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Article *in* The Journal of Hand Surgery (Asian-Pacific Volume) · June 2021

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The Italian Version of the Michigan Hand Outcomes Questionnaire (MHQ): Translation, Cross-Cultural Adaptation and Validation

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Background: Patient-reported outcome measures are largely used in clinical practice and scientific community. Michigan hand questionnaire (MHQ) is widely recognized as a standardized reliable instrument for the assessment of any kind of hand disorders. Aim of the study: translation, cross-cultural adaptation and validation of the Italian version of MHQ.

Methods: The study was composed by two phases. Phase 1 consisted in translation and cross-cultural adaptation of MHQ, from original language version (English) into Italian, according to the standard procedure of translation and back translation. The final Italian version of MHQ was tested on 136 Italian patients with hand disorders (Phase 2), in addition to Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, Visual analogue scale (VAS) for pain assessment and grip strength, to psychometric properties of the new version, 55 patients repeated the questionnaire after 7 days for test-retest to assess the reproducibility of the questionnaire. All data were subsequently analyzed (descriptive statistics, multitrait analysis, reliability and construct validity assessment).

Results: Phase 1 was performed without major problems, thus the final Italian version was approved for Phase 2. The questionnaire was clear and easily understood (missing data 0–2.9%). Multitrait analysis brought very good results for each outcome measure. High reliability (Cronbach's alpha: 0.91–0.99) and very good reproducibility (Intraclass correlation coefficients: 0.83–0.98) were revealed. High to moderate correlation was found between MHQ and DASH, grip strength and VAS.

Conclusions: The Italian version of MHQ has demonstrated to be reliable and valid.

Keywords: *Michigan Hand Outcomes Questionnaire, Italian version, Psychometric, MHQ, Cross-cultural adaptation*

INTRODUCTION

Over the last decades Patient Reported Outcome Measures (PROM) have gained increasing importance for overall evaluation of the patient, which includes patient's perception-based outcomes in addition to objective evaluations (i.e. range of motion, strength). The self-administered questionnaires we use every day in clinical practice are PROMs. They should be standardized instruments, validated and tested to reliably perform the function for which they were developed. Accordingly, when a questionnaire is translated into another language, a cross-cultural adaptation is needed to ensure its validity and its reliability in different cultural settings. Standard methods

Received: Nov. 10, 2020; Revised: Jan. 13, 2021; Accepted: Feb. 9, 2021
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should be applied to adapt and validate a questionnaire, to highlight and adjust any critical points that could potentially affect the reliability of a PROM.[1-4] Several questionnaires have been proposed to assess upper limb and hand function. Some of them have been welcomed by experts in the field.[5] The Michigan Hand Outcome Questionnaire (MHQ), which was drafted in 1998 at Michigan University in the USA, is one of the most widely used standardized instruments to assess hand functionality, both in acute and chronic hand and wrist diseases. MHQ allows investigators to perform an overall and side-specific assessment of the hand/wrist. It is usually self-assessed in about 10 minutes and consists in 37 questions (items), evaluating hand function in 6 scales (domains): overall function, daily living activities, work, pain, aesthetic appearance, and personal satisfaction.

Its reliability and effectiveness are widely acknowledged in the literature and it is useful in monitoring hand function after surgical or nonsurgical treatment.[4-18] MHQ has been translated and validated in several languages.[4,15-24] As it happens for all self-administered questionnaires, a national cross-cultural adaptation was needed in order to make surgical and conservative treatments outcomes comparable beyond individual geographical area of reference. Therefore, the purpose of this work was to develop and validate the Italian version of this questionnaire through a process of cross-cultural adaptation. The hypothesis of the study was that the Italian version of MHQ is reliable and valid.

METHODS

The present cross-sectional monocentric study was performed between January 2014 and December 2019 and approved by the Institutional review board and ethical committee of our Institution in accordance with the Helsinki Declaration. The official license and translation agreement from the University of Michigan were obtained (academic license #15195).

The study consisted in two phases: translation and cross-cultural adaptation of MHQ, from original language version (English) into Italian (phase 1) and validation of the final version (phase 2).

The flowchart of the study is reported in Fig. 1. Translation, cross-cultural adaptation and validation of the Italian version of MHQ were performed according to AAOS Outcomes Committee cross-cultural adaptation guidelines[13,25] and to IQOLA project's first step.[1]

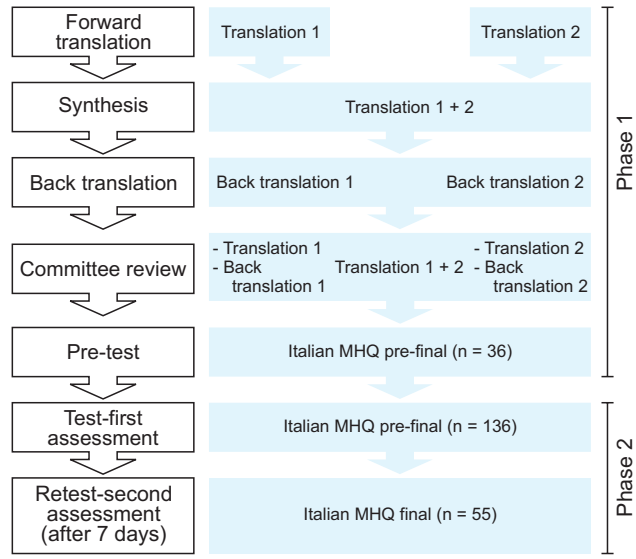

Fig. 1. Flowchart of the study.

Translation and cross-cultural adaptation (phase 1)

The study was supervised by G.T. and R.D.V. (expert hand surgeons). Two bilingual (Italian and American English – speaking) professional translators independently translated the questionnaire from English to Italian language, assisted by three upper limb specialized physiotherapists and four orthopaedic hand surgeons. A translation report was produced, highlighting and discussing every critical point. All discrepancies between the two translations were recognized and subsequently solved. A synthesis process was performed under direct supervision. A first version of the questionnaire (version 1) was obtained merging the two independent translations. Version 1 was back translated in English independently by two further translators, different from the previous ones, to make sure that the translation had not modified the original content. Subsequently a committee comprising nine researchers, the four translators, two epidemiologists, a statistician and an Italian linguist compared the original questionnaire to the two back-translations. A detailed report of that meeting was drafted. A pre-final version of Italian MHQ was created as a result. The pre-final version was administered to 36 randomly selected patients attending an outpatient hand surgery, with their prior consent. The sample size was in accordance with the guidelines.[13,26] All the patients completed the questionnaire and were then interviewed about the difficulties they might have found in replying to it. Any ensuing minor problems were addressed. Thereafter, the authors approved the final version of MHQ (Italian version) (Appendix 1).

Validation: final version's psychometric properties assessment (phase 2)

The validation of the Italian version of MHQ was performed in accordance with the second stage of the IQOLA research process.[1)] In phase 2 we verified if the questions were appropriate, if items were appropriate for the domain to which each of them had been assigned, and the reproducibility of the questionnaire. During this phase another larger sample of patients (n = 136), different from those who had participated in phase 1, was used.

Inclusion and exclusion criteria were set. Patients over the age of 18 who accepted to participate in the study, suffering from a pathology involving one hand for at least 4 weeks were included into the study. An informed consent was obtained at the first examination. The diagnosis was based on clinical findings and confirmed using imaging and neurophysiological investigations.

Patients who did not want to participate in the study, who were unable to read and write, who were not able to complete the questionnaire by themselves, who were suffering from cognitive impairment, who had experienced different symptoms between the first and the second evaluation, who had undergone hand surgery on the examined hand less than 3 months before enrolment, or who suffered from a rheumatic disease were excluded from the study.

During the first visit, data were collected by a physical therapist or a hand surgeon. General demographic data (age, sex, body mass index, education, disease, diagnosis, duration of symptoms, dominant side) and grip strength (GS) measurement were recorded by the examiner. The final version of MHQ (Italian version), the Italian version of Disabilities of the Arm Shoulder and Hand (DASH) questionnaire, including the work section (Work-DASH).[2)] and the visual analogue scale (VAS) for pain measurement were administered.

DASH, VAS and GS were measured for construct validity assessment, as compared to MHQ. The DASH questionnaire is a multi-item scale (30 items), with scores ranging from 0–100, which measures symptoms and function in patients suffering from upper limb musculoskeletal disorders. A lower DASH score corresponds to better health status. Pain was measured through Visual Analogue Scale (VAS), with scores ranging from 0-10. GS was measured through the Jamar dynamometer, according to a standardized method.[27)]

A sample of 55 patients randomly chosen from among 136 patients were asked to complete the MHQ questionnaire again after 7 days (retest), a sufficient number to validate the scale according to the guidelines and the recent literature.[1,4,13,17,18,26)] All the data were analyzed by SPSS 20.0 software (Chicago, Illinois). Descriptive statistics were reported for questions (percentage and distribution of missing data, distribution of the answers, and mean and standard deviation to every question) and domains (lower and upper bound answer percentages were calculated for every scale, to identify ceiling and floor effect).

Multitrait analysis was used to assess the correlation between every single question and its hypothetic domain and the other domains. Item internal consistency, Equality of item scale correlation and item discriminant validity were assessed.[13,26)]

Reliability was assessed by internal consistency and test-retest. Cronbach's alpha coefficient measured internal consistency for every domain. Internal consistency higher than 0.70 indicates good reproducibility.[28)] Test-retest was measured by intraclass correlation coefficient (ICC). ICC values ranged from 0 to 1, with 1 indicating perfect reliability, and they were interpreted as follows: values less than 0.50 are indicative of poor reliability; values between 0.50 and 0.75 indicate moderate reliability; values between 0.75 and 0.90 indicate good reliability, and values greater than 0.90 indicate excellent reliability.[29)]

Construct validity was assessed calculating Spearman correlation coefficient between MHQ and DASH, VAS for pain, and grip strength of the injured hand.

Considering that in DASH, Work-DASH, and VAS, higher scores indicate worse results, inverse correlation was required. Pre-test hypothesis acceptance levels were chosen according to the literature[3)] as follows: a strong correlation was revealed if coefficient correlation was more than 0.6; an acceptable correlation was revealed if coefficient correlation was between 0.3 and 0.6; and a low correlation was revealed if coefficient correlation was less than 0.3.

RESULTS

In phase 1, neither linguistic nor lexical problems were detected. Hence no translation problems were detected. No major difficulties in comprehension were revealed during the pre-final version test. Patients took about 10 minutes to complete the questionnaire.

Data analysed in phase 2 were collected from 136 patients. There were 48 men (45.3%) and 88 women (64.7%); the average age was 57 years (SD: ± 15.7,

Table 1. Item Descriptive Statistics

Item	Missing (%)	Mean	SD	Response values frequency				
				1	2	3	4	5
Scale = F-R (overall function – right hand)								
F-R1	0.7	2.43	1.29	51	12	42	23	7
F-R2	0.7	2.25	1.24	54	24	32	19	6
F-R3	1.5	2.01	1.14	58	40	18	13	5
F-R4	0.0	2.46	1.37	52	16	32	25	11
F-R5	0.0	2.13	1.22	60	27	26	18	5
Scale = F-L (overall function – left hand)								
F-L1	0.0	1.90	1.27	83	12	19	16	6
F-L2	0.0	1.76	1.18	86	18	16	10	6
F-L3	0.0	1.59	1.01	93	20	11	10	2
F-L4	0.0	1.93	1.32	83	12	14	21	6
F-L5	0.0	1.67	1.11	88	24	11	7	6
Scale = ADL-R (activity of daily living – right hand)								
ADL-R1	0.0	1.69	1.12	90	16	16	10	4
ADL-R2	0.0	1.86	1.27	82	19	17	8	10
ADL-R3	0.0	1.66	1.12	92	17	13	9	5
ADL-R4	0.0	1.82	1.21	81	24	14	9	8
ADL-R5	1.5	1.96	1.30	75	22	14	14	9
Scale = ADL-L (activity of daily living – left hand)								
ADL-L1	0.0	1.46	0.99	106	10	10	7	3
ADL-L2	0.0	1.50	1.05	103	15	7	5	6
ADL-L3	0.0	1.39	0.87	108	11	11	4	2
ADL-L4	0.0	1.54	1.05	99	17	10	4	6
ADL-L5	0.7	1.63	1.18	97	14	8	9	7
Scale = ADL-B (activity of daily living – both hands)								
ADL-B1	1.5	3.05	1.43	23	31	28	20	32
ADL-B2	0.7	2.40	1.41	48	37	15	18	17
ADL-B3	0.7	2.02	1.27	68	27	17	15	8
ADL-B4	0.0	2.76	1.44	33	36	23	19	25
ADL-B5	2.9	2.14	1.35	62	29	10	22	9
ADL-B6	0.0	2.01	1.31	72	26	11	19	8
ADL-B7	0.7	2.21	1.34	54	40	11	18	12
Scale = W (work performance)								
W1	0.7	3.29	1.13	4	31	50	22	28
W2	0.0	3.41	1.18	5	29	40	29	33
W3	0.7	3.30	1.19	8	28	43	27	29
W4	1.5	3.36	1.19	8	23	47	25	31
W5	0.7	3.23	1.20	8	34	39	27	27
Scale = P (pain)								
P1	0.0	2.60	1.16	22	51	35	16	12
P2	2.2	2.97	1.03	5	40	59	12	17
P3	2.2	3.40	1.33	11	27	33	22	44
P4	0.7	3.25	1.23	12	24	45	26	28
P5	0.7	3.56	1.16	4	24	38	31	38
Scale = AE-R (aesthetics – right hand)								
AE-R1	0.0	3.93	1.14	4	12	33	27	60
AE-R2	0.0	4.12	1.14	2	15	23	21	75
AE-R3	0.0	4.32	1.04	3	8	16	24	85
AE-R4	0.0	4.29	0.96	1	6	24	26	79

Table 1. Continued

Item	Missing (%)	Mean	SD	Response values frequency				
				1	2	3	4	5
Scale = AE-L (aesthetics – left hand)								
AE-L1	0.7	4.37	1.05	2	12	10	21	90
AE-L2	1.5	4.43	1.00	3	7	11	21	92
AE-L3	0.0	4.64	0.79	2	3	5	22	104
AE-L4	0.0	4.60	0.79	1	4	8	23	100
Scale = S-R (satisfaction – right hand)								
S-R1	0.0	2.38	1.34	52	25	22	29	8
S-R2	0.0	2.29	1.31	54	29	21	24	8
S-R3	0.0	1.95	1.18	68	33	13	18	4
S-R4	0.0	2.51	1.46	56	15	15	40	10
S-R5	1.5	2.37	1.40	58	16	21	30	9
S-R6	2.9	2.16	1.26	59	31	15	27	4
Scale = S-L (satisfaction – left hand)								
S-L1	1.5	1.91	1.30	82	12	17	16	7
S-L2	2.2	1.73	1.19	87	18	11	11	6
S-L3	0.7	1.59	1.07	96	16	9	11	3
S-L4	0.0	1.92	1.34	84	14	11	19	8
S-L5	0.0	1.93	1.33	84	11	13	22	6
S-L6	0.0	1.65	1.11	91	21	8	12	4

F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand.

Table 2. Descriptive Statistics for Scales (Transformed Scores: 0–100)

Scale	Observed/possible values						
	Mean	SD	Lowest	Highest	Range	% at floor	% at ceiling
F-R	68.57	27.97	10/0	100/100	90/100	2.2	36.0
F-L	80.73	27.21	15/0	100/100	85/100	0.7	60.3
ADL-R	80.11	27.01	0/0	100/100	100/100	0.7	48.5
ADL-L	87.43	22.97	5/0	100/100	95/100	0.7	67.6
ADL-B	65.86	27.76	0/0	100/100	100/100	0.7	11.8
W	58.01	26.80	0/0	100/100	100/100	0.7	13.2
P	46.25	23.68	0/0	100/100	100/100	8.1	0.7
AE-R	79.27	23.32	6/0	100/100	94/100	0.7	39.0
AE-L	87.83	19.74	0/0	100/100	100/100	0.7	64.0
S-R	68.02	30.09	0/0	100/100	100/100	0.7	37.5
S-L	80.03	27.62	8/0	100/100	92/100	0.7	59.6

F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand.

median: 57). Dominant hand was affected in 80 patients (58.8%), non-dominant in 49 (36.1%), both in 7 (5.1%). Patients suffered from the following diseases: carpal tunnel syndrome (42 cases, 30.9%), osteoarthritis (39 cases, 28.7%), tendonitis (28 cases, 20.6%), Dupuytren disease (12 cases , 8.8%), ulnar nerve compression (8 cases, 5.9%), injury (7 cases, 5.1%). Education level was primary school in 7 patients (5.1%), early secondary school education in 20 (14.7%), high school graduation in 70 (51.5%), and tertiary in 39 (28.7%).

Descriptive statistics: questions (item level)

Results about descriptive statistics are reported in Table 1. Missing data varied from 0 to 2.9%. Patients used all the available response options. Scores deviated to the worst ones, as expected in a population of people affected by hand diseases except for the "aesthetics" domain, where the majority of the scores were among the higher ones.

Descriptive statistics: domains (scale level)

Table 2 shows normalized data. Mean values, standard deviation, proportion between higher value responses (ceiling) and lower value responses (floor) are reported. A ceiling effect was observed for all items, except for "pain", where a floor effect was observed.

Multitrait analysis

Data of multitrait analysis are reported in Appendix 2–4.

Item internal consistency

An appropriate item-domain correlation was proved in all domains. Correlations were 0.40 or more after overlap correction.

Equality of item-scale correlation

"Aesthetic aspect of the right hand" showed the highest item-domain correlation (0.19); nevertheless, each item contributes in the same measure to the overall score in every single domain.

Item discriminant validity

The correlation between each item and its own domain was higher in comparison with other domains. However, the correlation was not significant in all cases. The correlation between any item and its own scale was higher if compared with the correlation between any item and the other scales. The correlation ranged between 63.3% (everyday activity of right hand) and 91.7% (left hand's aesthetic aspect).

Reliability

Cronbach's alpha in the final version of MHQ ranged from 0.91 (aesthetic aspect of left hand) to 0.99 (right hand function) (Table 3).

Test-retest was performed on 55 patients who completed the questionnaire twice. Reproducibility was considered excellent. All the ICCs ranged between 0.83 (aesthetic aspect of left hand) and 0.98 (right hand function) (Table 4).

Construct validity

MHQ, DASH, VAS and GS were correlated for construct validity assessment, calculated on the whole sample. Results are reported in Table 5. A weak to moderate correlation has been found between MHQ subscales, and DASH grip strength.

DISCUSSION

The practitioners in the field of hand surgery and hand therapy require appropriate instruments to assess individuals' perceptions of hand function, pain, aesthet-

Table 3. Reliability Coefficients and Inter-Scale Correlations

Scale	F-R	F-L	ADL-R	ADL-L	ADL-B	W	P	AE-R	AE-L	S-R	S-L
F-R	**0.99**		0.81		0.43	0.31	0.37	0.62		0.93	
F-L		**0.97**		0.84	0.25	0.27	0.17		0.65		0.95
ADL-R	0.81		**0.98**		0.70	0.49	0.48	0.48		0.80	
ADL-L		0.84		**0.98**	0.43	0.37	0.24		0.53		0.83
ADL-B	0.43	0.25	0.70	0.43	**0.96**	0.73	0.68	0.19	0.10	0.46	0.24
W	0.31	0.27	0.49	0.37	0.73	**0.95**	0.78	0.12	0.07	0.37	0.25
P	0.37	0.17	0.48	0.24	0.68	0.78	**0.96**	0.14	0.05	0.47	0.15
AE-R	0.62		0.48		0.19	0.12	0.14	**0.93**		0.64	
AE-L		0.65		0.53	0.10	0.07	0.05		**0.91**		0.69
S-R	0.93		0.80		0.46	0.37	0.47	0.64		**0.99**	
S-L		0.95		0.83	0.24	0.25	0.15		0.69		**0.97**

F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand. Scale internal consistency reliability (cronbach's alpha) is presented in the diagonal.

ics and general satisfaction, in addition to objective measurements. A comprehensive assessment of the hand should certainly include a self-reported patient's point of view, in addition to objective measurements. DASH has been demonstrated to be appropriate and effective as PROM in the field of hand disorders.[2,15,30,31] However, there are some important differences between MHQ and DASH. MHQ is hand/wrist specific as compared with DASH. Furthermore, MHQ focuses on a single hand (side specific) and evaluates the impact of the disease on the dominant or non-dominant hand. Aesthetic features are considered only within MHQ. This is considered to be an interesting and unique component of MHQ, and it should not be overlooked in the whole evaluation of the hand.

Hence, a proper cross-cultural adaptation of MHQ is absolutely necessary for both clinical practice (to assess clinical evolution) and scientific production (to compare and integrate knowledge). The standardized method should be applied for a correct cross-cultural adaptation, to avoid misinterpretations derived from a simple translation.[13,25]

According to our results, the cross-cultural adaptation process achieved very good results in terms of psychometric properties. Our results are in accordance with previously published cross-cultural adaptations and validations of other national versions of the MHQ.[3,4,8,18,32]

During the translation and cross-cultural adaptation process (phase 1), much attention was given to the straightforwardness of the text. The Italian version of MHQ was written using simple vocabulary and terms in common use, to be easily understood and to allow completion as far as possible. As a result, the questionnaire has proved to be simple and comprehensible (a few missing data have been noted). The time used to complete the questionnaire form (10 minutes) was similar in reported literature, thus it should be considered appropriate.[18,33] The population analyzed was not healthy, thus the responses were predictably deviated towards the worse scores. On the other hand, better responses have been found in the aesthetics domain. In any case, the final version has demonstrated good psychometric properties. In terms of reliability, we found Cronbach's alpha coefficient ranging from 0.91 and 0.99 and ICC ranging from 0.83 and 0.98. The aforementioned ranges should be considered narrow, in accordance with other authors.[3,17,18] Therefore, we can conclude that the population we studied was appropriate both in terms of stability of clinical status between the two surveys and in terms of time elapsed between the two surveys (7 days).[18,21] In fact lower variability is expected in chronic disease, enough to guarantee a longer period between the two surveys, up to 2 weeks.[17,18]

Table 4. Intraclass Correlation Coefficients

Scale	ICC	95%CI	
		Lower limit	Upper limit
F-R	0.98	0.96	0.99
F-L	0.94	0.89	0.97
ADL-R	0.96	0.92	0.98
ADL-L	0.96	0.91	0.98
ADL-B	0.93	0.86	0.97
W	0.91	0.82	0.96
P	0.93	0.86	0.97
AE-R	0.87	0.75	0.94
AE-L	0.83	0.68	0.92
S-R	0.98	0.96	0.99
S-L	0.94	0.87	0.97

F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand.

Table 5. Construct Validity

	DASH (n = 75)		DASH work (n = 52)		VAS (pain) (n = 51)		Grip strength (n = 40)	
	r value	*p* value	r value	*p* value	r value	*p* value	r value	*p* value
Overall hand function	**–0.52**	**< 0.0001***	**–0.49**	**0.001***	**–0.50**	**< 0.0001***	**0.35**	**0.027***
Activities of daily living	**–0.65**	**< 0.0001***	**–0.36**	**0.008***	**–0.35**	**0.031***	**0.65**	**< 0.0001***
Work performance	**–0.62**	**< 0.0001***	**–0.47**	**0.003***	–0.19	0.123	**0.41**	**< 0.0001***
Pain	**0.52**	**< 0.0001***	**0.42**	**0.001***	**0.39**	**0.009***	–0.22	0.268
Aesthetic	**–0.41**	**< 0.0001***	**–0.35**	**0.021***	–0.15	0.532	**0.39**	**0.011***
Satisfaction with hand function	**–0.52**	**< 0.0001***	**–0.46**	**< 0.0001***	**–0.40**	**0.034***	**0.31**	**0.019***
Total	**–0.65**	**< 0.0001***	**–0.52**	**< 0.0001***	**–0.41**	**0.015***	**0.35**	**0.023***

Significant values are starred and reported in bold.

A Turkish study for cross-cultural adaptation of MHQ found an issue of interpretation in the aesthetics domain described by a significant but lower internal consistency (Cronbach's alpha coefficient = 0.76–0.79).[3] A higher internal consistency has been reported in the present study, in the same way as other studies for cross-cultural adaptation of MHQ reported.[17,18]

DASH questionnaire was chosen to investigate the construct validity in the present study, given its approved reliability as a standard instrument for the assessment of upper limb disorders. Construct validity investigation has given excellent results concerning correlation between MHQ and DASH questionnaires in every subscale. A good correlation was also found between VAS, grip strength and MHQ. However, a low correlation was found in some subscales ("aesthetics" and "work performance" for VAS pain and grip strength). However, this does not influence the construct validity. The excellent correlation between MHQ and DASH should be expected according to the literature and to the overall meaning, that is to evaluate the whole function of a body segment.

Although the study was performed in accordance with the standard guidelines, there could be some limitations. The examined sample was large enough to reach the validation of the MHQ Italian version; however, the study group could not be large enough to represent the Italian population.

In conclusion, the Italian version of MHQ has proved to be reliable and valid. Internal consistency, reliability and construct validity of the questionnaire support its great value.

ACKNOWLEDGMENTS

The authors thank Dr. Eileen Mckendrick for English language editing assistance.

CONFLICT OF INTEREST

The authors report no conflicts of interest.

FUNDING

The authors report no source of funding.

ETHICAL APPROVAL

The study was approved by the Institutional review board and ethical committee of our Institution on December 19th, 2013 (Università Cattolica del Sacro Cuore, Prot. n. 96/14, protocol 29390/13).

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Appendix 1

MICHIGAN HAND OUTCOME QUESTIONNAIRE (VERSIONE ITALIANA)

DATA _____ CODICE PAZIENTE_____

Per favore, risponda alle seguenti 37 domande a risposta multipla che si riferiscono alla funzionalità della sua mano e del suo polso nell'ultima settima:

1. **Complessivamente quanto funziona bene la sua mano?**

A- molto bene	**B-** bene	**C-** sufficientemente	**D-** scarsamente	**E-**molto scarsamente

2. **Quanto si muovono bene le sue dita?**

A- molto bene	**B-** bene	**C-** sufficientemente	**D-** scarsamente	**E-**molto scarsamente

3. **Quanto si muove bene il suo polso?**

A- molto bene	**B-** bene	**C-** sufficientemente	**D-** scarsamente	**E-**molto scarsamente

4. **Come giudica la forza della sua mano?**

A- molto buona	**B-** buona	**C-** sufficiente	**D-** scarsa	**E-**molto scarsa

5. **Come percepisce la sensibilità della sua mano?**

A- molto buona	**B-** buona	**C-** sufficiente	**D-** scarsa	**E-**molto scarsa

6. **Per lei, girare la maniglia di una porta è** difficile?

A- per niente	**B-** un po'	**C-** a volte	**D-** moderatamente	**E-**molto

7. **Prendere una moneta è difficile?**

A- per niente	**B-** un po'	**C-** a volte	**D-** moderatamente	**E-**molto

8. **Tenere in mano un bicchiere d'acqua è difficile?**

A- per niente	**B-** un po'	**C-** a volte	**D-** moderatamente	**E-**molto

9. Girare una chiave nella serratura è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

10. Tenere in mano una padella è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

11. Aprire un barattolo è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

12. Abbottonare una camicia o una giacca è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

13. Mangiare utilizzando coltello e forchetta è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

14. Trasportare una busta della spesa è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

15. Lavare i piatti è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

16. Lavarsi i capelli è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

17. Allacciare le scarpe o fare nodi è difficile?

A- per niente	**B**- un po’	**C**- a volte	**D**- moderatamente	**E**-molto

18. Quanto spesso non sei in grado di fare il tuo lavoro a causa di problemi al tuo polso e/o alla tua mano?

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

19. Quanto spesso devi ridurre il tuo lavoro giornaliero a causa di problemi a polso e/o mano?

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

20. Quanto spesso devi rallentare il tuo lavoro giornaliero a causa di problemi a polso e/o mano?

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

21. Quanto spesso rendi di meno nel tuo lavoro a causa di problemi a polso e/o mano?

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

22. Quanto spesso ci metti più tempo ad eseguire i compiti del tuo lavoro a causa di problemi a polso e/o mano?

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

23. **Quanto spesso hai dolore a polso e/o mano?**

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

24. Descrivi il dolore che percepisci al polso e/o alla mano

A- molto lieve	**B-** lieve	**C**- moderato	**D-** Severo	**E**-molto severo

25. **Quanto spesso il dolore interferisce con il sonno?**

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

26. Quanto spesso il dolore a polso e/o mano interferisce con le tue attività quotidiane (lavarsi, mangiare etc..) ?

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

27. **Quanto spesso il dolore a polso e/o mano interferisce con il tuo umore?**

A- sempre	**B-** spesso	**C**- a volte	**D-** Raramente	**E**-mai

28. Sono soddisfatto dell'aspetto estetico della mia mano?

A- sempre	**B-** spesso	**C-** a volte	**D-** Raramente	**E-**mai

29. L'aspetto estetico della mia mano alcune volte mi crea imbarazzo in pubblico

A- sono molto d'accordo con questa affermazione	**B-** sono d'accordo con questa affermazione	**C-** non sono né d'accordo né in disaccordo	**D-** sono in disaccordo con questa affermazione	**E-** sono fortemente in disaccordo con questa affermazione

30. L'aspetto estetico della mia mano mi rende depresso

A- sono molto d'accordo con questa affermazione	**B-** sono d'accordo con questa affermazione	**C-** non sono né d'accordo né in disaccordo	**D-** sono in disaccordo con questa affermazione	**E-** sono fortemente in disaccordo con questa affermazione

31. L'aspetto estetico della mia mano interferisce con le mie consuete attività sociali

A- sono molto d'accordo con questa affermazione	**B-** sono d'accordo con questa affermazione	**C-** non sono né d'accordo né in disaccordo	**D-** sono in disaccordo con questa affermazione	**E-** sono fortemente in disaccordo con questa affermazione

32. Giudico la funzione complessiva della mia mano:

A- molto soddisfacente	**B-** piuttosto soddisfacente	**C-** né soddisfacente né insoddisfacente	**D-** piuttosto insoddisfacente	**E-** molto insoddisfacente

33. **Giudico la motilità delle dita della mia mano:**

A- molto soddisfacente	**B-** piuttosto soddisfacente	**C-** né soddisfacente né insoddisfacente	**D-** piuttosto insoddisfacente	**E-** molto insoddisfacente

34. Giudico la motilità del mio polso:

A- molto soddisfacente	**B-** piuttosto soddisfacente	**C-** né soddisfacente né insoddisfacente	**D-** piuttosto insoddisfacente	**E-** molto insoddisfacente

35. Giudico il livello di forza della mia mano:

A- molto soddisfacente	**B**- piuttosto soddisfacente	**C**- né soddisfacente né insoddisfacente	**D**- piuttosto insoddisfacente	**E**- molto insoddisfacente

36. Giudico il livello di dolore della mia mano:

A- molto soddisfacente	**B**- piuttosto soddisfacente	**C**- né soddisfacente né insoddisfacente	**D**- piuttosto insoddisfacente	**E**- molto insoddisfacente

37. Giudico il livello di sensibilità della mia mano:

A- molto soddisfacente	**B**- piuttosto soddisfacente	**C**- né soddisfacente né insoddisfacente	**D**- piuttosto insoddisfacente	**E**- molto insoddisfacente

Appendix 2. Pearson Item-Scale Correlations (Corrected for Overlap*)

Item	F-R	F-L	ADL-R	ADL-L	ADL-B	W	P	AE-R	AE-L	S-R	S-L
Scale = F-R (overall function – right hand)											
F-R1	0.92**		0.73		0.35	0.25	0.29	0.60		0.86	
F-R2	0.81*		0.73		0.34	0.19	0.21	0.63		0.79	
F-R3	0.75*		0.66		0.35	0.35	0.38	0.38		0.74	
F-R4	0.91*		0.79		0.45	0.36	0.42	0.58		0.90	
F-R5	0.76*		0.71		0.40	0.26	0.33	0.54		0.73	
Scale = F-L (overall function – left hand)											
F-L1		0.95*		0.81	0.24	0.25	0.15		0.65		0.92
F-L2		0.90*		0.79	0.26	0.24	0.13		0.65		0.87
F-L3		0.79*		0.73	0.22	0.30	0.20		0.49		0.79
F-L4		0.92*		0.85	0.26	0.26	0.15		0.64		0.90
F-L5		0.82*		0.69	0.18	0.21	0.15		0.53		0.82
Scale = ADL-R (activity of daily living – right hand)											
ADL-R1	0.73		0.83*		0.60	0.47	0.47	0.38		0.70	
ADL-R2	0.73		0.80*		0.60	0.44	0.43	0.39		0.72	
ADL-R3	0.69		0.84*		0.67	0.42	0.44	0.46		0.70	
ADL-R4	0.75		0.87*		0.64	0.43	0.42	0.38		0.72	
ADL-R5	0.75		0.85*		0.63	0.43	0.41	0.52		0.75	
Scale = ADL-L (activity of daily living – left hand)											
ADL-L1		0.75		0.84*	0.40	0.37	0.27		0.46		0.74
ADL-L2		0.71		0.74*	0.32	0.28	0.16		0.45		0.67
ADL-L3		0.71		0.81*	0.40	0.24	0.16		0.47		0.67
ADL-L4		0.78		0.90*	0.40	0.35	0.23		0.50		0.77
ADL-L5		0.81		0.86*	0.42	0.39	0.25		0.50		0.83
Scale = ADL-B (activity of daily living – both hands)											
ADL-B1	0.25	0.30	0.47	0.38	0.72*	0.70	0.64	0.00	0.08	0.31	0.27
ADL-B2	0.35	0.15	0.56	0.29	0.71*	0.59	0.54	0.13	0.04	0.38	0.11
ADL-B3	0.37	0.19	0.61	0.41	0.76*	0.56	0.50	0.23	0.07	0.39	0.19
ADL-B4	0.36	0.25	0.51	0.37	0.71*	0.59	0.58	0.11	0.03	0.38	0.25
ADL-B5	0.32	0.25	0.58	0.39	0.80*	0.60	0.54	0.18	0.14	0.36	0.25
ADL-B6	0.39	0.12	0.62	0.31	0.73*	0.55	0.52	0.26	0.11	0.41	0.14
ADL-B7	0.40	0.17	0.66	0.34	0.78*	0.58	0.56	0.22	0.12	0.42	0.18
Scale = W (work performance)											
W1	0.26	0.25	0.40	0.33	0.66	0.81*	0.66	0.12	0.06	0.30	0.23
W2	0.29	0.22	0.45	0.30	0.66	0.88*	0.72	0.11	0.02	0.36	0.20
W3	0.30	0.22	0.46	0.32	0.65	0.88*	0.73	0.09	0.02	0.33	0.21
W4	0.30	0.26	0.47	0.36	0.70	0.86*	0.74	0.13	0.12	0.37	0.24
W5	0.28	0.30	0.44	0.37	0.69	0.87*	0.73	0.11	0.12	0.34	0.27
Scale = P (pain)											
P1	0.25	0.21	0.35	0.24	0.56	0.67	0.70*	0.13	0.06	0.35	0.19
P2	0.36	0.07	0.44	0.16	0.57	0.64	0.75*	0.13	0.11	0.42	0.07
P3	0.30	0.05	0.28	0.03	0.38	0.47	0.61*	0.05	0.13	0.38	0.00
P4	0.33	0.18	0.49	0.29	0.71	0.76	0.79*	0.12	0.03	0.43	0.18
P5	0.24	0.16	0.39	0.26	0.54	0.53	0.59*	0.14	0.05	0.32	0.17
Scale = AE-R (aesthetics – right hand)											
AE-R1	0.64		0.47		0.15	0.08	0.10	0.64*		0.61	
AE-R2	0.52		0.39		0.16	0.09	0.06	0.83*		0.54	
AE-R3	0.46		0.38		0.21	0.13	0.14	0.80*		0.51	
AE-R4	0.52		0.42		0.18	0.14	0.19	0.81*		0.58	

Appendix 2. Continued

Item	F-R	F-L	ADL-R	ADL-L	ADL-B	W	P	AE-R	AE-L	S-R	S-L
Scale = AE-L (aesthetics – left hand)											
AE-L1		0.56		0.41	0.03	0.03	0.11		0.67*		0.61
AE-L2		0.63		0.52	0.13	0.07	0.05		0.83*		0.61
AE-L3		0.51		0.47	0.18	0.10	0.00		0.80*		0.58
AE-L4		0.55		0.48	0.12	0.15	0.01		0.80*		0.60
Scale = S-R (satisfaction – right hand)											
S-R1	0.90		0.80		0.46	0.37	0.42	0.63		0.94*	
S-R2	0.80		0.73		0.40	0.28	0.30	0.65		0.81*	
S-R3	0.81		0.70		0.45	0.37	0.47	0.47		0.83*	
S-R4	0.89		0.74		0.43	0.38	0.49	0.60		0.92*	
S-R5	0.83		0.72		0.39	0.32	0.44	0.58		0.87*	
S-R6	0.82		0.68		0.39	0.32	0.44	0.55		0.87*	
Scale = S-L (satisfaction – left hand)											
S-L1		0.90		0.79	0.22	0.20	0.12		0.66		0.91*
S-L2		0.81		0.75	0.24	0.23	0.11		0.66		0.83*
S-L3		0.80		0.70	0.24	0.32	0.20		0.56		0.82*
S-L4		0.90		0.83	0.25	0.26	0.15		0.61		0.93*
S-L5		0.81		0.71	0.16	0.16	0.10		0.60		0.84*
S-L6		0.81		0.67	0.21	0.19	0.14		0.62		0.82*

Starred correlations were hypothesized to be highest in same row. F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand.

Appendix 3. Item-Level Discriminant Validity Tests

Item	F-R	F-L	ADL-R	ADL-L	ADL-B	W	P	AE-R	AE-L	S-R	S-L
Scale = F-R (overall function – right hand)											
F-R1	*		2		2	2	2	2		1	
F-R2	*		1		2	2	2	2		1	
F-R3	*		1		2	2	2	2		1	
F-R4	*		1		2	2	2	2		1	
F-R5	*		1		2	2	2	2		1	
Scale = F-L (overall function – left hand)											
F-L1		*		1	2	2	2		2		1
F-L2		*		1	2	2	2		2		1
F-L3		*		1	2	2	2		2		1
F-L4		*		1	2	2	2		2		1
F-L5		*		1	2	2	2		2		1
Scale = ADL-R (activity of daily living – right hand)											
ADL-R1	1		*		2	2	2	2		1	
ADL-R2	1		*		2	2	2	2		1	
ADL-R3	1		*		1	2	2	2		1	
ADL-R4	1		*		2	2	2	2		1	
ADL-R5	1		*		2	2	2	2		1	
Scale = ADL-L (activity of daily living – left hand)											
ADL-L1		1		*	2	2	2		2		1
ADL-L2		1		*	2	2	2		2		1
ADL-L3		1		*	2	2	2		2		1
ADL-L4		1		*	2	2	2		2		1
ADL-L5		1		*	2	2	2		2		1
Scale = ADL-B (activity of daily living – both hands)											
ADL-B1	2	2	2	2	*	1	1	2	2	2	2
ADL-B2	2	2	1	2	*	1	1	2	2	2	2
ADL-B3	2	2	1	2	*	2	2	2	2	2	2
ADL-B4	2	2	2	2	*	1	1	2	2	2	2
ADL-B5	2	2	2	2	*	2	2	2	2	2	2
ADL-B6	2	2	1	2	*	2	2	2	2	2	2
ADL-B7	2	2	1	2	*	2	2	2	2	2	2
Scale = W (work performance)											
W1 0.640	2	2	2	2	1	*	1	2	2	2	2
W2 0.711	2	2	2	2	2	*	1	2	2	2	2
W3 0.708	2	2	2	2	2	*	1	2	2	2	2
W4 0.684	2	2	2	2	1	*	1	2	2	2	2
W5 0.697	2	2	2	2	2	*	1	2	2	2	2
Scale = P (pain)											
P1 0.528	2	2	2	2	1	1	*	2	2	2	2
P2 0.577	2	2	2	2	2	1	*	2	2	2	2
P3 0.436	2	2	2	2	2	1	*	2	2	2	2
P4 0.617	2	2	2	2	1	1	*	2	2	2	2
P5 0.419	2	2	2	2	1	1	*	2	2	2	2
Scale = AE-R (aesthetics – right hand)											
AE-R1 0.466	1		1		2	2	2	*		1	
AE-R2 0.661	2		2		2	2	2	*		2	
AE-R3 0.628	2		2		2	2	2	*		2	
AE-R4 0.642	2		2		2	2	2	*		2	

Appendix 3. Continued

Item	F-R	F-L	ADL-R	ADL-L	ADL-B	W	P	AE-R	AE-L	S-R	S-L
Scale = AE-L (aesthetics – left hand)											
AE-L1 0.497		1		2	2	2	2		*		1
AE-L2 0.656		2		2	2	2	2		*		2
AE-L3 0.625		2		2	2	2	2		*		2
AE-L4 0.628		2		2	2	2	2		*		2
Scale = S-R (satisfaction – right hand)											
S-R1 0.764	1		1		2	2	2	2		*	
S-R2 0.638	1		1		2	2	2	1		*	
S-R3 0.610	1		1		2	2	2	2		*	
S-R4 0.752	1		2		2	2	2	2		*	
S-R5 0.697	1		1		2	2	2	2		*	
S-R6 0.696	1		2		2	2	2	2		*	
Scale = S-L (satisfaction – left hand)											
S-L1 0.739		1		1	2	2	2		2		*
S-L2 0.657		1		1	2	2	2		1		*
S-L3 0.624		1		1	2	2	2		2		*
S-L4 0.760		1		1	2	2	2		2		*
S-L5 0.666		1		1	2	2	2		2		*
S-L6 0.646		1		1	2	2	2		2		*

*Discriminant validity test not conducted. F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand.

Appendix 4. Frequency and Percentage of Item-Scale Correlations at Each Level of Scaling Process

Scale	–2		–1		1		2		1 + 2	
	n	%	n	%	n	%	n	%	n	%
F-R	0	0.0	0	0.0	9	30.0	21	70.0	30	100.0
F-L	0	0.0	0	0.0	10	33.3	20	66.7	30	100.0
ADL-R	0	0.0	0	0.0	11	36.7	19	63.3	30	100.0
ADL-L	0	0.0	0	0.0	10	33.3	20	66.7	30	100.0
ADL-B	0	0.0	0	0.0	10	14.3	60	85.7	70	100.0
W	0	0.0	0	0.0	7	14.0	43	86.0	50	100.0
P	0	0.0	0	0.0	8	16.0	42	84.0	50	100.0
AE-R	0	0.0	0	0.0	3	12.5	21	87.5	24	100.0
AE-L	0	0.0	0	0.0	2	8.3	22	91.7	24	100.0
S-R	0	0.0	0	0.0	11	30.6	25	69.4	36	100.0
S-L	0	0.0	0	0.0	13	36.1	23	63.9	36	100.0

F-R: Overall Function-Right Hand, F-L: Overall Function-Left Hand, ADL-R: Activity of Daily Living-Right Hand, ADL-L: Activity of Daily Living-Left Hand, ADL-B: Activity of Daily Living-Both Hands, W: Work Performance, P: Pain, AE-R: Aesthetics-Right Hand, AE-L: Aesthetics-Left Hand, S-R: Satisfaction-Right Hand, S-L: Satisfaction-Left Hand.