

# The use of an iPad to collect patient-reported functional outcome measures in hand surgery

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## Abstract

**Background** The purpose of this study was to evaluate (1) patient preferences regarding iPad and paper-based questionnaires, (2) the efficacy of iPad and paper questionnaires in a hand surgery practice, (3) the influence of questionnaire length on patient preferences and data collection, and (4) patient characteristics associated with a preference for iPad-based questionnaires.

**Methods** Two hundred total patients in a single hand surgery practice were randomly assigned to one of four groups. Each group completed either the Michigan Hand Questionnaire (MHQ) or QuickDASH (QD) using either an iPad or pen and paper. Patient preferences, questionnaire completion and timing, and demographic data were analyzed.

**Results** The use of an iPad was associated with a statistically stronger preference for the same delivery format in the future compared to paper for the MHQ (93.9 vs 52.1 %,  $p < 0.001$ )

and QD (90.0 vs 41.7 %,  $p < 0.001$ ). The MHQ iPad group found the survey “physically easy” more often compared to the MHQ paper group, while no difference was found among QD groups. Questionnaire timing between iPad and paper groups was similar for the MHQ but statistically longer with the iPad for QD. A significantly higher proportion of patients who preferred the iPad were under the age of 50 compared to those who preferred paper.

**Conclusions** The addition of an iPad is an efficient and preferable questionnaire format for functional outcome assessment in a hand and upper extremity surgery practice setting. The iPad is particularly preferable for longer outcome questionnaires and for patients under the age of 50.

**Keywords** Hand surgery · Patient reported outcomes · Functional outcomes · iPad

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This study was performed at Indiana Hand to Shoulder Center and approved by the Institutional Review Board of St. Vincent Health System.

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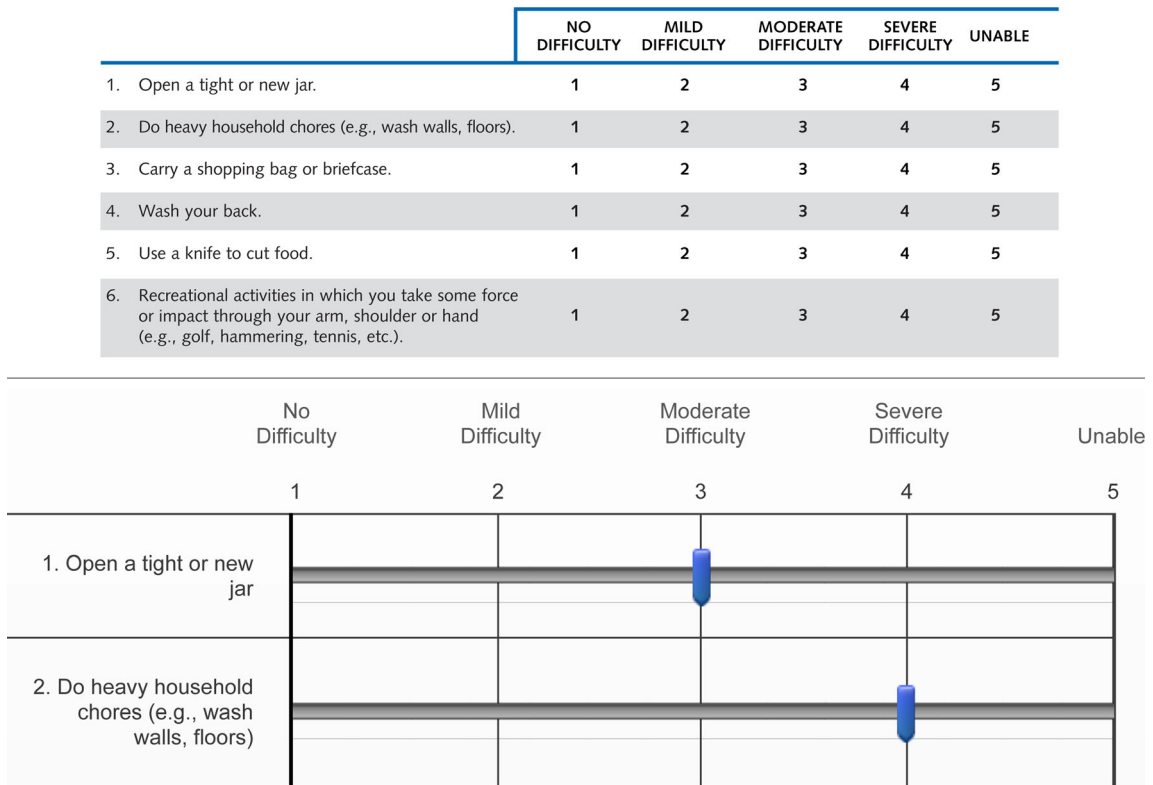
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## Introduction

Accurate and efficient recording of patient-reported outcome measures is critical for improving quality of care. Patient-reported outcome measures allow surgeons to critically and objectively self-assess surgical outcomes and subsequently make decisions rooted in evidence as opposed to anecdote. On the national level, health care quality improvement has become a focus as health care delivery and reimbursement undergo rapid changes [1], including a shift toward value-based insurance models, which will require evidence-based patient-reported outcomes to help distinguish between high and low value services [2]. Despite the benefits of obtaining patient-reported outcome measures, practical barriers with



**Fig. 1** Interface of traditional pen and paper (*top*) and iPad (*bottom*) questionnaires

regard to traditional pen and paper data collection are significant, including the time, labor, and resource-intensive nature of this process, all of which may not be conducive to a high-volume practice setting [3].

The use of an iPad-based data collection tool may offer a more efficient alternative to traditional pen and paper data collection(4). Clinical and functional data entered on an iPad can automatically be transferred to a secure database, quickly generating functional outcome scores that can be aggregated, analyzed, and trended over time. There are multiple possible advantages of this type of system. For the patient, the touch pad entry may be more tolerable and physically easier to complete for those with hand and upper extremity pathology. For the clinician, the automatic upload of

data may reduce the cost and labor burden of manual data entry and improve the ability of clinicians to efficiently generate validated functional outcome scores. Dy et al. have shown in a retrospective series that electronic administration of the DASH questionnaire improved survey completion compared to traditional pen and paper [5]. However, practical aspects of administering an electronic data collection tool in a hand surgery practice have yet to be studied.

The purposes of this study were to (1) evaluate patient preferences regarding the use of iPad and paper questionnaires, (2) assess the efficacy of using an iPad versus paper questionnaires in a hand surgery practice to assess patient functional outcomes, (3) determine whether questionnaire length influences patient

**Table 1** Demographic data

Measure	MHQ iPad (N=50)	MHQ paper (N=50)	p value	QD iPad (N=50)	QD paper (N=50)	p value
Age (years)	54.9	56.0	0.702	54.9	51.2	0.280
Schooling beyond high school (%)	85.1	83.0	0.781	77.6	73.9	0.684
Income over \$60,000 (%)	57.1	59.0	0.870	38.8	36.4	0.828
Gender (% male)	40.8	55.1	0.160	53.1	42.9	0.317

**Table 2** Comparison of iPad and pen/paper format for MHQ and QuickDASH

Measure	MHQ iPad (N=50)	MHQ paper (N=50)	p value	QD iPad (N=50)	QD paper (N=50)	p value
Would prefer same delivery format again (%)	93.9	52.1	<0.001	90.0	41.7	<0.001
Physically “easy” to complete (%)	100.0	89.8	0.024	94.0	90.0	0.466
Cognitively “clear” to complete (%)	83.7	93.9	0.839	90.0	96.0	0.245
Scorable questionnaires (%)	98.0	90.0	0.095	100	94.0	0.083
Omitted questions (#)	0.4	2.0	0.124	0.0	0.2	0.025
Time to completion (min)	7.1	7.4	0.160	3.3	2.5	0.012

preferences and data collection, and (4) determine which patient characteristics are associated with a preference for an iPad-based outcome assessment system.

We hypothesized that patients presenting with hand and upper extremity pathology would prefer the iPad to pen and paper, the iPad would be physically easier for patients to use, and the iPad would be associated with fewer omissions and more complete data collection, with a similar time to completion for iPad and pen and paper questionnaires.

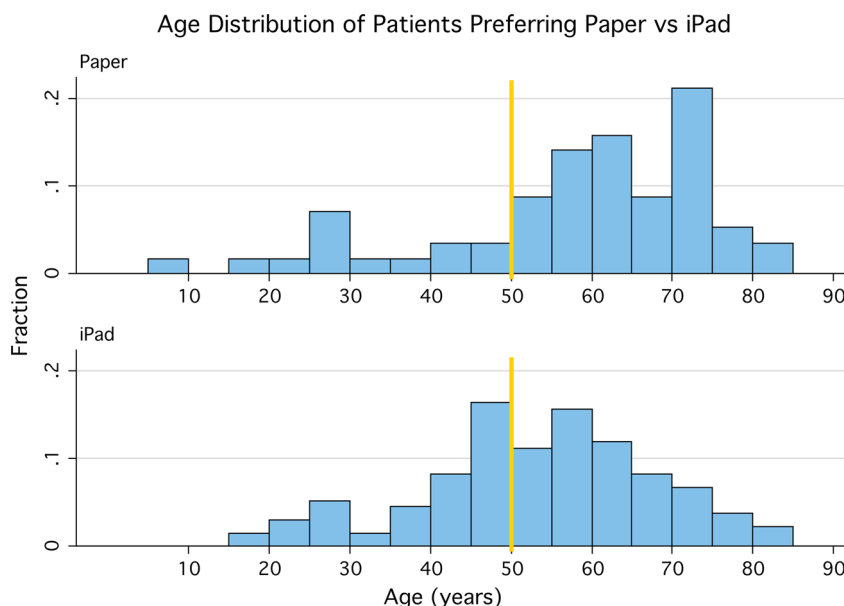
**Materials and methods**

Two hundred total patients (mean age 54 years, age range 9 to 83 years; 48 % male/52 % female) in a single hand surgery private practice were enrolled in this prospective, randomized controlled study approved by the Institutional Review Board. After informed consent was obtained, patients were randomly assigned to

one of four groups (50 patients per group) using a sealed envelope randomization technique. Two of these four groups completed the Michigan Hand Questionnaire (MHQ), with one group using an iPad (iPad Air 1, iOS 7.0) and the other group using pen and paper. The remaining two groups completed the QuickDASH (QD) questionnaire, with one group using an iPad and the other group using pen and paper. Both the MHQ and QD are validated instruments for measuring hand and upper extremity outcomes [6, 7]. The MHQ is a 37-item questionnaire divided into six domains that has been shown to take 10 min to complete [7]. The QD is an 11-item questionnaire that has been shown to take 2.6 min to complete [8]. Qualtrics®, a secure web-based survey provider for academic institutions, was the platform used to collect iPad-based questionnaires.

Each participant was given identical verbal and written instructions by the treating physician (MY, DK, GM) for completion of his or her questionnaire. The iPad utilized a sliding touch bar interface to allow

**Fig. 2** Age distribution of patients preferring paper vs iPad



participants to select responses, and the pen and paper involved circling of responses (Fig. 1). Based on a previously published protocol [9], patients were prompted regarding incomplete questions on the iPad but were not required to complete any omitted questions before progressing and submitting the survey. Patients were instructed to write down the current time at the beginning of the questionnaire and at the end of the questionnaire, from which time to completion was calculated.

Following survey completion, patients were queried whether they would prefer an iPad or pen and paper if asked to “complete a similar questionnaire at [their] next visit.” They were additionally asked how “clear or confusing” and how “physically easy or difficult” the questionnaire was to complete. Demographic data including age, gender, education level, and income were also collected in a format consistent with the demographics section of the MHQ [10].

Guidelines regarding questionnaire scoring and completion have been previously established [10, 11]. The MHQ requires at least 50 % completion in each of the six domains in order to be scorable [11]. The QD requires at least 10 of the 11 items to be complete for a score to be calculated [10].

The sample size was determined according to a pre-study power analysis based upon the primary outcome, which was the proportion of patients who would prefer the same delivery format in the future that they used during this study. It was determined that a minimum of 45 patients per group were needed in order to detect a 30 % difference with alpha level 0.05 and power level 0.80. No significant differences in age, gender, educational level, or income were found between iPad and pen and paper groups for both the MHQ and QD questionnaires (Table 1).

Statistical analysis was performed using Stata 10 Statistical Software (StataCorp, 2007. *Stata Statistical Software: Release 10*, College Station, TX: StataCorp LP). Unpaired Student’s *t* tests were performed to assess differences in quantitative variables. Pearson’s chi-squared tests were performed to assess differences in iPad preference when stratifying for demographic variables. A *p* value threshold of 0.05 was set to determine statistical significance.

## Results

A significantly higher proportion of patients in the iPad group reported that they would prefer to use the same delivery format in the future compared to those in the paper group for both the MHQ (93.9 vs 52.1 %,

$p<0.001$ ) and QD surveys (90.0 vs 41.7 %,  $p<0.001$ ). With regard to physical ease of use, a significantly higher proportion of patients in the MHQ iPad group found the survey physically easy to use compared to the MHQ paper group (100 vs 89.8 %,  $p=0.024$ ), while no difference was found among the QD groups (Table 2). No differences were found between iPad and paper groups with regard to cognitive ease of use.

The iPad group was associated with significantly fewer omissions for the QD questionnaire (0.0 vs 0.2,  $p=0.025$ ), but no differences were found for the MHQ. The proportion of scorable questionnaires was not statistically different between iPad and paper groups for the MHQ (98 vs 90 %;  $p=0.095$ ) or QD (100 vs 94 %;  $p=0.083$ ). Time to completion between iPad and pen and paper groups was similar for the MHQ questionnaire (7.1 vs 7.4 min;  $p=0.662$ ), but using an iPad took significantly longer than using pen and paper for the QD (3.3 vs 2.5 min;  $p=0.012$ ).

Demographic data were compared between patients who reported a preference for the iPad and patients who reported a preference for paper. A significantly higher proportion of patients who preferred the iPad were under the age of 50 compared to those who preferred paper (40.3 vs 22.8 %,  $p=0.014$ ) (Fig. 2). No significant differences in education level, income, or gender were found (Table 3).

## Discussion

This study was designed to assess the practicality of integrating an iPad into a hand and upper extremity clinical practice with the goal of potentially improving the efficacy and efficiency of collecting patient-reported functional outcome measures [4].

Patients in both the MHQ and QD iPad groups reported a stronger preference for the same format in a future survey compared to those in the pen and paper groups. This strong preference for the iPad may be attributed to increased physical ease of use in the case of

**Table 3** Analysis of patients who prefer iPad vs pen/paper

Measure	Prefer iPad	Prefer pen/paper	<i>p</i> value
Mean age	53.0	57.3	0.098
Age under 50 (%)	40.3	22.8	0.014
Schooling beyond high school (%)	83.3	72.2	0.114
Income over \$60,000 (%)	47.9	46.5	0.877
Gender (% male)	45.2	55.2	0.207

the MHQ questionnaire, the novelty of technology, or some other advantage of the iPad not measured by our query.

With regard to the efficiency and effectiveness of using an iPad compared to pen and paper, the iPad

was associated with fewer omitted questions for the QD questionnaire compared to pen and paper. The improvement in data completion is likely due to the ability of the iPad to prompt patients regarding unanswered questions. In terms of time to completion, the iPad

1

Hand Registry - QuickDASH

Please enter the current time: 02:49

Instructions: This survey asks for your views about your hands and your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Answer **EVERY** question by marking the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Do heavy household chores (e.g., wash walls, floors).	1	2	3	4	5
3. Carry a shopping bag or briefcase.	1	2	3	4	5
4. Wash your back.	1	2	3	4	5
5. Use a knife to cut food.	1	2	3	4	5
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	1	2	3	4	5

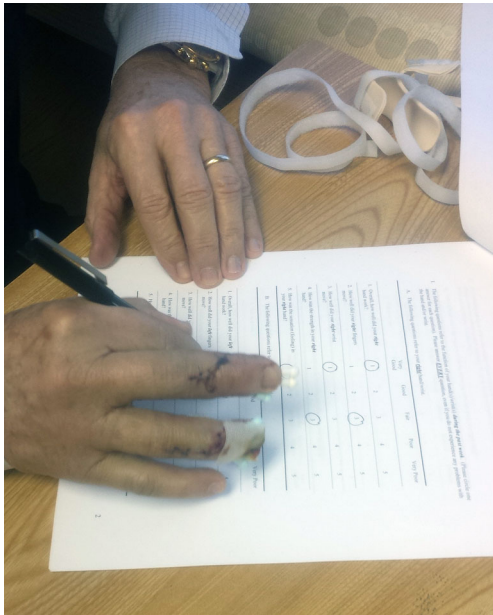
	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. (circle number)

	NONE	MILD	MODERATE	SEVERE	EXTREME
9. Arm, shoulder or hand pain.	1	2	3	4	5
10. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? (circle number)	1	2	3	4	5

Fig. 3 Paper questionnaire showing multiple responses



**Fig. 4** Patient with K-wires attempting to complete paper questionnaire

was similar in length to paper for the MHQ questionnaire (7.1 min on iPad vs 7.4 min on paper) but did add an average of 48 s for the QD questionnaire (3.3 min on iPad vs 2.5 min on paper). There is likely a short learning curve associated with the use of an iPad, which would help explain why differences in completion time diminished when the longer questionnaire was used and make this technology more preferable as questionnaire length increases.

The use of an iPad for the longer questionnaire (MHQ) was also associated with improved physical ease of use (100 % of patients found the MHQ on iPad physically easy to use compared to 89.8 % of patients who found the MHQ on paper physically easy to use), which is an important variable when considering overall patient experience. The iPad may offer improved handling and reduced physical effort for completion compared to pen and paper, a benefit that is most appreciated in a clinical setting where patients are presenting exclusively with hand or upper extremity pathology. With regard to questionnaire length, the MHQ questionnaire is a longer questionnaire that patients in this study with hand and upper extremity pathology found more difficult or tiresome to complete on paper compared to the shorter QD questionnaire. The improved physical ease of use benefit appreciated with the use of the iPad may thus only be detectable in longer questionnaires.

With regard to characterizing patients who prefer the iPad to pen and paper, we found a higher proportion of patients who preferred the iPad to be under the age of 50. This novel technology likely appeals to younger

patients who may have had more exposure to and familiarity with the iPad than older patients.

We identified several characteristics of pen and paper questionnaires that contribute to reductions in the number of scorable surveys and lower patient satisfaction. When using pen and paper, patients often skip questions or provide multiple responses (Fig. 3), which prevents score calculation. Furthermore, with a patient population presenting exclusively with hand and upper extremity injuries and degenerative conditions, the simple act of completing a pen and paper questionnaire can be uncomfortable and at times impossible (Fig. 4).

The flexible nature of the iPad interface offers the ability to restrict selections to a singular response and prevent multiple or hybrid responses, both of which enhance accurate score calculation. It also offers the clinician the ability to prompt the patient if questions are omitted or restrict forward progress and submission until all required items are completed. These factors potentially increase the proportion of scorable surveys and reduce questionnaire omissions, which directly contributes to improvements in data collection.

This study exclusively utilized an iPad for electronic survey administration. However, given that a web-based platform was utilized to host the electronic questionnaires, any touch-screen tablet could be used to access the electronic questionnaires. Thus, the validity of this study extends to include any touch-screen tablet.

A limitation of this study involves the questionnaires tested. This study explored the use of an iPad for the MHQ and QD questionnaires, and it is possible that other questionnaires may show different results when used with an iPad. However, the conclusions with regard to patient preferences and questionnaire length likely apply to other questionnaires with similar length and difficulty. An expanded study with additional questionnaires, such as PROMIS, may further contribute to our understanding of format preference for patient-reported outcome analysis.

This study suggests that the addition of an iPad is an efficient and preferable questionnaire format to obtain patient-reported outcomes in a hand and upper extremity surgery practice setting. The iPad is particularly advantageous for longer questionnaires and for use in patients under the age of 50.

**Conflict of Interest** Mark Yaffe declares that he has no conflict of interest.

Nitin Goyal declares that he has no conflict of interest.

Daniel Kokmeyer declares that he has no conflict of interest.

Gregory A Merrell declares that he has no conflict of interest.

**Statement of Human and Animal Rights** All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

**Statement of Informed Consent** Informed consent was obtained from all individual participants included in the study.

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