Linking QuickDASH with PROMIS UE

Introduction

Patient-reported outcome measures (PROMs) are quantitative tools to elicit patients' self-reports of health outcomes involving symptoms, function, and well-being (Schalet et al., 2015). Clinicians have shown interests in using these tools in daily clinical practice to detect physical or psychological problems, monitor disease progress and evaluate how well patients recover from disease, surgery or other interventions (Valderas et al., 2008). They can further help to facilitate patient–clinician communication.

Patient-reported physical function—including self-care, instrumental activities of daily living, mobility, and dexterity—is frequently assessed by PROMs in clinical practice and research. Upper extremity function, as a domain of physical functioning, has been used specifically for patients with disorders of the upper limb. The QuickDASH is a commonly-used, well-established and validated PROM in upper extremity function (Beaton et al., 2005). It is an 11-item short form derived from the 30-item Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure. Measuring patient-reported outcomes from a generic perspective, the NIH Patient-Reported Outcomes Measurement Information System (PROMIS®) offers a set of generic measures developed based on a rigorous mixed-methods approach including input from content experts, clinicians, and patients as well as utilizes item response theory (IRT) to enable brief and efficient assessments that are feasible to implement and appropriate for use across the general population (Cella et al., 2010; Cella et al., 2007; Liu et al., 2010). The PROMIS Upper Extremity scale (PROMIS-UE) assesses activities that require use of the upper extremity including shoulder, arm, and hand activities.

It would be helpful to harmonize commonly-used measures by linking and rescoring them on a common metric, thereby supporting comparative effectiveness research (Kaat et al., 2018). This study conducts a linking analysis between the QuickDASH and the PROMIS-UE and computes a crosswalk table for clinicians and researchers to convert scores between the two measures for research and for daily clinical practice.

Data

Data for the patients (N = 656) with disorders of the upper limb was collected by clinicians at two health care systems. In this sample, the mean age is 47.92, and 54% are female. Responses to PROMIS UE 7-item short form was extracted from the PROMIS UE-CAT.

Measures

The DASH Outcome Measure has been increasing in popularity for use in both clinical and research settings and has proven to be a useful self-report outcome measure for people with musculoskeletal upper-limb disorders (*The QuickDASH: Information for Users*). The QuickDASH is a shortened version of the DASH Outcome Measure. The QuickDASH, which is exclusive to upper extremity function, uses 11 items to measure physical function and symptoms in persons with any or multiple musculoskeletal disorders of the upper limb. It provides clinicians with an option that enables faster measurement of disability and symptoms.

PROMIS-UE assess activities that require use of the upper extremity including shoulder, arm, and hand activities. Examples include writing, using buttons, or opening containers. The PROMIS-UE short form has 7 item, and its validity has been reported for patients with upper extremity trauma in another study (Kaat et al., 2019; Kaat et al., 2017).

Linking Methods

The IRT-based *fixed-parameter calibration* method calibrates the legacy measure (in this case, the QuickDASH) and the anchor measure (in this case, PROMIS-UE short form) at the same time with fixed item parameters extracted from the anchor measure's existing calibrated item bank (UE v2.0). By doing so, the item parameters of the legacy measure are then calibrated on the same metric as the anchor measure. Based on the item parameters of the legacy measure that have been linked onto the metric of anchor measure, we can then score participants' item responses and create the crosswalk table to convert each possible raw score of the legacy measure to the anchor measure based on the Lord and Wingersky recursive algorithm for EAP summed scoring (Cai, 2015).

Analytical Plan

This study uses a single group design, in which the two measures were administered to all participants at the same time. All linking assumptions have been investigated. First, to verify the similar content assumption, we qualitatively examined the item content of each measure. Second, we calculated the correlation between the raw scores of the two measures to determine whether they were highly correlated. Third, bi-factor exploratory factor analysis (bEFA) was used to assess the unidimensionality of the combined scale (i.e., QuickDASH and PROMIS-UE). An Omega Hierarchical (OmegaH) statistic (McDonald, 1999; Zinbarg et al., 2005) higher than 0.75 (Reise et al., 2013) suggests broad unidimensionality of the combined scale. After all assumptions have been checked, we applied the IRT-based fixed parameter calibration method and conducted the analysis using flexMIRT software (Cai, 2017).

Results

We found overlap on the item content of the two measures. The Pearson's correlation between the raw scores of the two measures had a value of 0.75, suggesting an adequate correlation between the two measures. Regarding unidimensionality, the OmegaH (0.86) suggested that the combined scale was sufficiently unidimensional. Table 1 shows the QuickDASH item parameters estimated by fixed-parameter calibration. The crosswalk table (Table 2) can be used to map each raw summed score from the QuickDASH to the corresponding T-score values on the PROMIS-UE metric.

Discussion

The linking between the QuickDASH and the PROMIS-UE short form met the conceptual and statistical assumptions for the linking analysis and IRT modeling. Drawing on best practices for score-linking (Dorans, 2007), we used a single-group design where participants were co-administered both instruments at the same time. We applied the IRT-based fixed-parameter calibration method, which we used to generate a crosswalk table (Table 2) that can be used to convert QuickDASH scores to PROMIS-UE scores.

Linking two measures is not meant to suggest the superiority of one measure over another but rather that they can be treated as interchangeable. Indeed, the utility of linking should not be understated. This crosswalk table holds significant potential for improving clinical and research activities within populations of patients with upper extremity trauma. It provides the interpretability of both measures on a common metric for further group-level analysis. For example, researches can use this crosswalk to compute clinically critical values of each measures based on the reference values of the other measure. Beyond the comparative analysis of the two measures at the group level, researchers can use this crosswalk to conduct integrative data

analysis, which aggregate existing information with data of only one measure collected for a prospective data collection purpose. The linking method for data integration can be used across research projects and consortia, thus enabling harmonization without requiring all entities or cohorts to use the same measure. Moreover, in order to compare levels of upper extremity trauma over time, investigators may want to use a comparable measure that could be sufficiently harmonized with the QuickDASH. The crosswalk can be further leveraged for longitudinal follow-up where one measure was administered at early visits but the other measure was used in subsequent visits.

Overall, the current study provides a way to convert scores from the widely-used Quick-DASH to PROMIS-UE short form using the established crosswalk table. Along with the need for assessing upper extremity activities, this study offers clinicians and researchers a practical tool to link scores from two popular UE measures based on the IRT-based linking method of fixed parameter calibration. We encourage researchers and clinicians to use this crosswalk table to compare and integrate data based on a common metric.

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Tables

Table 1 Transformed item parameters for QuickDASH

Item	c1	c2	c3	c4	a
D1	7.20	5.53	3.57	0.98	2.85
D2	8.37	7.06	4.93	2.11	3.43
D3	8.28	7.36	5.15	2.92	2.88
D4	8.49	7.06	5.44	3.18	3.13
D5	9.71	8.26	6.37	4.43	3.50
D6	5.42	4.43	3.02	0.82	2.65
D7	6.74	5.21	3.92	2.16	2.01
D8	6.89	5.09	3.70	1.56	2.29
D9	6.61	4.57	2.36	-0.04	1.48
D10	6.05	4.28	2.59	1.44	1.02
D11	7.05	5.49	3.63	1.98	1.80

Note. a denotes the slope parameter; c1- c4 denote the intercept parameters. To compute corresponding thresholds b, the formula b=-c/a can be used.

Table 2 Raw Score to T-Score Conversion Table for the QuickDASH to PROMIS Physical Function Upper Extremity (v2.0)

QuickDASH Raw Score	PROMIS UE T-Score	SD
11	60.5	6.5
12	54.9	5.0
13	51.8	4.6
14	49.4	4.1
15	47.4	3.7
16	45.8	3.3
17	44.4	3.1
18	43.2	2.9
19	42.1	2.8
20	41.1	2.7
21	40.1	2.6
22	39.2	2.5
23	38.4	2.5
24	37.6	2.4
25	36.8	2.4
26	36.0	2.4
27	35.3	2.3
28	34.6	2.3
29	33.9	2.3
30	33.2	2.3
31	32.5	2.3
32	31.8	2.3
33	31.1	2.3
34	30.5	2.3
35	29.8	2.3
36	29.1	2.3
37	28.4	2.3
38	27.8	2.3
39	27.1	2.3
40	26.4	2.3
41	25.7	2.4
42	24.9	2.4
43	24.2	2.4
44	23.4	2.5
45	22.5	2.6
46	21.7	2.7
47	20.7	2.8
48	19.7	2.9

49	18.7	3.1
50	17.5	3.2
51	16.2	3.4
52	14.9	3.7
53	13.3	4.0
54	11.7	4.3
55	9.8	4.7