects as having severe difficulties and differed only in one person for moderate and mild difficulties.

Beyond the assessment of agreement between the paper and the touch screen computer format, we were interested in patients’ acceptance and preferences. This was assessed by a supplementary 5-item questionnaire. Half of our study sample was 65 years or older, 47% never used a computer before and only 15% used the Internet. Nevertheless, 92% of subjects either stated that both formats were equally easy to use or the computer format was easiest to use. Of the subjects expressing a preference, approximately 3 times as many found the computer format easier to use and approximately 5 times as many preferred the computer format over the paper format. Most subjects appreciated the combination of cartoon, writing and voice offered by the touch screen computer format (94%) and the majority of subjects stated that the presentation of a single question by the computer format was helpful and informative (60%).

In summary, there are several advantages of the touch screen computer format of the WOMAC Osteoarthritis Index (Version 3.1.). First, the computer format allows direct data entry and immediate display of results, which may improve patient monitoring in research and clinical practice. Second, we show that the computer format is reliable across subgroups of patients, including those without computer experience, the elderly

and both sexes. Third, the majority of subjects in this study found the computer format easiest to use or as easy as the paper format to use, and among those who expressed a preference approximately 5 times as many preferred the computer format over the paper format. This suggests that the computer format finds acceptance among OA patients evaluated in the outpatient clinic and is preferred over the paper format by the majority of these patients.

We conclude that the touch screen format of the WOMAC Osteoarthritis Index 3.1 is a reliable assessment tool in persons with OA at the hip or knee independent of prior computer experience, age and gender. This format may facilitate patient assessment in clinical practice and research.

Table 1:
Characteristics of study population

Gender	
Males	N = 32 (60%)
Females	N = 21 (40%)
Age in years (mean, \pm SD; range)	64.2 (\pm 9.5)
\geq 65 years	N = 28 (53%)
Body mass index in kg/m ² (mean, \pm SD)	28.3 (\pm 5.3)
Diagnosis	
Primary unilateral knee OA	N = 43 (81%)
Primary bilateral knee OA	N = 5 (9%)
Primary hip OA	N = 4 (8%)
Secondary hip OA	N = 1 (2%)
Previous experience with computers	
Professionally	N = 15 (28%)
In private life	N = 13 (25%)
None	N = 25 (47%)
Internet user	
Yes	N = 15 (28%)
No	N = 38 (72%)
Missing items in the WOMAC 3.1.	
Paper format	0.55 %
Computer format	0.31 %

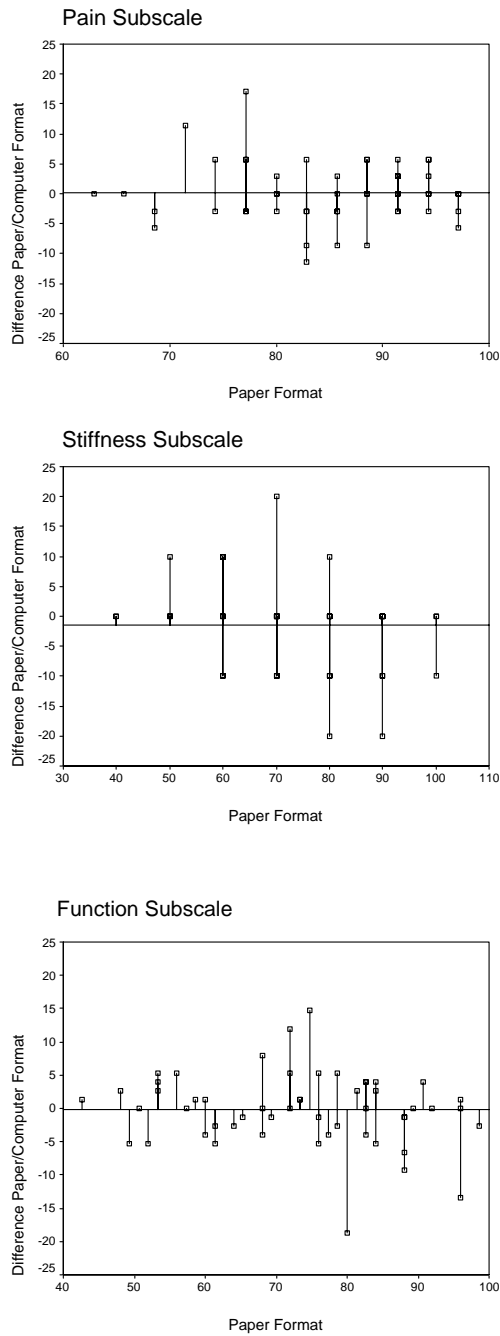
Table 2:

Comparison of Paper and Computer touch screen version of the WOMAC Osteoarthritis Index 3.1.

WOMAC subscale	Mean score	S.D.	Mean Score difference	S.D. of Difference	Paired t-test p-values	ICC 95% CI
Pain						
Paper	74.1	15.4	0.19	8.8	0.88	0.92
Computer	74.3	17.3				[0.87, 0.96]
Stiffness						
Paper	66.8	19.5	1.9	9.0	0.13	0.94
Computer	64.9	19.2				[0.90, 0.97]
Function						
Paper	70.3	15.9	0.17	6.1	0.84	0.96
Computer	70.2	16.1				[0.94, 0.98]

Figure 1:

By Person and by Subscale Difference between Paper and Computer Format of the WOMAC Osteoarthritis Index 3.1.

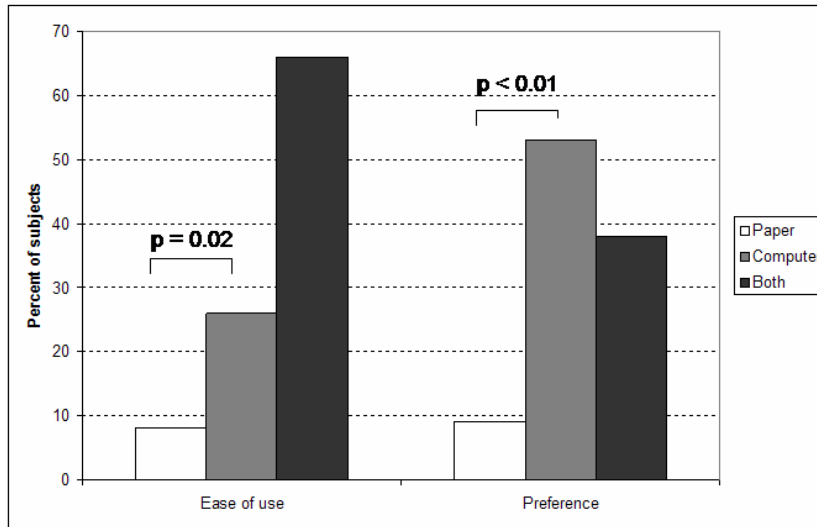


Legend Figure 1:

The graphs display differences between formats using the paper format as the gold standard for each individual. Squares represent those individuals who had discrepant subscale scores, while identical scores are not displayed. Horizontal line gives mean difference between formats.

Figure 2:

Patients' Preferences in regard to Paper and Computer Format of the WOMAC



Legend Figure 2:

Of persons who expressed a preference, there were significantly more subjects who stated that the computer format was easiest to use and significantly more subjects preferred the computer over the paper format.

Table 3:
 Specifics in Patients' Preferences of the Paper and Computer
 Format of the WOMAC

Question (% of subjects)	Is Informative / helpful	Feel indifferent	Is irritating
The computer format combines cartoon, writing and voice. How did feel about that?	94%	2%	4%
The computer format presents only one question at a time. How did you feel about that?	60%	40%	0%
The paper format allows going forth and back between pages. How did you feel about that?	49%	51%	0%

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