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VALIDATION STUDIES

Validity and interpretability of the QuickDASH in the assessment of hand disability in rheumatoid arthritis

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Abstract

Objective of this study is to evaluate the construct validity and the interpretability of the shortened Disability of Arm, Shoulder and Hand Questionnaire (QuickDASH) in the assessment of rheumatoid arthritis (RA) hand disability. Consecutive RA patients were assessed through the QuickDASH and other function and disease activity indices, respectively, the Health Assessment Questionnaire-Disability Index (HAQ-DI) and the Recent-Onset Arthritis Disability questionnaire (ROAD). For each patient were evaluated the tender and swollen 28-joints counts. Interpretability was defined determining cut-off points of impairment in accordance to the Simplified Disease Activity Index (SDAI) definition of disease activity states. A total of 440 patients (89 men and 351 women, mean age of 57.0 ± 12.7 years) were enrolled. Following the SDAI definition, 98 patients (22.3%) resulted in REM, 115 subjects (26.1%) in LDA, 74 patients (16.8%) in MDA, and 153 subjects (34.8%) in HDA. Mean QuickDASH differed significantly between patients classified as remission (REM), low disease activity (LDA), moderate disease activity (MDA), or high disease activity (HDA) ($p < 0.001$). High correlations were found comparing QuickDASH to composite indices of disease activity and of physical health function: of special interest are the correlations between the comparable dimension of the QuickDASH and the ROAD Upper Extremity Function (rho = 0.876; $p < 0.001$). The cut-off points for functional categories (SDAI categories as external criterion) resulted: no impairment ≤ 13, 13 < low impairment ≤ 18.5, 18.5 < moderate impairment ≤ 31.5, and high impairment > 31.5. QuickDASH is useful in clinical practice, for its ease of administration, and positively correlates with the disease activity. It may be a surrogate for evaluating upper extremity impairment, disability index and disease control in RA patients.

Keywords Rheumatoid arthritis · Hand disability · Disease activity · QuickDASH · Patient-reported outcomes

Introduction

Rheumatoid arthritis (RA) is one of the most common disorder causing hand impairment, both in terms of strength and dexterity [1, 2].

Different regional outcome measures, focused on the upper extremity, site specific or disease specific, are available from many years [3], and this kind of patient-reported measures have become integral for assessing impairments in research studies as well as clinical practice.

Among patient-reported outcomes (PROs), several questionnaires to quantify the hand involvement in RA have been elaborated. Historically, the Health Assessment Questionnaire–Disability Index (HAQ-DI) [4], the Duruöz Hand Index [5], the Arthritis Hand Function Test [6], or the Arthritis Impact Measurement Scales 2 (AIMS2) [7], represented the primary measures of physical function in RA. However, these tools have been criticized for different features: the floor and

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ceiling effects are limitations of HAQ-DI, for example, while length, requiring more than 20 min to be filled in, is a critical issue if AIMS2. More recently, the Recent-Onset Arthritis Disability questionnaire (ROAD) has been developed [8]. Easy to be filled in, the questionnaire can be split into the sections for the upper and for the lower limbs. However, a major gap is represented by the need of a mathematical normalization for the interpretation of the results.

One of the most extensively employed instrument to assess the upper extremity function, across different conditions, is the Disability of the Arm, Shoulder and Hand questionnaire (DASH) [9–13]. DASH is a 30-item tool, with an optional section to identify specific professional difficulties. Reliability was tested on cross-sectional and longitudinal studies in different hand, arm, and shoulder disorders. DASH is used from many years in different settings, both in clinical trials and in other studies focused on the upper extremity disorders. The instrument is available in many languages.

The original DASH questionnaire, probably too long to be currently employed, has been shortened in the QuickDASH version using a "concept-retention" approach [14]. The QuickDASH may be more appealing than the DASH: is a shorter questionnaire (consisting of 11 items from the original DASH), and is associated with a minor burden on the responder as well as less administrative obligations. Recently, QuickDASH demonstrated good clinimetric properties in RA patients, showing to correlate with Disease Activity Score-28 joints (DAS28) in two different cohorts, to be sensitive to change in RA disease activity, including elderly patients (≥ 65 years), and to correlate with objective measures of handgrip strength [15, 16].

While the minimal clinically important difference (MCID) has been determined, both for DASH and QuickDASH [17], one of the major issues in interpreting QuickDASH is the lack of cut-off values to distinguish between functional categories. Cut-off values greatly reinforce the meaning of an ordinal scale in clinical practice. Moreover, for a research purpose, if the same measure is being employed across different settings, cut-offs allows the comparison of data and can be employed for clinical benchmarking.

The aim of this study was to evaluate, in the rheumatologic setting, the performance of the QuickDASH in terms of construct validity and the interpretability in the assessment of RA hand disability. In particular, interpretability was evaluated defining the QuickDASH cut-off points to distinguish the impairment categories.

Materials and methods

Study population

Between March 2014 and October 2017, consecutive RA patients (89 men and 351 women, mean age of 57.0 ± 12.7 years), were enrolled from the outpatient clinic of an Italian tertiary rheumatology center. Eligibility criteria were: age > 18 years, adult-onset RA as defined by the 2010 American College of Rheumatology/European League Against Rheumatism classification criteria [18]. Patients were excluded if suffering from conditions contraindicating the introduction of immunosuppressants (i.e., severe ongoing infections); if suffering from neurologic disorders including Parkinson's disease, Alzheimer's disease, or stroke; if suffering of major organ failure (i.e., hearth failure, chronic kidney disease—defined as a glomerular filtration rate ≤ 30 mL/min/1.73 m^2) or malignancy; or if suffering from conditions able to interfere with the articular assessment (i.e., depression or fibromyalgia).

Patients were categorized in the disease activity states according to the Simplified Disease Activity Index (SDAI) definition: remission (REM), low disease activity (LDA), moderate disease activity (MDA), or high disease activity (HDA).

All patients were receiving at least one conventional disease-modifying antirheumatic drug (cDMARD) (methotrexate, leflunomide, sulphasalazine, or hydroxychloroquine), or a biologic DMARD (bDMARD) (infliximab, etanercept, adalimumab, certolizumab pegol, golimumab, abatacept, or tocilizumab).

Demographics, clinical assessment and composite disease activity indices

Demographic features and all the core set of measures have been extrapolated from the internal center database. These data included age, gender, and disease duration (defined as years after diagnosis). The presence of the following comorbidities was also evaluated: hypertension, myocardial infarction, lower extremity arterial disease, major neurological problems, diabetes, gastrointestinal disease, chronic respiratory disease, kidney disease, and poor vision. Laboratory assessment comprised the following points: the presence of the rheumatoid factor (RF), the anti-citrullinated protein antibodies (ACPA), the C-reactive protein level (CRP), and the erythrocyte sedimentation rate (ESR). The clinical evaluation included the following items: the swollen joint count 28-joints (SJC) and the tender joint count 28-joints (TJC), patient self-administered TJC (self-TJC), the pain Numerical Rating Scale (NRS-pain), the Physician and Patient Global Assessments of disease activity (PhGA and PaGA, respectively) by NRS, and the patient assessment of General Health status (GH). PhGA was estimated by the statement: "please mark below your assessment of the patient's current disease activity", on a 0–10 NRS (where 0 = "no activity" and 10 = "very active"). PaGA was assessed by the question: "in terms of joint tenderness (i.e., joint pain associated with light touch) and joint swelling (i.e., joint

enlargement due to inflammation), how active would you say your rheumatic condition is today?", on a 0–10 NRS, with "not active at all" and "extremely active" as anchors. These variables were used to calculate composite disease activity indices, respectively, the DAS28, the Clinical Disease Activity Index (CDAI), the SDAI, and the Patient-Reported Outcomes CLinical ARthritis Activity (PRO-CLARA) [19–23]. The disease activity assessment is the "core business" of the rheumatological daily practice.

Functional measures

All patients completed the QuickDASH [14, 24], the HAQ-DI [4], and the ROAD [8]. In comparison to the original DASH, the QuickDASH is shortened to 11 items, allowing it to be widely used in clinical practice [25, 26]. To be computed, at least 10 of the 11 items must be completed [27]. The QuickDASH tool uses a 5-point Likert scales in which the patient select the appropriate value corresponding to the level of function impairment [28]. The values of all the completed answers are merely summed and averaged, giving a score from 1 to 5. This value is then turned to a 0–100 scale by subtracting one and multiplying by 25. Higher scores indicate greater disability (0 = no disability, 100 = most severe disability). In the present study, we used the Italian validated QuickDASH version [17, 29].

The main features of HAQ-DI, ROAD, as well as of the composite disease activity indices are summarized in Table 1.

Statistical analysis

Data were stored in a Microsoft Excel database and processed with SPSS 11.0, and MedCalc 11.3.1.0 (statistical software packages for Windows XP). Parametric techniques may be applicable for certain ordinal level data; however, our data were generally not normally distributed (Kolomogorov–Smirnov test for normal distribution), and therefore, the use of non-parametric techniques provided a more conservative estimate of statistical significance. Where appropriate, median and interquartile ranges (IQR) are presented as well as means and standard deviations (SD).

The construct validity of the QuickDASH was investigated in two ways. First, we explored the convergent validity of the questionnaire. Convergent validity examines the extent to which a particular measurement relates to other measurements that is believed to be assessing the same construct. In the absence of a true 'gold standard' against which to assess criterion validity of the QuickDASH, we compared this questionnaire with commonly used external measurements reflecting the impact of RA on physical health function (HAQ-DI and ROAD) and with composite disease activity indices. Spearman's Rho correlation coefficients were used to test convergent validity of the QuickDASH. Second, we investigated a possible influence of patient characteristics, such as age, gender, educational level, and the number of comorbidities on the QuickDASH. The associations between the total score and these characteristics were analyzed using the chi-squared test (discriminant validity). The Kruskal–Wallis and Wilcoxon tests were performed to evaluate the relationships between the different levels of QuickDASH scores and these sociodemographic features.

The interpretability was substantiated categorizing patients in the four disease activity states of SDAI. In each SDAI disease activity status, the QuickDASH arithmetic means with SDs, medians, and the 25th and 75th percentiles have been calculated. To define the QuickDASH cut-off values between disease activity states, the "reconciliation approach" between the 75th and 25th percentiles mean values of adjacent ranks has been used. This method to define cut-off points has been already described and accepted in the rheumatologic literature [30–32]. More in detail, first of all data were categorized according to the four SDAI disease activity states (respectively, SDAI REM, SDAI LDA, SDAI MDA, and SDAI HDA). Then, the attention was focused on the 25th and 75th percentiles QuickDASH mean values of the four categories. Starting from the lower disease activity states, the cut-off between REM and MDA has been attained considering the QuickDASH mean value of the 75th percentile of REM (the "lower" rank) and the QuickDASH mean value of the 25th percentile of LDA (the "higher" rank). We computed the arithmetic mean between these two values, and if necessary the mean has been settled to the first decimal number. The value obtained represents the cut-off point in the transition from REM to LDA. The same method, namely the arithmetic mean adjusted to the first decimal number between the mean QuickDASH values of the 75th percentile of the lower disease activity status, and the 25th percentile of the adjacent higher disease activity status, has been used to define the QuickDASH cut-off in the transition from LDA and MDA, and from MDA to HDA. Since QuickDASH is a measure of function and not of disease activity, SDAI REM was referred as "no impairment", SDAI LDA as "low impairment", SDAI MDA as "moderate impairment", and SDAI HDA as "high impairment".

Lastly, we assessed the presence of floor and ceiling effects, by examining the frequency of the highest and lowest possible scores at baseline. Floor effect was considered present if more than 15% of the patients had a minimal score at baseline, ceiling effect was considered present if more than 15% of the patients had a maximum baseline score.

Table 1 Overview of the disease activity indices and the functional measures

Disease activity indices	Main features
Disease Activity Score 28 joints (DAS28) [18]	DAS28 includes the swollen and tender 28-joint counts, in addition to the global health status (0–100) and to the erythrocyte sedimentation rate or C-reactive protein values. It is computed by entering these four variables into a Web calculator (http://www.das-score.nl/www.das-score.nl/index.htm). It ranges from 0 (totally inactive disease) to 9.4 (very active disease). Cut-off points: remission—DAS28 ≤ 2.6, low disease activity—2.6 < DAS28 ≤ 3.2, moderate disease activity—3.2 < DAS28 ≤ 5.1, high disease activity—DAS28 > 5.1
Simplified Disease Activity Index (SDAI) [17]	SDAI employs the linear sum of five untransformed and unweighted variables, including swollen 28-joint count, tender 28-joint count, patient global assessment of disease activity, physician global assessment of disease activity, and C-reactive protein (in mg/dL), with a range from 0 to 86. Cut-off points: remission—SDAI ≤ 3.3, low disease activity—3.3 < SDAI ≤ 11, moderate disease activity—11 < SDAI ≤ 26, high disease activity—SDAI > 26
Clinical Disease Activity Index (CDAI) [17]	CDAI is a modification of the SDAI; it does not consider the C-reactive protein. CDAI allows an immediate clinical assessment. Cut-off points: remission—CDAI ≤ 2.8, low disease activity—2.8 < CDAI ≤ 10, moderate disease activity—10 < CDAI ≤ 22, high disease activity—CDAI > 22
Patient-Reported Outcomes CLinical ARthritis Activity (PRO-CLARA) [21]	PRO-CLARA combines three domains: patient's physical function (as measured by Recent-Onset Arthritis Disability [ROAD] questionnaire), self-administered tender joint count and patient global assessment of disease activity into a single measure. The self-administered tender joint count is assessed according to joint list of the Rheumatoid Arthritis Disease Activity Index (RADAI). The RADAI joint mannequin list asks pain "today" in 16 joints or joint groups, including left and right shoulders, elbows, wrists, fingers, hips, knees, ankles, and toes. The self-administered tender joint count weights the degree of tenderness of each joint on the following scale: 0 = none; 1 = mild; 2 = moderate; 3 = severe. The self-administered tender joint count is scored from 0 to 48, and the raw 0–48 score can be encoded to a 0–10 scale using the scoring template. PRO-CLARA total score is obtained by the sum of the scores of the three individual measures and dividing this by three. The final value ranges from 0 to 10. Cut-off points: remission—PRO-CLARA ≤ 2, low disease activity—2 < PRO-CLARA ≤ 3.3, moderate disease activity—3.3 < PRO-CLARA ≤ 5, high disease activity—PRO-CLARA > 5
Functional measures	
Health Assessment Questionnaires Disability Index (HAQ-DI) [4]	HAQ-DI assesses the patient's physical function in daily life activities. It estimates the degree of difficulty in accomplishing tasks in eight functional areas: dressing and grooming, arising, eating, walking, hygiene, reach, grip, activities. For each item, patients are asked to rate level of difficulty over the past week on a 4-point scale, which ranges from 0 (no difficulty) to 3 (unable to perform), with higher scores indicating more disability. For each functional area is considered the greater value. The HAQ-DI final score is given by the mean of the 8 scales. Cut-off points: none disability—HAQ-DI < 0.5, mild disability—0.5 ≤ HAQ-DI < 1, moderate disability—1 ≤ HAQ-DI < 2, severe disability—HAQ-DI ≥ 2

Table 1 (continued)

Disease activity indices	Main features
Recent-Onset Arthritis Disability questionnaire (ROAD) [6]	ROAD consists of 12 items assessing the subject's level of functional ability, including items exploring the fine movements of the upper extremity, tasks of the lower extremity, and functions involving both upper and lower limbs. For each item, patients are asked to rate level of difficulty over the past week on a 5-point scale, which ranges from 0 (without any difficulty) to 4 (unable to do). The ROAD ranges from 0 to 48. To express these scores in a more clinically meaningful format, with an easy mathematical normalization procedure the result can be expressed in the range 0–10, with 0 representing better status and 10 representing poorer status. Cut-off points: none disability—ROAD < 1.5, mild disability—1.5 ≤ ROAD < 3, moderate disability—3 ≤ ROAD < 7, severe disability—ROAD ≥ 7 The only Upper Extremity Function subscore of the ROAD has used in the present study

Results

Demographic and clinical data

Of 498 subjects participating in the study, 58 patients (11.6%) were excluded due to incomplete data: the principal reasons were forgetting or discomfort to refer the questions. Patients with incomplete data were significantly older (69.6 years, $p < 0.001$). In total, 440 patients were analyzed: 89 men and 351 women (79.8%), with a mean age of 57.0 ± 12.7 years (range 19–80 years). The majority of the patients were ACPA (70.7%) or RF (73.9%) positive. The mean disease duration at baseline was 6.1 years (SD = 6.1). Of the 440 subjects enrolled, 181 (41.1%) reported one or more medical comorbidities where the most prevalent combinations were arterial hypertension (9.1%), hypercholesterolemia (8.8%), cardiologic diseases (7.0%), digestive diseases (6.8%), and diabetes mellitus (5.4%).

Three hundred and ninety-one (88.8%) patients were taking a cDMARD (in particular 283–64.3%, were taking methotrexate), while 277 (62.9%) were receiving a bDMARD. Respectively, 71 (16.1%) were taking adalimumab, 66 (15.0%) etanercept, 51 (11.6%) golimumab, 50 (11.4%) abatacept, 29 (6.6%) tocilizumab, and 10 (2.3%) infliximab. 93 patients (21.1%) were taking oral corticosteroids at a mean prednisone or equivalent dose of 5.6 mg/day (range 2.5–25), and 125 (28.4%) were prescribed non-steroidal anti-inflammatory drugs on demand. Demographic and clinical characteristics of the study population are summarized in Table 2.

Following the SDAI definition, 98 patients (22.3%) resulted in REM, 115 subjects (26.1%) in LDA, 74 patients (16.8%) in MDA, and 153 subjects (34.8%) in HDA. Mean QuickDASH differed significantly between patients classified as REM, LDA, MDA or HDA ($p < 0.001$), and minimum and maximum QuickDASH scores for each disease activity state were: 3 and 19 in REM, 6 and 55 in LDA, 7 and 56 in MDA, 11 and 66 in HDA.

Construct validity

In testing for the convergent validity, we found higher significant correlations comparing QuickDASH to composite indices of disease activity such as DAS28 (rho = 0.779; $p < 0.001$), CDAI (rho = 0.778; $p < 0.001$), SDAI (rho = 0.748; $p < 0.001$), and PRO-CLARA (rho = 0.808; $p < 0.001$) (Table 3), with a high ability to measure physical health function (HAQ-DI rho = 0.867; $p < 0.0001$). Of special interest are the correlations between the comparable dimension of the QuickDASH and the ROAD Upper Extremity Function (rho = 0.876; $p < 0.001$) (convergent construct validity). Lower significant correlations were seen when QuickDASH was compared to CRP (rho = 0.160, $p = 0.001$), and ESR (rho = 0.429, $p < 0.001$). No correlation was found with socio-demographic variables such as age (rho = 0.026; $p = 0.692$), RA disease duration (rho = 0.106; $p = 0.103$). A small correlation was revealed with number of comorbidities (rho = 0.150; $p = 0.021$) (divergent construct validity).

Interpretability

The comparison of the QuickDASH scores to the other clinimetric variables in the different disease activity states is reported in Table 4. Based on the percentile distributions of QuickDASH in these groups, the cut-off values obtained are: no impairment ≤ 13, 13 < low impairment ≤ 18.5, 18.5 < moderate impairment ≤ 31.5, and high impairment > 31.5. Concentrating on the approach of the 75th–25th percentile mean values of adjacent categories to define the cut-off points, in the transition from SDAI REM to SDAI LDA, the percentile values considered were 11 (mean value of the QuickDASH at 75th percentile of SDAI REM) and 15

Table 2 Demographic data and the mean (SD) and median (25–75 percentiles) QuickDASH, ROAD Upper Extremity Function, HAQ-DI, ESR, CRP, NRS pain, PhGA, PaGA, TJC, SJC, and composite disease activity scores

Variable	Mean	SD	Median	25–75 percentiles
Age (years)	57.02	12.65	59.00	50.00–66.00
Disease duration (years)	6.09	6.07	4.00	2.00–9.00
Number of comorbid diseases	1.64	1.54	1.00	0.00–2.00
QuickDASH	24.83	15.72	20.00	11.00–38.00
ROAD-upper extremity function	3.11	2.50	2.19	0.99–4.68
HAQ-DI	0.81	0.74	0.50	0.20–1.31
ESR	25.70	21.78	18.50	10.00–37.50
CRP	3.17	8.20	0.95	0.37–3.06
NRS pain	4.31	3.12	4.00	1.00–7.00
PhGA	3.89	2.94	4.00	1.00–6.25
PaGA	4.56	2.94	5.00	2.00–7.00
TJC	6.01	7.26	2.00	0.00–10.00
SJC	4.08	5.61	1.00	0.00–6.00
DAS28	4.03	2.04	3.61	2.37–5.85
CDAI	18.55	16.88	12.00	5.00–29.55
SDAI	21.28	17.57	16.95	6.50–32.31
PRO-CLARA	9.87	7.01	8.45	4.05–15.05

QuickDASH Quick Disabilities of the Arm, Shoulder and Hand questionnaire; *ROAD* Recent-Onset Arthritis Disability questionnaire; *HAQ-DI* Health Assessment Questionnaire Disability Index; *ESR* erythrocyte sedimentation rate; *CRP* C-reactive protein; *NRS* Numerical Rating Scale; *PhGA* Physician Global Assessment of disease activity; *PaGA* Patient Global Assessment of disease activity; *TJC* tender joint count; *SJC* swollen joint count; *DAS28* Disease Activity Score—28 joints; *CDAI* Clinical Disease Activity Index; *SDAI* Simplified Disease Activity Index; *PRO-CLARA* Patient-Reported Outcomes CLinical ARthritis Activity

Table 3 Correlation of QuickDASH scores and composite disease activity indices

	ROAD upper extremity function	HAQ-DI	DAS28	CDAI	SDAI	PRO-CLARA
QuickDASH	0.876 < 0.001	0.771 < 0.001	0.779 < 0.001	0.778 < 0.001	0.748 < 0.001	0.808 < 0.001
ROAD upper extremity function		0.857 < 0.001	0.780 < 0.001	0.783 < 0.001	0.741 < 0.001	0.844 < 0.001
HAQ-DI			0.777 < 0.001	0.803 < 0.001	0.777 < 0.001	0.890 < 0.001
DAS28				0.927 < 0.001	0.884 < 0.001	0.835 < 0.001
CDAI					0.949 < 0.001	0.892 < 0.001
SDAI						0.842 < 0.001

Spearman rank correlation coefficient

QuickDASH Quick Disabilities of the Arm, Shoulder and Hand questionnaire; *ROAD* Recent-Onset Arthritis Disability questionnaire; *HAQ-DI* Health Assessment Questionnaire Disability Index; *DAS28* Disease Activity Score-28 joints; *CDAI* Clinical Disease Activity Index; *SDAI* Simplified Disease Activity Index

(mean value of the QuickDASH at 25th percentile of SDAI LDA). The arithmetic mean of these two numbers is 13 (not necessary to round off to the decimal digit in this case), the QuickDASH cut-off value for "no impairment". The QuickDASH cut-off values resulted of 18.5 between "low impairment" and "moderate impairment" (arithmetic of the mean values of the QuickDASH at 75th percentile of SDAI LDA and at 25th percentile of SDAI MDA), and of 31.5 between "moderate impairment" and "high impairment" (31.47 the arithmetic of the mean values of the QuickDASH at 75th percentile of SDAI MDA and at 25th percentile of SDAI HDA). The differences among the four levels were significant (Fig. 1).

Applying the reconciliation between the 75th and 25th percentiles of adjacent categories we calculated also the ROAD cut-off points: no impairment ≤ 1.5, 1.5 < low impairment ≤ 3.5, 3.5 < moderate impairment ≤ 5.5, and high impairment > 5.5. The number of patients receiving floor or ceiling effects was low (< 15%) for all the QuickDASH items.

Table 4 Comparison of QuickDASH scores and the other clinimetric variables in the different disease activity states

Variables	Disease activity states															
	Remission				Low disease activity				Moderate disease activity				High disease activity			
	Mean	SD	Median	25–75 P	Mean	SD	Median	25–75 P	Mean	SD	Median	25–75 P	Mean	SD	Median	25–75 P
QuickDASH	9.13	3.1	9.0	7.0–11.0	17.5	5.7	18.0	15.0–21.0	23.6	11.6	22.0	16.0–30.0	40.9	12.5	41.0	32.7–51.2
HAQ-DI	0.2	0.2	0.1	0.0–0.3	0.4	0.3	0.3	0.2–0.5	0.9	0.7	0.7	0.3–1.2	1.5	0.6	1.5	1.0–2.0
ROAD upper extremity function	0.6	0.5	0.5	0.4–0.9	1.9	0.7	2.0	1.4–2.2	3.1	2.2	2.8	1.4–4.3	5.5	2.1	5.3	4.0–7.2
DAS28	1.8	0.7	1.8	1.5–2.1	2.6	0.5	2.6	2.3–2.8	4.2	0.8	4.1	3.6–4.7	6.3	0.8	6.3	5.7–6.9
CDAI	2.6	2.6	2.0	0.0–4.0	7.1	3.7	7.0	4.0–9.0	18	7.7	18.0	12.0–24.0	37.3	12.7	35.0	27.7–46.0
SDAI	5.3	5.1	3.4	1.3–7.7	10.4	7.0	9.5	5.6–13.5	19.7	7.6	19.1	14.7–25.6	40.3	13.9	37.7	30.5–48.3
PRO-CLARA	2.2	2.2	2.0	0.6–3.5	6.2	2.7	6.1	4.7–7.8	11.4	4.9	10.9	8.2–13.7	16.7	5.0	17.0	13.0–20.7
NRS pain	0.8	1.1	0.5	0.0–1.0	2.9	1.91	3.0	1.0–4.0	5.1	2.2	5.0	4.0–7.0	7.1	2.0	7.5	6.0–9.0
PaGA	1.1	1.1	1.0	0.0–2.0	3.4	1.8	3.0	2.0–4.0	5.2	1.8	5.0	4.0–7.0	7.2	1.9	8.0	6.0–9.0
PhGA	0.9	1.3	0.0	0.0–2.0	2.2	1.8	2.0	1.0–4.0	4.4	1.9	5.0	3.0–6.0	6.8	1.7	7.0	6.0–8.0

QuickDASH Quick Disabilities of the Arm, Shoulder and Hand questionnaire; *HAQ-DI* Health Assessment Questionnaire Disability Index; *ROAD* Recent-Onset Arthritis Disability questionnaire; *DAS28* Disease Activity Score—28 joints; *CDAI* Clinical Disease Activity Index; *SDAI* Simplified Disease Activity Index; *PRO-CLARA* Patient-Reported Outcomes CLinical ARthritis Activity; *NRS* Numerical Rating Scale; *PaGA* Patient Global Assessment of disease activity; *PhGA* Physician Global Assessment of disease activity

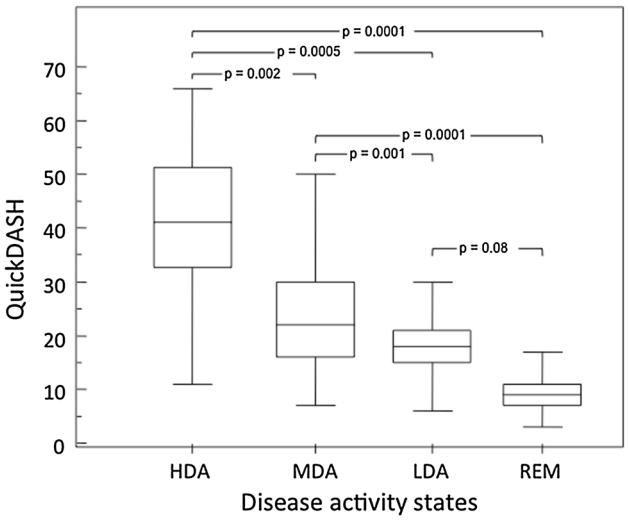

Fig. 1 Box–Whisker plots showing the relation between the QuickDASH scale and the disease activity states, and *p* values for each pairwise comparison. The horizontal line in each box in the two top graphs represents the median, and the box height represents the interquartile range. *HDA* High disease activity, *MDA* moderate disease activity, *LDA* low disease activity, *REM* remission

Discussion

In this study, we confirmed the validity of QuickDASH in RA and we provided the keys for interpretation of the tool in such kind of patients. The determination of cut-off points to distinguish between functional categories is a mainstay issue: the ability of PROs to improve decision-making in clinical practice relies greatly on their possibility to be correctly interpreted.

RA is a progressive, chronic, systemic, inflammatory joint disease that includes hands and wrists approximately in the 60–80% of patients [33]. Hands and wrists phlogistic involvement generates a great burden for the function, with huge impact in daily activity life [34, 35]. From the rheumatologic perspective, great efforts are made to reach REM or at least LDA, and often little attention is carried out to assess the patient hand function and dexterity [36–39]. The use of various questionnaires is the main way for the determination of functional impairment of hand in RA patients, including the assessment of pain and disability.

The DASH is a valid and reliable tool used in assessing disability due to musculoskeletal disorders of the upper limb, including surgical procedures [40, 41]. In RA, DASH demonstrated excellent clinimetric properties [39, 42, 43]. In particular, different studies revealed that DASH correlates with the disease activity in RA measured by DAS28 [39, 42], and demonstrated that the questionnaire is a favorable instrument also for the assessment of rheumatoid surgery [43]. However, the use of DASH, which consists of 30 items, could cause several difficulties, especially in elderly individuals and in patients with physical disabilities, resulting in low response rates [44–46]. To overcome this issue, the original questionnaire was modified reducing the number of questions from the 30 to the 11 of the QuickDASH.

In previous studies, QuickDASH has been used for different upper extremity disorders, such as acute traumatic conditions (soft tissue injuries, fractures), and upper extremity and neck region problems [47–49].

Results coming from a systematic review support the reliability and validity of the QuickDASH [46]. The tool has been already employed also in inflammatory joint diseases. QuickDASH was found to be a reliable and valid questionnaire in patients with RA, for the evaluation and assessment of the upper extremity functions [15, 25, 40]. QuickDASH also demonstrated to positively correlate with RA disease activity, as measured by a composite index such as DAS28 [15], or by PROs like the Routine Assessment of Patient Index Data 3 (RAPID3) [50]. Ochi and colleagues even proposed the QuickDASH as a disease control measure, demonstrating a strong correlation with DAS28 in those patients with a disease duration < 5 years, reflecting the fact that in the early phase of RA the disability is driven by inflammation [16].

In the present study, we confirmed the optimal convergent validity with disease activity (DAS28, SDAI, CDAI, and PRO-CLARA), and function indices (HAQ-DI and ROAD). Compared to the function index employed in this research (HAQ-DI and ROAD), QuickDASH seems to offer some advantages. In relation to HAQ-DI, QuickDASH is entirely dedicated to the upper extremity. This can be greatly informative in RA patients, especially in those with an early disease. Different activities explored by HAQ-DI are influenced by the large joints inflammatory involvement, more frequent in the late disease. Compared to ROAD Upper Extremity, QuickDASH computation is easier since does not require any mathematical normalization. Considering the time constraints experienced in the everyday clinical practice, this aspect is clearly beneficial.

The principal and original element introduced by our research is the proposal of the cut-off points distinguishing between functional categories. Cut-offs allow a better and faster interpretation of the results in the single patient, making them more meaningful in the clinical practice. For a research purpose, the utilization of the same score with the same cut-off points allows data to be compared and pooled across different settings. This aspect can reflect important implications for clinical benchmarking and for carrying out meta-analyses [32].

The principal strengths of the present study are the large sample size and the methodology used to establish the cut-off points. The approach proposed (reconciliation of 75th–25th percentiles of adjacent categories) is not the only one, but is in general use and valid [30–32].

Two major limitations have to be mentioned: first, we performed a single assessment without evaluating the responsiveness; second, information about the radiologic status was lacking, thus we were not able to evaluate the influence of the articular damage. Moreover, in our cohort, we can speculate that hand severe deformities were under-represented (relative young patients, relative short mean disease duration, and more than 60% of patients in biologic treatment).

In conclusion, this study provides a broader validation of the QuickDASH in a RA population. The instrument is useful in clinical practice, for its ease of administration, and positively correlates with the disease activity. It evaluates upper extremity impairment, but it may be also used as a surrogate of disease activity in RA patients. The longitudinal construct validity, which concerns the measure's ability to detect a true change in health status and its precision in detecting changes of different magnitudes (also referred to as responsiveness or sensitivity to change), of the cut-off points obtained in this research, needs to be addressed to further substantiate the clinical usefulness of the questionnaire.

Author contributions FS and MDC conceived and designed the study. MDC, MC, and SF collected the data. FS performed the statisical analysis. FS and MC drafted the paper. MDC and SF revised the paper. All the authors approved the final version.

Compliance with ethical standards

Conflict of interest All the authors declare that they have not received any financial support or other benefits from commercial sources for the work described in this paper. They also declare that they have no other financial interests that could create a potential conflict of interest or the appearance of a conflict of interest with regard to this work.

Ethical approval All the procedures in this work were in accordance with the ethical standards of the institutional research committee (Comitato Etico Regionale, number of approval 2014-084), and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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