The Michigan Hand Outcomes Questionnaire (MHQ) after 15 years of field trial

Melissa J. Shauver, MPH[1] and **Kevin C. Chung, MD, MS**[2]

[1]Clinical Research Coordinator, Section of Plastic Surgery, Department of Surgery, The University of Michigan Health System

[2]Professor of Surgery, Section of Plastic Surgery, Department of Surgery, The University of Michigan Health System

Abstract

Background—The Michigan Hand Outcomes Questionnaire (MHQ) has been used to assess a variety of hand and upper extremity injuries and conditions for nearly 15 years. It has been included in several overviews of upper extremity outcomes measures, but it has not been systematically examined regarding its clinimetric properties during field trials.

Methods—We conducted a review of the MHQ in the English language literature from 1998 through March 2012. Data from clinical studies were abstracted and compiled.

Results—The MHQ has been used in 58 clinical studies and its clinimetric properties have been analyzed in an additional 18 publications. The MHQ compares favorably with other hand outcomes instruments in the areas of test-retest reliability, validity, and responsiveness. High internal consistency may indicate redundancy within the items in the MHQ. The strength of the MHQ is its multidimensional construct in measuring patient-rated outcomes in symptom, function, aesthetics, and satisfaction.

Conclusions—The MHQ has been applied across a variety of conditions affecting the hand and upper limb. Its psychometric properties have been tested through field trials in various clinical settings around the world.

Level of Evidence—Systematic Review; Level II

Keywords

Michigan Hand Outcomes Questionnaire; outcomes instruments; hand and upper limb conditions

Introduction

Patient-rated outcomes have become the centerpiece of the outcomes movement, as improvement and overall well-being are becoming the most desired form outcomes valued by payers.[1] In 2004, the National Institutes of Health (NIH) began funding for the Patient Reported Outcomes Measurement Information System (PROMIS).[2] The goal of PROMIS is to create a rigorous set of methodological standards for the creation and use of patient-rated outcomes measures.[2] To this end, the project has created a number of item banks, a collection of survey questions that measure a single concept. For example, Physical Functioning is the largest of the current PROMIS item banks, with 124 questions.[3] This

Corresponding Author: Kevin C. Chung, MD, MS, Section of Plastic Surgery, Department of Surgery, University of Michigan Health System, 2130 Taubman Center, SPC 5340, 1500 E. Medical Center Drive, Ann Arbor, MI, 48109-0340, kecchung@umich.edu, Phone 734-936-5885, Fax 734-763-5354.

means that PROMIS has identified and validated 124 questions that can be used alone or in combination to assess patients' self-rated physical functioning. Other item banks include Emotional Distress, Cognition, Pain, Fatigue, Sleep, and Sexual Functioning.[3] Work is ongoing to validate more items and create more specific item banks. The NIH's commitment to outcomes measures underscores the prominence of such measures. Furthermore, PROMIS' commitment to the use of well-defined, validated questions brings to light the importance of ongoing review of currently used patient-rated outcomes measures.

The Michigan Hand Outcomes Questionnaire (MHQ) is one such measure. Created in 1998 by the senior author (KCC) to assess hand outcomes that are of importance to patients, the MHQ includes 6 domains (overall hand function, activities of daily living (ADLs), pain, work performance, aesthetics, and satisfaction) and was developed with the input of a panel of hand clinic patients, as well as hand therapists and hand surgeons.[4] (Figure 1) The MHQ has several unique features among patient-rated upper extremity outcomes measures. First, the MHQ includes a section on aesthetics, which is especially important for patient with rheumatoid arthritis (RA), hand burns, and other disfiguring conditions.[5] The MHQ also measures impairment by hand (left and right separately), rather than overall disability, as the Disabilities of Arm, Shoulder and Hand (DASH) does.[5,6]

The MHQ has been in use for nearly 15 years. During this time, it has been applied to assess a host of hand conditions and injuries, and its responsiveness, reliability, and validity have been explored. There have been several publications in a range of journals summarizing the MHQ's use and its clinimetric properties in relation to other outcomes measures. For an investigator who is unfamiliar with the MHQ, synthesizing this information is time-consuming. In the social sciences and quality of life research, publications presenting usage and psychometric/clinimetric data are common for frequently used instruments.[7–12] We were only able to find one example of this type of publication in the surgical literature.[13] Leite et al. performed a systematic review of the Boston Carpal Tunnel Questionnaire (BCTQ), presenting its use and clinimetric properties. They found that based on its responsiveness to change, test-retest reliability, and construct validity, the BCTQ is a recommended disease-specific measure.[13] Periodic review of outcomes measures allows the developers and users of a tool to assess its utility, its strengths, and more importantly, its weaknesses.[7] The results of such a review can help to refine the MHQ, if necessary, or help to guide future projects, like the development and testing of the Brief MHQ.[14] The specific aim of this project is to review the use and the clinimetric properties of the MHQ in the published literature since its inception.

Materials and Methods

A systematic review of the English language literature was performed in CINAHL, Embase, and Medline using the search terms "Michigan Hand Outcomes Questionnaire" OR "MHQ" through March 2012. Papers were included if they presented primary data consisting of total and/or domain specific MHQ scores. Data were collected using a data abstraction form, created *a priori*. Author name, publication year, journal, study type, administration method, language of administration, country of study, research topic, population, response rate, time-points of study, other outcomes measures used, and results were recorded. Clinical studies and clinimetric studies were analyzed separately. This methodology is similar to the Leite et al. review of the BCTQ.[13]

Additional criteria were collected for clinimetric studies, including properties analyzed and outcomes used for comparison. We focused on 4 commonly assessed clinimetric properties: test-retest reliability, internal consistency, construct validity, and responsiveness. Test-retest reliability, or reproducibility, indicates whether a test will yield identical results upon

repeated administration.[15] The reliability of a measure is determined by calculating the interclass correlation coefficient (ICC); a value of 1 indicates perfect reproducibility, whereas a value of 0 indicates no reproducibility.[16] Internal consistency refers to the equivalence of survey items that are intended to measure the same concept.[17] If there is inconsistency in these items, responses to these items may be contradictive or cancel each other out. Internal consistency is measured by calculating Cronbach's alpha correlation coefficient; a value of lower than 0.4 is considered to indicate inconsistent items, a value of greater than 0.8 is indicates high consistency or may even reveal redundancy in a scale.[15] Construct validity is the extent to which a tool measures what it claims to measure and that the results behave as expected.[15] For the MHQ, this would mean that patients with more severe hand impairment would be expected to score worse on the MHQ than patients with less impairment. This property can be measure by calculating Spearman's correlation coefficient; values from 0.5–1 (both negative and positive) are considered large correlations.[18] Responsiveness is the ability of a measure to detect actual change and is measured by calculating the Standardize Response Mean (SRM).[19] A value of 0.2 corresponds to a small effect size, 0.5 to a medium effect size, and 0.8 to a large effect size.[20] Finally, we collected data regarding the minimal clinically significant different of the MHQ, which gives guidance regarding the change in score that corresponds to a clinically relevant, rather than statistically relevant, effect.

Results

After accounting for duplicate articles, a total of 212 citations were identified. A title and abstract screen eliminated 122 citations pertaining to different uses of MHQ, such as the Middlesex Health Questionnaire or methylquinolin. Fourteen citations did not present primary data and were eliminated upon text screening, leaving a total of 76 citations. Of those, 58 presented clinical research data and 18 focused on the MHQ's clinimetric properties. (Figure 2) Studies were published from 1998 when Chung et al. introduced the MHQ, through 2012. Publications number increased steadily over the years. Studies were published in 32 different journals. (Table 1) The most (38%; 29/76) were published in *Journal of Hand Surgery – American.* Plastic Surgery journals and Orthopaedic Surgery journal each published 14% of publication (11/76), whereas 13% (10/76) were published in Hand, Physical, or Occupational Therapy journal. Although all manuscripts were published in English, data collection was conducted in English, Chinese, Dutch, Korean and Turkish and was performed in 13 countries. (Table 2)

Clinical Studies

Arthritis and trauma were the most frequently examined conditions, each in 40% of publications (23/58). (Table 3) Cross-sectional studies represented 43% of publications (25/58).[21,22] (Table 4) Another 43% were prospective studies. Nineteen of the prospective studies utilized a preoperative or baseline time-point. Those that did not were primarily studies of trauma for which obtaining baseline measurements are not feasible. Eighteen studies followed patients for more than 1 year. Participant samples were primarily drawn from investigators' patient populations, as opposed to the general population. However, two studies used subsets of larger arthritis registries (The Genetics, Arthrosis and Progression registry and the North Stratfordshire Osteoarthritis Project).[23,24] Participants ranged in age from 1.5–93 years.[25,26] Patients aged 18 years and older were included in 43% (25/58) of studies. Only one study (of carpal tunnel syndrome (CTS)) solely included patients 65 years of age and older and two studies (both of treadmill injuries) specifically focused on a pediatric sample.[25,27,28] Sample size varied from 4 to over 2100. Nearly half of studies included less than 30 participants. Just over half of studies reported a response rate, which varied from 19% to 100% (mean: 72%). Very few studies reported administration methods,

which included in person, mail and over the phone. Patients reported on their own experiences, with the exception of the pediatric groups. In these 2 publications, parents were asked to respond on behalf of their children.

Ninety-five percent of studies used the complete MHQ. The Aesthetics domain was used alone in a study of the impact of hand musculoskeletal problems in English adults and in a study of dorsal digital nerve island flaps.[23,29] A study of cross-finger flaps for the treatment of venous congestion following digit replantation used the Aesthetics domain along with the Pain domain.[30] Only 4 studies used the MHQ as the sole outcome measure. Virtually all other studies include functional measures, such as strength or motion or radiographic measures, and many included additional subjective measures, most frequently the SF-36.

Clinimetric Properties

Test-Retest Reliability—Test-retest reliability was assessed in 3 publications. (Table 5) The MHQ was compared to the Australian Canadian Osteoarthritis Hand Index (AUSCAN), the Dreiser's Functional Hand Index (DFI), the Hand Function Disability Scale (HFDS), and the Sequential Occupational Dexterity Assessment (SODA) in populations of patients with RA, OA, and diabetes-related hand impairment.[31–33] The ICC ranged from 0.85 (MHQ in a sample of patients with age 45 years and older with osteoarthritis (OA)) to 0.96 (HFDS in a sample of patients with hand impairment associated with type II diabetes).[32,33] Chung et al. examined the test-retest reliability of the MHQ at the domain level and found ICC values ranging from 0.81 for Aesthetics to 0.97 for ADLs.[4] An ICC value greater than 0.70 indicates high test-retest reliability, meaning that changes in score are more likely to be attributable to actual change in status.

Internal Consistency—Internal consistency was assessed in 4 publications - in 2 groups of patients with ongoing hand conditions and 2 groups of RA patients. Values were calculated for individual domains,[17,31] for each domain by hand, and for each domain by dominant and nondominant hand.[4,34] The MHQ was also compared with AUSCAN, SODA, DASH, and the Patient Evaluation Measure. Cronbach's alpha for all surveys averaged 0.89 and ranged from 0.80–0.98, indicating high internal consistency (Cronbach's alpha greater than 0.80).[4,17,31,34] DASH demonstrated the highest internal consistency (0.98), in a sample of patients with ongoing hand and wrist disorders. The Pain domain of SODA had the lowest internal consistency (0.80), in a sample of RA patients. Internal consistency for the MHQ domains ranged from 0.81 for the Pain domain to 0.96 for ADLs. (Table 6) The high internal consistency for all domains indicates that there may be redundancy in the questions.

Construct Validity—Construct validity of the MHQ was assessed to test score behavior compared to patients' reports of improvement and the results of other hand function measures. (Table 7) Large correlations (Spearman's correlation coefficient between −1 and −0.50 or 0.50 and 1) were seen between patient-reported improvement (0.64, in a sample of patient with RA), the HFDS (−0.82, in a sample of patients with OA and −0.76, in a sample of patients with hand impairment related to type II diabetes), and the DFI (−0.86 in the OA sample and −0.72 in the type II diabetes sample).[18,32,33] Correlations between the MHQ summary score and traditional tests of hand function were not within the threshold.[34] However, when examined at the domain level, Spearman's correlation coefficients of 0.50 were seen between the Jebsen-Taylor Test and the Function and ADLs domains of the MHQ in a sample of RA patients.[34] This indicates that there is more than function involved in patients' assessments of hand status.

Responsiveness—Responsiveness was the most frequently measured clinimetric property – it was measured in 12 samples. (Table 8) The responsiveness of the MHQ varied

greatly. The MHQ showed large effect size (SRM greater than 0.80) most often when administered to groups of patients with acute hand injuries and patients undergoing silicone metacarpophalangeal (MCP) joint arthroplasty for RA.[34,35] Large effect sizes were also seen in a sample of distal radius fracture (DRF) patients early after treatment with volar locking plating systems (VLPS) and CTS patients 6 months after carpal tunnel release.[36,37] This can be attributed these being conditions that show marked improvement relatively quickly. In contrast, The MHQ showed a small effect size (SRM less than 0.20) when given to a sample of patients with RA who were being treated with medical management. These patients will experience slow improvement, if any. In this case, it is not that the MHQ is not capturing change that is occurring in these patients. Rather, it is that little to no change exists.

Minimal Clinically Significant Difference—The minimal clinically significant difference (MCID) of the MHQ was assessed in three samples: patients with RA undergoing silicone MCP joint arthroplasty, patients with CTS receiving carpal tunnel release, and patients with DRF treated with VLPS. For RA patients, MCIDs were identified for the Pain (11), Function (13), and ADLs (3) domains of the MHQ, whereas MCIDs for Pain (23), Function (13) and Work (8) were identified for CTS patients.[38] This indicates that CTS patients require far more pain relief to be satisfied with a procedure than do RA patients, although both are satisfied with the same degree of functional gain. DRF patients display a ceiling effect, that is, they return to their normal high level of functioning, after 3 months of treatment. This prevented the calculation of the MCID for MHQ in a DRF sample.[38]

Discussion

The MHQ is one of the dominant outcomes questionnaires in hand surgery. We have shown that in nearly 15 years of field testing, the MHQ has been used to measure health-states and outcomes most extensively for arthritis and trauma. The MHQ is multidimensional and includes both pain and aesthetic questions, which are not present in many other questionnaires, and which eliminate the need for additional measures. It compares favorably to its peer questionnaires in test-retest reliability. Its high internal consistency can discern small changes, which is particularly applicable when small clinical change is expected, (e.g. steroid injection for thumb carpometacarpal (CMC) joint OA). High internal consistency in an outcomes instrument is also useful when exploring the natural course of a disease such as Dupuytren's contracture, in which changes may occur in small increments. However, for procedures that results in large changes, carpal tunnel release for example, the high consistency can seem redundant to patients taking the survey.

The Brief-MHQ can be used in these cases to discern changes without burdening participants with the full MHQ.[14] The Brief-MHQ aims to alleviate participant burden, especially when used to assess procedures that have a large effect or when used to collect routine clinical data. The Brief-MHQ is a 12-item survey that takes approximately half the time of the full MHQ. Its responsiveness, reliability, and validity have been established for 4 common hand conditions: RA, thumb CMC OA, CTS, and DRF.[14]

Responsiveness, as with many questionnaires, can be viewed more as a function of the condition and time periods being measured than as a factor of the survey. For example, a high effect size was seen when the MHQ was given to patients soon after VLPS treatment for DRF. But a medium effect size was seen when the survey was administered later in patients' recovery. This can be attributed to patients' experiencing rapid recovery and reaching a ceiling of high-functioning status between 3 and 6 months after surgical treatment.[38] The MHQ may be tedious for patients to complete, especially for relatively healthy patients with trauma limited to one hand. These patients may not understand the

importance of collecting data about the contralateral, uninjured hand, which can be used as a control or reference.

This review is not with limitations. The sample size of most studies was quite small (<30 subjects). A much larger sample may be necessary to fully assess clinimetric properties. Also, the samples were very heterogeneous with varying ages and conditions of study. This is fitting with the design of the MHQ – to be applicable to a variety of conditions and populations, but it creates difficulty when assessing properties, as was seen with responsiveness. Finally, we limited our search to the English language literature. The MHQ has been translated into 8 languages. It is possible that some publications in languages other than English were missed.

On the national front, PROMIS is leading the way to a new era of patient-rated outcomes measures[2] and evidence-based medicine, another item on the national health agenda, requires valid and reliable tools to measure outcomes.[39] Articles such as this one provide all the available information about a questionnaire in one place. This is a publication type that is lacking in the surgical literature. Because clinimetric properties are population and condition specific, the review of these properties can never truly be complete, especially when it comes to a multiuse questionnaire such as the MHQ. Continued review, such as this manuscript, allows the MHQ's creators and other researchers to assess where testing and evidence is lacking. For instance, the authors are planning to calculate age- and gender-matched normative values to complement research using the MHQ. Regular examination of an instrument also helps investigators use the MHQ with confidence by comparing it with other outcomes instruments. This article presents a critical assessment of the MHQ for the hand and upper limb and fits the national agenda to derive scientifically sound outcomes instruments to measure advances in medicine that will rely on these instruments for comparative effectiveness programs.

Acknowledgments

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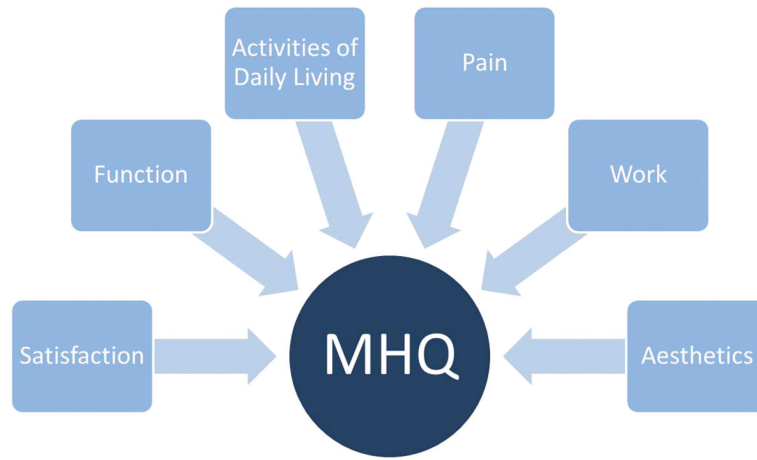
Figure 1.
Domains of the Michigan Hand Outcomes Questionnaire

Initial Search
348

Duplicates
136

Title/Abstract Screen
212

Eliminated
122

Text Screen
90

No Data
14
8 reviews, 2 commentaries, 2 hypotheses, 2 translation processes

Analysis
76

Psychometric Properties
18

Clinical Research
58
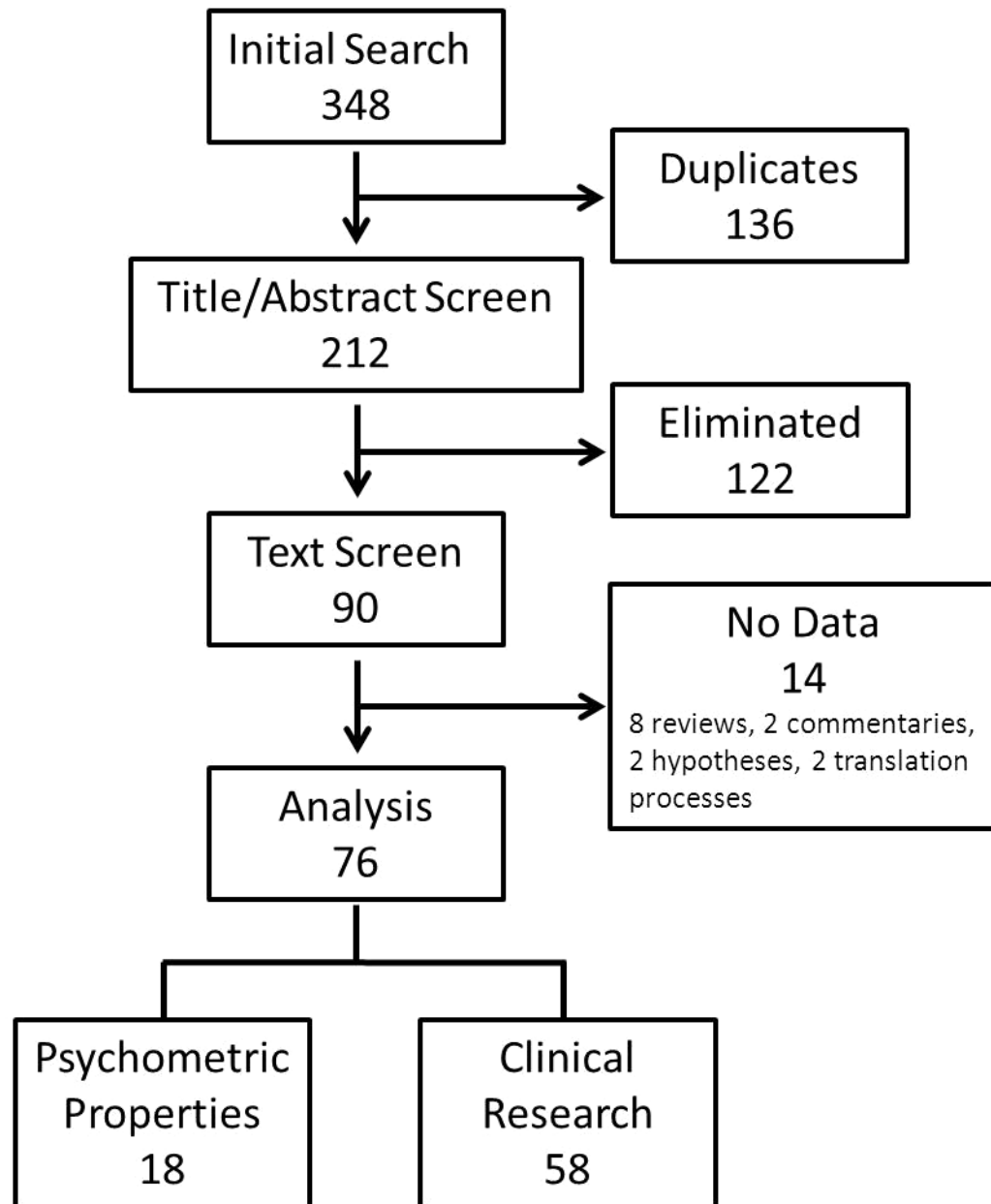
Figure 2.
Diagram of systematic literature search

Table 1

Publications by Journal/ Journal Type

Journal/ Journal Type	n
Journal of Hand Surgery - American	29
Plastic and Reconstructive Surgery	7
Journal of Bone and Joint Surgery - American	3
Journal of Hand Therapy	3
Other Journals by specialty	
Orthopaedic Surgery	8
Arthritis/Rheumatology	6
Physical/Occupational Therapy	7
Plastic Surgery	3
Burn Care	2
Otolaryngology	2
Neurosurgery	2
General Medicine	1
Oncology	1
Pain	1
Trauma	1

Table 2

Publications by Country

Country	n
United States[*]	39
United Kingdom[*]	16
Canada	6
The Netherlands	6
China	2
Taiwan	2
Australia	1
Germany	1
Ireland	1
New Zealand	1
Singapore	1
South Korea	1
Turkey	1

[*] Five studies were performed in both the US and the UK

We were not able to ascertain where the study was performed in 3 cases.

Table 3

Publications by Topic

Topic	n
Rheumatoid Arthritis	9
Distal Radius Fracture	8
Carpal Tunnel Syndrome	5
Proximal Interphalangeal Joint Arthritis	5
Trapeziometacarpal Joint Arthritis	5
Hand Burn	4
Other Hand and/or Wrist Osteoarthritis	4
Finger Amputation	3
Metacarpal Fracture	3
Other Trauma	3
Dupuytren Contracture	2
Finger Avulsion Injury	2
Forearm Free Flap	2
Complex Regional Pain Syndrome	1
Neuropathy	1
Squamous Cell Carcinoma	1

Table 4

Publications by study type

Study Type	n
Cross-Sectional	25
Prospective	25
Randomized Control Trial	5
Case-Control	2
Case Series	1

Table 5

Test-Retest Reliability

First Author	Year	Sample	MHQ*	AUSCAN*	DFI*	HFDS*	SODA*
Massy-Westropp	2004	Patients with diagnosed rheumatoid arthritis	0.95	0.94	0.89		
Poole	2010	Patients aged 45+ with diagnosed osteoarthritis	0.85			0.94	0.94
Poole	2010	Patients with type II diabetes and hand sensory or motor impairment	0.93			0.96	0.90

*
Interclass correlation coefficient: 1 indicates perfect reproducibility, 0 indicates no reproducibility. A value of 0.70 and above is considered sufficient.

MHQ: Michigan Hand Outcomes Questionnaire; AUSCAN: Australian Canadian Osteoarthritis Hand Index; DFI: Dreiser's Functional Hand Index; HFDS: Hand Function Disability Scale; SODA: Sequential Occupational Dexterity Assessment

Table 6

Mean Internal Consistency of the Michigan Hand Outcomes Questionnaire by Domain

Domain	Cronbach's alpha
Function	0.88
Activities of Daily Living	0.93
Work	0.92
Pain	0.84
Aesthetics	0.84
Satisfaction	0.90

[*]Cronbach's alpha: a value of lower than 0.4 is considered to indicate inconsistent items, a value of greater than 0.8 is indicates high consistency.

Table 7

Construct Validity

First Author	Year	Sample	Patient-reported improvement	DFI	HFDS	Grip Strength	Key Pinch	2-point Pinch	3-jaw Pinch	Jebsen-Taylor Test
			Correlation between MHQ summary score and listed measure *							
van der Giesen	2008	Patients with rheumatoid arthritis	0.64							
Poole	2010	Patients aged 45+ with diagnosed osteoarthritis		−0.86	−0.82					
Poole	2010	Patients with type II diabetes and hand sensory or motor impairment		−0.72	−0.76					
Waljee	2010	Patients with rheumatoid arthritis				0.34	0.26	0.33	0.37	−0.46

*
Spearman's correlation coefficient; values from 0.5–1 (both negative and positive) are considered large correlations.

MHQ: Michigan Hand Outcomes Questionnaire; DFI: Dreiser's Functional Hand Index; HFDS: Hand Function Disability Scale

Table 8

Responsiveness to Change

First Author	Year	Sample	Time Periods	MHQ*	AIMS*	CTQ*	DASH*	HAQ*	PSFS*	SODA*
Kotsis	2007	Patients with distal radius fracture treated with volar locking plating system	3 months vs 6 months	0.90						
Kotsis	2007	Patients with distal radius fracture treated with volar locking plating system	6 months vs 12 months	0.60						
van der Giesen	2008	Patients with rheumatoid arthritis	Baseline vs 3 months	−0.72	0.15					−0.41
Chatterjee	2009	Patients undergoing carpal tunnel release	Preop vs 6 months	0.80		1.22				
McMillian	2009	Patients undergoing carpal tunnel release	Preop vs 3 months	0.77			0.74		0.35	
McMillian	2009	Patients undergoing surgery for wrist pain	Preop vs 3 months	0.55			0.65		0.31	
McMillian	2009	Patients undergoing surgery for finger contracture	Preop vs 3 months	0.34			0.23		0.25	
McMillian	2009	Patients undergoing surgery for tumor removal	Preop vs 3 months	0.56			0.62		0.68	
Adams	2010	Patients with rheumatoid arthritis	Baseline vs 12 months	0.49			−0.31	−0.12		
Horng	2010	Patients with acute hand injuries	1 months vs 5 months	1.05			0.86			
Waljee	2010	Patients undergoing Swanson metacarpophalangeal joint arthroplasty for rheumatoid arthritis	Baseline vs 6 months	1.61						
Waljee	2010	Patients with rheumatoid arthritis receiving medical management	Baseline vs 6 months	0.10						

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Standardized Response Mean: A value of 0.2 corresponds to a small effect size, 0.5 to a medium effect size, and 0.8 to a large effect size.

MHQ: Michigan Hand Outcomes Questionnaire; AIMS: Arthritis Impact Measurement Scale; CTQ: Carpal Tunnel Questionnaire; DASH: Disabilities of Arm, Shoulder and Hand; HAQ: Health Assessment Questionnaire; PSFS: Patient-specific Functional Scale; SODA: Sequential Occupational Dexterity Assessment