

# Can Generic Outcome Questionnaires Replace QuickDASH in Monitoring Clinical Outcome Following Surgical Treatment of Distal Radius Fractures?

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**Purpose** In contrast to region-specific patient-reported outcome measures (PROMs), generic PROMs can be argued to have an added benefit of enabling cost-utility analyses and allowing for comparisons to be made across different conditions. The aim of this study was to assess the responsiveness and strength of the association between region-specific and generic PROMs in patients treated operatively for a displaced intra-articular distal radius fracture.

**Methods** Over a 4-year period, 166 patients aged 18–70 years with a displaced intra-articular fracture of the distal radius were treated with either a volar locking plate or external fixation augmented by K-wires and followed-up prospectively for 2 years. The main outcome measure was the Quick Disabilities of the Arm, Shoulder, and Hand (*QuickDASH*) score, but EuroQol-5D (EQ-5D) and 36-Item Short Form Survey (SF-36) were also employed. The associations between the *QuickDASH* score and EQ-5D and between the *QuickDASH* score and SF-36 were assessed using a linear mixed model.

**Results** There was a significant positive association between the *QuickDASH* score and EQ-5D and between the *QuickDASH* score and SF-36 throughout the follow-up period, although wide dispersion existed for the outcome measures at an individual level. However, the association between the *QuickDASH* score and SF-36 was significantly weaker at 6 weeks and 3 months than that at baseline, indicating that EQ-5D more closely mirrors changes in the *QuickDASH* score in the early postoperative period.

**Conclusions** The study demonstrates that the *QuickDASH* score and EQ-5D correlate well on a group level, but large individual variations exist. The SF-36 had decreased sensitivity for the changes in the *QuickDASH* score at 6 weeks and 3 months.

**Clinical relevance** Our findings indicate that generic PROMs cannot fully replace the region-specific *QuickDASH* score when evaluating the outcomes of distal radius fractures. (*J Hand Surg Am.* 2022;47(1):92.e1-e9. Copyright © 2022 by the American Society for Surgery of the Hand. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>.)

**Key words** EQ-5D, PROMs, *QuickDASH*, SF-36, wrist fracture.



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**D**ISTAL RADIUS FRACTURES (DRFs) are the most common fracture in adults and have attracted the attention of clinical researchers. In clinical research, the choice of a measure to assess the outcome of a DRF is important. Most researchers use radiographs and objective measures of capability, such as range of motion and grip strength. In addition, observer-reported outcome measures, such as variations in the Gartland and Werley score, have been used.<sup>1,2</sup> However, the implementation of

patient-reported outcome measures (PROMs) has gradually become the primary choice for evaluating the effect of a treatment. The choice of PROM is influenced not only by the research question, which can be used to determine the treatment that yields the best functional outcome, but also based on whether one is interested in short- or long-term consequences or cost-benefit analysis.

Region- or condition-specific PROMs, such as the Disabilities of the Arm, Shoulder, and Hand (DASH) score, lower *QuickDASH* score, patient-rated wrist evaluation, and Michigan hand outcome questionnaire, are now commonly used in the clinical research of upper-extremity injury and treatment. Most of these questionnaires are designed to indicate variations in the patient's condition over time, most frequently before and after treatment. They have been validated for several injuries and conditions of the upper extremity and in a variety of populations and languages.

In contrast to region-specific PROMs, generic PROMs tend to emphasize aspects that fit a plethora of different conditions to allow comparisons to be made across various medical conditions. They also enable a cost-utility analysis to examine the cost of a health-related intervention and the benefit it produces in terms of the number of years lived in full health (quality-adjusted life years). A region-specific PROM is often regarded as more suitable and credible than generic PROMs when assessing function following a fracture but does not allow comparisons to be made across conditions, such as other orthopedic or non-musculoskeletal conditions. To enable a cost-utility analysis alongside clinical trials, generic PROMs, such as EuroQol-5D (EQ-5D) and 36-Item Short Form Survey (SF-36), are to an increasing extent, included in orthopedic trials. This may lead to a questionnaire burden for patients enrolled in clinical trials. If the association between the generic and region-specific PROMs is strong enough, it may be possible to reduce the number of PROMs administered to a trial participant without losing relevant information.

Therefore, the purpose of this study was to investigate the responsiveness and strength of the association between region-specific and generic PROMs. We hypothesized that the strength of the association between region-specific and generic PROMs in patients treated operatively for a displaced intra-articular DRF is poor.

## MATERIALS AND METHODS

### Intervention and sample

Between September 2009 and January 2013, 166 patients aged 18–70 years with a displaced intra-

articular fracture of the distal radius were treated with either a volar locking plate or external fixation augmented by K-wires. The demographic characteristics and preinjury level of function were assessed preoperatively (baseline) and repeated at 6 weeks, 3 months, 6 months, 1 year, and 2 years. The primary outcome measure was the *QuickDASH* score.<sup>3</sup> In addition, EQ-5D and SF-36 data were collected.<sup>4,5</sup>

### Questionnaires

***QuickDASH score:*** To evaluate the *QuickDASH* score, a representative selection of 11 questions have been drawn from the 30-question DASH measure.<sup>4,6</sup> The questionnaire asks individuals about their symptoms and perceived ability to perform specific activities. Each answer is scored on a scale from 1 to 5, with 1 representing “no difficulty” and 5 representing “unable.” The final *QuickDASH* score ranges from 0, representing an excellent result, to 100, representing the worst possible outcome. The minimal clinically important difference varies between 8 and 19 among different studies.<sup>7–9</sup> The form has been validated in Norwegian.<sup>10</sup>

The SF-36 was not originally designed for use in economic evaluation or to determine quality-adjusted life years, but further research led to the development of a health state classification measure, the 6-Dimensional Short Form Survey (SF-6D), and a preference-based single index measure of health generated from SF-36 data using general population values.<sup>5</sup> The SF-6D focuses on 7 of 8 health domains covered by the SF-36, version 2, health survey: physical functioning, role participation (combined role—physical and emotional), social functioning, bodily pain, mental health, and vitality. Only the general health domain is not included. The dimensions have 4–6 levels that together generate 18,000 possible 6-digit health states. Based on a sample of 249 valued health states, these multilevel dimensions are used by the algorithm to generate an SF-6D index, scored from 0.0 (worst health state) to 1.0 (best health state).<sup>11,12</sup>

The EQ-5D-3L (3 Level) form consists of the EQ-5D descriptive system and EQ visual analog scale. The EQ-5D-3L descriptive system comprises the following 5 dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Each dimension has 3 levels: no problems, some problems, and extreme problems. The patient indicates their health state by checking the box next to the most appropriate statement in each dimension. This indication results in a 1-digit number for each

dimension, which, for all dimensions, combines to form a 5-digit number that describes the patient's health state. A total of 243 possible health states are defined this way. These 5-digit health states are then converted into a single summary index by applying a formula that assigns weights to each of the levels in each dimension. Value sets have been derived for EQ-5D in several countries. The final score ranges from  $-0.594$  (worst possible health state) to  $1.0$  (best health state) and allows researchers to calculate quality-adjusted life years for use in the cost-utility analysis. The study used EQ-5D-3L (Norwegian version).<sup>13</sup>

### Statistical methods

The demographic and clinical characteristics of patients at baseline were described as means and SDs or as frequencies and percentages. For the analyses, the *QuickDASH* score was inverted and transformed to a scale from 0 to 1. Associations between the *QuickDASH* score and EQ-5D and between the *QuickDASH* score and SF-6D were assessed using linear mixed models adjusted for within-patient correlations because of repeated measurements for each patient. The models included fixed effects for each time point, EQ-5D or SF-6D, and the interaction between time dummies and EQ-5D or SF-6D. The time trend in the *QuickDASH* score, EQ-5D, and SF-6D was assessed using a linear mixed model, with fixed effects for each time point. Random effects for patients nested with surgeons were included in the linear mixed models. The agreement between the *QuickDASH* score and EQ-5D and between the *QuickDASH* score and SF-6D was illustrated using a scatter plot. Further, a Bland-Altman analysis assessing the association between the average of and difference between 2 measures was employed. The bias (average difference between 2 measures) and 95% limits of agreement were estimated. Ceiling or floor effects were assumed to be present if the percentage of total respondents with a maximal or minimal score was 15% or more.

All tests were 2-sided. Results with  $P$  values  $<.05$  were considered statistically significant.

### Ethics

The study was approved by the Regional Ethics Committee of Eastern Norway (ref. 2009/1517) and the local data protection officer. Written informed consent was obtained from all the patients.

**TABLE 1. Baseline Demographic and Clinical Characteristics of Patients with Intra-articular DRFs (n = 166)**

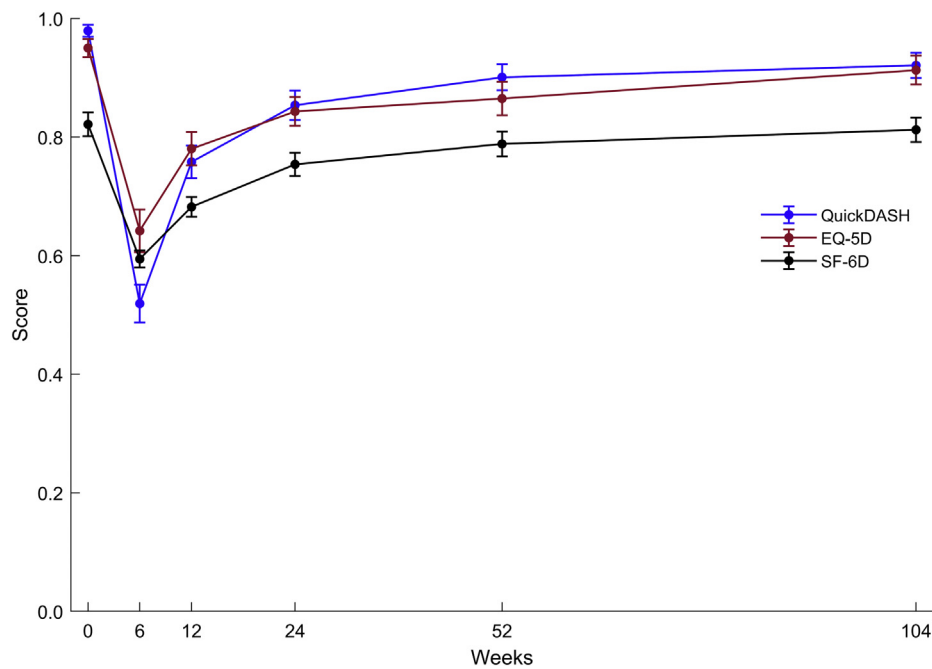
Basic Clinical Characteristic	Value
Age at the time of injury (y), mean $\pm$ SD	55.0 (11.5)
Females, n (%)	114 (68.7)
Mechanism of injury	
Low-energy trauma, n (%)	141 (84.9)
High-energy trauma, n (%)	25 (15.1)
ASA-score at the time of surgery	
ASA 1, n (%)	75 (45.2)
ASA 2, n (%)	89 (53.6)
ASA 3, n (%)	2 (1.2)
Occupation	
Office worker, n (%)	57 (34.3)
Manual labor, n (%)	56 (33.7)
Retired, n (%)	38 (22.9)
Other, n (%)	15 (9.0)
Eq5D score, mean $\pm$ SD	0.95 $\pm$ 0.10
Surgery time (min), mean $\pm$ SD	60.9 $\pm$ 20.2
Outpatient, n (%)	117 (70.5)
Inpatient, n (%)	49 (29.5)

ASA, American Society of Anesthesiologists.

### RESULTS

Among the 166 patients with a displaced intra-articular DRF included in the study, 114 were women (68.7%). The mean age at the time of inclusion was 55 years (SD 11.5). Randomization allocated 84 patients to treatment with a volar locking plate and 82 to treatment with external fixation. The overall attendance at follow-up was 96.7%. The details and clinical results of this study have been reported previously (Table 1).<sup>14</sup> The descriptive statistics for the *QuickDASH* score, SF-6D, and EQ-5D at each time point are presented in Figure 1.

According to the unadjusted linear mixed model, there was a statistically significant positive association between the *QuickDASH* score and EQ5D and between the *QuickDASH* score and SF-6D throughout the follow-up period (Table 2). The association between the *QuickDASH* score and SF-6D was significantly weaker at 6 weeks and 3 months than that at baseline, whereas the association between the *QuickDASH* score and EQ-5D was stable throughout the follow-up period. This indicates that EQ-5D mirrors the changes in the *QuickDASH* score more closely than SF-6D in the early postoperative



**FIGURE 1:** Descriptive statistics of EQ-5D, SF-6D, and the *QuickDASH* score. Observed mean score with corresponding 95% confidence interval for the *QuickDASH* score, SF-6D, and SF-6D.

period (Fig. 2). Adjustment for sex and age did not alter the conclusion (Table 2).

As the healing process of the wrist fracture progresses after surgery, the rate at which the values return to baseline level may indicate their sensitivity to actual wrist function. Neither the *QuickDASH* score nor EQ-5D returned to the baseline values during the 2-year follow-up, but SF-6D did reach the baseline values after 2 years, as determined by the linear mixed models assessing trend adjusted for sex and age (Table 3 and Fig. 3). There was no floor effect for any of the PROMs. For the *QuickDASH* score, there were no minimal scores at any time point, and for SF-6D and EQ-5D, less than 0.2% of all scores were minimal scores. The ceiling effects for all time points are listed in Table 4.

As illustrated in the scatterplots (Fig. 4), the dispersion was large despite the clear linear relationship between the *QuickDASH* score and EQ-5D and between the *QuickDASH* score and SF-6D. There was no significant bias between the *QuickDASH* score and EQ-5D (bias 0.01,  $P = .25$ ). However, the bias between the *QuickDASH* score and SF-6D was significantly different from zero (bias  $-0.04$ ,  $P < .001$ ). The 95% limits of agreement were relatively wide for both ( $-0.01$ ; 0.61) agreement between the *QuickDASH* score and EQ-5D and ( $-0.39$ ; 0.55) for agreement between the *QuickDASH* score and SF-6D, as also illustrated in the

Bland-Altman plots (Fig. 4), indicating a low agreement.

## DISCUSSION

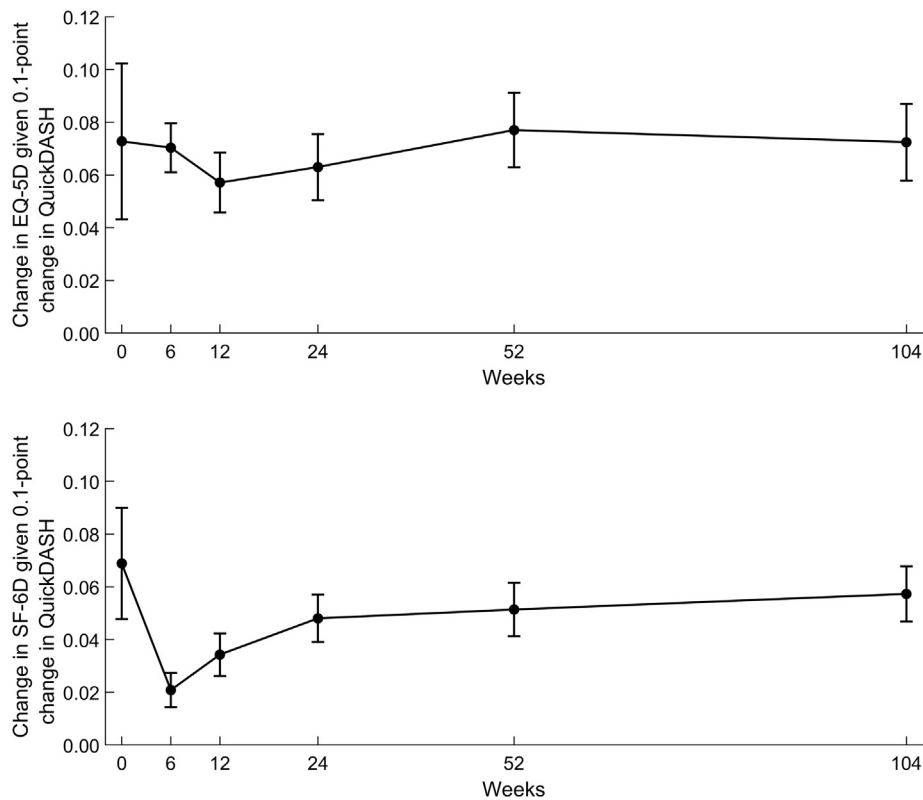
The main finding of this study is that the *QuickDASH* score and EQ-5D correlate well on a group level. To make clinical trials efficient to run, investigators might be tempted to use only the EQ-5D generic PROM. We did, however, find large individual variations, warranting caution that EQ-5D cannot fully replace the *QuickDASH* score when evaluating the outcome of DRFs. The SF-6D had reduced sensitivity for the changes in the *QuickDASH* score at 6 weeks and 3 months and, as such, would not be the first choice of a generic PROM in the setting of studies on DRFs.

The benefit of PROMs is that in contrast to objective measures, such as range of motion and grip strength, they reflect the outcomes as experienced by the patient. Generic measures, such as SF-6D and EQ-5D, are only clinically relevant as long as they have an acceptable correlation with region-specific PROMs and objective impairment measures. With many other aspects of patients' physical and mental health contributing to the quality of life, as indicated by generic PROMs, the sensitivity of these tools may be expected to be less than a region- or disease-specific scale. However, our data show that generic

**TABLE 2.** Association Between the EQ-5D or SF-6D and *QuickDASH* and the Results of Linear Mixed Model Adjusted for Sex and Age

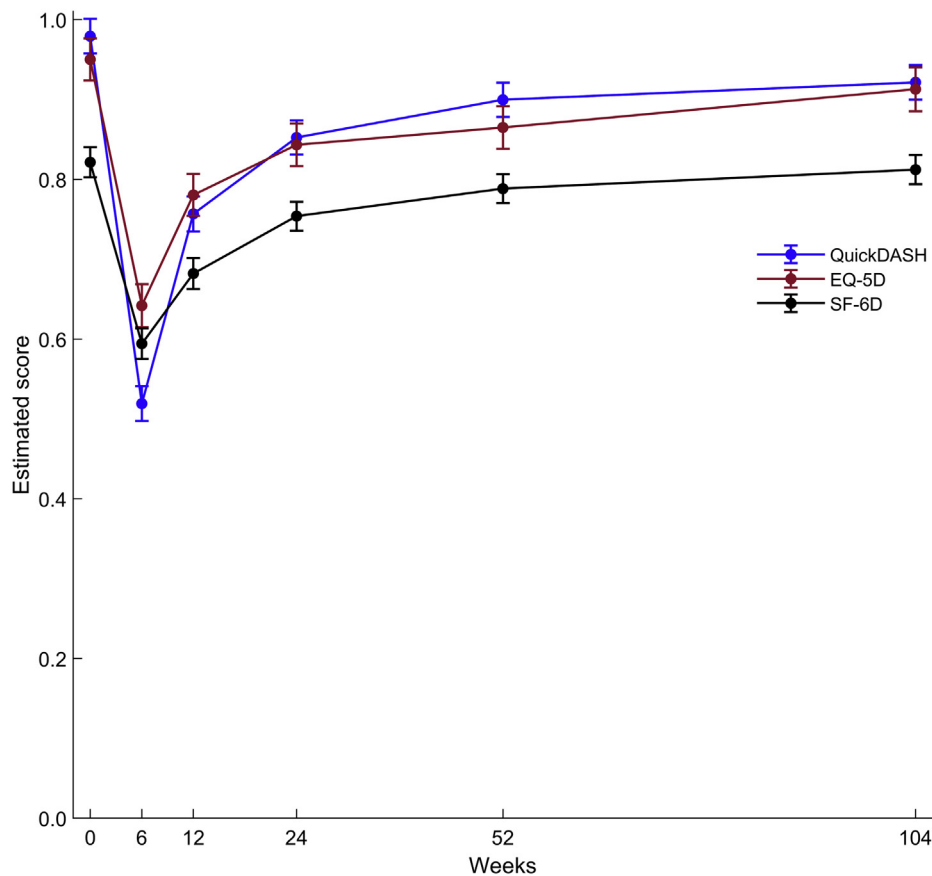
Time of Evaluation	EQ-5D		SF-6D	
	Regression Coefficient (SE)	P Value	Regression Coefficient (SE)	P Value
Intercept	0.31 (0.17)	.06	0.15 (0.12)	.20
Baseline	0		0	
6 wk	-0.10 (0.17)	.57	0.32 (0.12)	<.05
3 mo	0.01 (0.18)	.97	0.24 (0.13)	.06
6 mo	-0.07 (0.18)	.71	0.20 (0.13)	.13
12 mo	-0.15 (0.18)	.40	0.13 (0.13)	.30
24 mo	-0.11 (0.18)	.56	0.16 (0.13)	.21
<i>QuickDASH</i>	0.70 (0.15)	<.005	0.69 (0.11)	<.005
Baseline × <i>QuickDASH</i>	0		0	
6 wk × <i>QuickDASH</i>	0.01 (0.16)	.96	-0.48 (0.11)	<.005
3 mo × <i>QuickDASH</i>	-0.13 (0.16)	.44	-0.34 (0.11)	<.005
6 mo × <i>QuickDASH</i>	-0.07 (0.17)	.69	-0.21 (0.12)	.08
12 mo × <i>QuickDASH</i>	0.07 (0.17)	.66	-0.17 (0.12)	.15
24 mo × <i>QuickDASH</i>	0.02 (0.17)	.90	-0.11 (0.12)	.37

SE, standard error.

**FIGURE 2:** Illustration of associations between the *QuickDASH* score and EQ-5D and between *QuickDASH* and SF-6D. Results of linear mixed model for changes in EQ-5D (top panel) and SF-6D (bottom panel). Observed mean and 95% confidence interval for Q for a 0.1-point change in the *QuickDASH* score.

**TABLE 3.** Trend in the *QuickDASH* score, SF-6D, and EQ-5D and the Results of Linear Mixed Model Adjusted for Sex and Age

Time of Evaluation	<i>QuickDASH</i>		SF-6D		EQ-5D	
	Regression Coefficient (95% CI)	P Value	Regression Coefficient (95% CI)	P Value	Regression Coefficient (95% CI)	P Value
Intercept	1.03 (0.91 to 1.15)	<.005	0.86 (0.76 to 0.96)	<.005	1.03 (0.89 to 1.18)	<.005
Baseline	0		0		0	
6 wk	-0.46 (-0.58 to -0.34)	<.005	-0.27 (-0.36 to -0.17)	<.005	-0.41 (-0.57 to -0.26)	<.005
3 mo	-0.22 (-0.36 to -0.09)	<.005	-0.19 (-0.30 to -0.08)	<.005	-0.25 (-0.41 to -0.08)	<.005
6 mo	-0.16 (-0.30 to -0.02)	<.05	-0.11 (-0.22 to 0.0005)	.051	-0.24 (-0.40 to -0.07)	<.05
12 mo	-0.21 (-0.35 to -0.07)	<.005	-0.15 (-0.26 to -0.04)	<.05	-0.23 (-0.39 to -0.06)	<.05
24 mo	-0.18 (-0.32 to -0.03)	<.05	-0.08 (-0.19 to 0.04)	.18	-0.23 (-0.40 to -0.07)	<.05



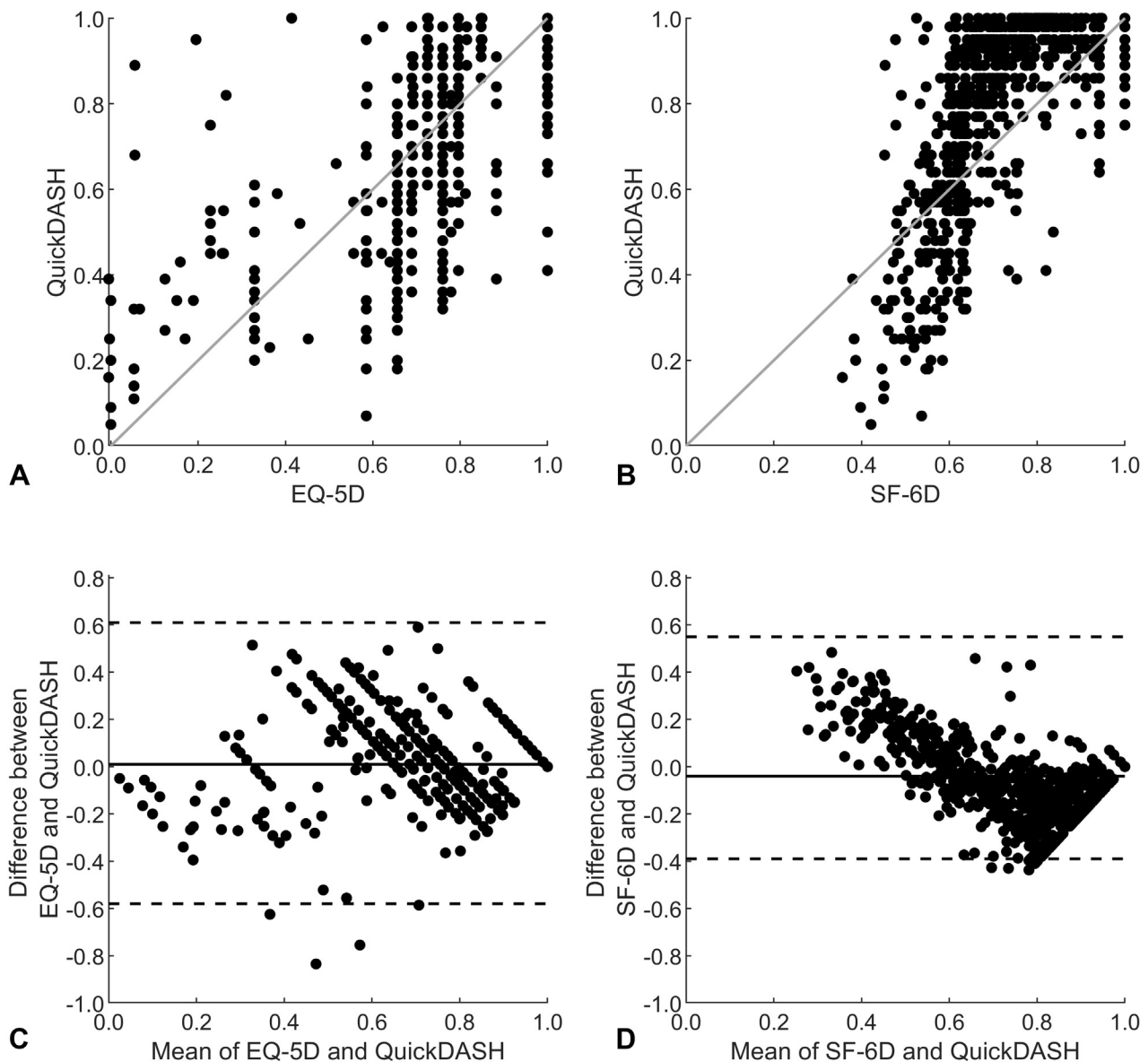
**FIGURE 3:** Illustration of trend in the *QuickDASH* score, EQ-5D, and SF-6D. Mean score with corresponding 95% confidence interval for the *QuickDASH* score, SF-6D, and SF-6D estimated using a linear mixed model.

PROMs, such as EQ-5D, can reflect variations in wrist function at the group level. This has been supported by authors, such as Costa et al,<sup>15</sup> who concluded that EQ-5D is a suitable measure of health utility following a wrist fracture. Similar responsiveness between SF-6D and commonly used physical outcome measures following wrist fractures was found by Amadio et al,<sup>16</sup> who concluded that SF-6D

captures functions and symptoms objectively. Empirically, it would be expected that the SF-6D subscales of physical functioning, role participation, and bodily pain would have the strongest correlation with region-specific PROMs.<sup>17</sup> Both Gruber et al<sup>18</sup> and Fernandez et al<sup>19</sup> found a correlation between poor function in patients with radiocarpal arthritis and poor results on the physical subscales of SF-6D.

**TABLE 4.** Ceiling Effect of the *QuickDASH* score, EQ-5D, and SF-6D at All Follow-Ups

Time (wk)	0	1.5	3	6	12	24	Total
<i>QuickDASH</i>	70.5%	0.0%	1.9%	13.3%	26.4%	34.8%	24.7%
EQ-5D	76.5%	7.8%	24.7%	39.2%	52.4%	68.1%	44.8%
SF-6D	12.7%	0.6%	1.2%	6.0%	9.6%	8.4%	1.4%



**FIGURE 4:** Scatter plots and Bland-Altman plots. Scatter plots between **A** the *QuickDASH* score and EQ-5D and **B** the *QuickDASH* score and SF-6D. Bland-Altman plots for agreement between **C** the *QuickDASH* score and EQ-5D and **D** the *QuickDASH* score and SF-6D (all time points included). The gray line in panels **A** and **B** represents perfect agreement and the black and black dashed lines in panels **C** and **D** represent bias and 95% limits of agreement, respectively. The apparent difference in the number of dots in panels **A** and **B** is because of more dots exactly overlapping in panel **A**.

The current study indicates that as expected, the *QuickDASH* score can better capture subtle changes in wrist function early in the follow-up period than

generic outcome measures. This is supported by MacDermid et al,<sup>17</sup> who found that region-specific questionnaires (*DASH* and patient-rated wrist

evaluation) are more responsive in detecting a clinical change than generic measures (SF-6D).

Given these results, it can be argued that the *QuickDASH* score and EQ-5D are interchangeable, with an equal representation of the patients' level of wrist function. Further, only one of these tools may, therefore, be needed to monitor wrist function. However, despite demonstrating sufficient covariation throughout the follow-up, the dispersion in the results means that what is observed at the group level may not extend to individual patients. In other words, a "good" *QuickDASH* score does not necessarily mean a "good" EQ-5D-score. As demonstrated by our results, individual patients may demonstrate an excellent *QuickDASH* score but score poorly on EQ-5D and vice versa. A patient may function well and have good general health despite a stiff wrist following a fracture, especially if the wrist is not fundamental to the patient's profession or other activities. Others might have an excellent wrist function but poor health due to unrelated reasons. These variations may not be detected at the group level, which explains why generic PROMs cannot replace region-specific PROMs. This finding is corroborated by the agreement analysis. For both generic PROMs, the bias was very close to zero (0.01 and -0.04), which is likely too small to represent any clinically relevant difference. However, it is also obvious from the Bland-Altman plots that the 95% limits of agreement were very wide, with absolute values amounting to about 50% of the scales' total. Notably, the Bland-Altman plot also illustrates that for SF-6D, the values are generally higher than *QuickDASH* values when the *QuickDASH* scores are poor and are lower than *QuickDASH* values when the *QuickDASH* scores approaches perfect scores. This further strengthens the observation that SF-6D values are less valuable than EQ-5D as a generic PROM to use in the setting of wrist function.

Souer et al<sup>20</sup> found that pain is the dominant predictor of the *QuickDASH* score following the operative treatment of DRFs. Therefore, it might be expected that questionnaires focusing on pain may be more responsive immediately following surgery, whereas in the longer term, the ability to return to normal activities would be more relevant. In this respect, the PROMs evaluated in the present study are quite similar; only 1 of the questions in EQ-5D and the *QuickDASH* score and 2 in SF-6D focused directly on pain.

The *QuickDASH* score, EQ-5D, and SF-6D do not provide interchangeable utility estimates. Like others, we found a ceiling effect of EQ-5D.<sup>21</sup> Upon comparing SF-6D to the *QuickDASH* score, Soohoo et al<sup>22</sup> found that the *QuickDASH* score has fewer

floor and ceiling scores than most of the subscales of SF-6D. Conversely, evidence of ceiling effects has been frequently reported for EQ-5D.<sup>11</sup> This is in line with our findings. Patients tend to report a level-1 response (indicating no problems) for each dimension and are, therefore, said to be in "full health" according to EQ-5D. They may, however, indicate impairment due to other measures such as the *QuickDASH* score. In our study, 68% of the patients reported perfect health at 2 years, as assessed by EQ-5D, whereas only 35% reported the maximum *QuickDASH* score. The result of the ceiling effect is that patients in good health are systematically moved up on the utility scale.

EuroQol-5D and SF-6D are widely used health outcome measures and have been shown to be reliable, valid, and responsive in a generic population. Limited evidence is available regarding their use in a wrist trauma population. Evidence has suggested that they are less valid and responsive than region-specific scoring systems, such as the *QuickDASH* score. Although we found this to be likely in the immediate period following surgery, we found the questionnaires to be equal for the remainder of the period.

The study was performed at a single institution, which may have limited the external validity of the results. Furthermore, the current study employs a later version of SF-36, the SF-6D. The SF-6D has 6 subscales, whereas the older version made popular by MacDermid et al<sup>17</sup> has 8 subscales and 2 summary scores. The applicability of generic PROMs is influenced by how their dimensions relate to the injury in question. Of the 5 dimensions in EQ-5D, 4 are directly related to the function of the upper extremity, whereas this is true only for 2 of the 6 health domains in the SF-6D.

Although the *QuickDASH* score is region-specific, it is still influenced by factors such as mental health and comorbidities.<sup>23,24</sup> The original sample size was determined based on a power calculation aimed at detecting a difference in 10 points on the *QuickDASH* scale.

The study demonstrates that the *QuickDASH* score and EQ-5D correlate well on a group level in a sample of patients with impaired wrist function, but large individual variations imply that the EQ-5D cannot replace the *QuickDASH* score when evaluating the outcomes of DRFs. The SF-6D had decreased sensitivity for the changes in the *QuickDASH* score in the early postoperative period when *QuickDASH* scores were poor. Clinicians may use the *QuickDASH* score as the only PROM to monitor the progress of each patient, but researchers should use EQ-5D to identify



variations in outcomes relating to wrist function. The SF-6D does not add additional information regarding wrist function and can be left out.

## ACKNOWLEDGMENTS

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