Original Article

Excellent Correlation of the Patient-Reported Outcomes Measurement Information System Upper Extremity Score With Legacy Outcome Scores Preoperatively and at 1 Year After Arthroscopic Rotator Cuff Repair

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Purpose: To assess the preoperative and postoperative performance of the Patient-Reported Outcomes Measurement Information System Upper Extremity (PROMIS-UE, version 2.0) outcome score in comparison to the American Shoulder and Elbow Surgeons (ASES) and Western Ontario Rotator Cuff Index (WORC) instruments in patients undergoing rotator cuff repair. **Methods:** This prospective longitudinal study included 91 patients undergoing rotator cuff repair. Patients completed the PROMIS-UE, ASES, and WORC instruments preoperatively and postoperatively at 2 weeks, 6 weeks, 3 months, and 12 months. The Pearson correlation coefficient (*r*) between these tools was calculated at each time point. Correlations were graded as excellent (>0.7), excellent-good (0.61-0.7), good (0.4-0.6), or poor (<0.4). Responsiveness to change was assessed using the effect size and the standardized response mean. Floor and ceiling effects for each instrument were also assessed. **Results:** The PROMIS-UE instrument showed good to excellent correlation with the legacy instruments at all time points. There were variations in the measured effect sizes of the various instruments, with the PROMIS-UE instrument showing responsiveness to change at 3 and 12 months but the ASES and WORC instruments showing responsiveness at 6 weeks, 3 months, and 12 months. Both PROMIS-UE and ASES scores displayed ceiling effects at 12 months. **Conclusions:** The PROMIS-UE instrument shows excellent correlation with the ASES instrument and a rotator cuff–specific outcome instrument—the WORC instrument—preoperatively and at 1 year after arthroscopic rotator cuff repair. Variations in the measured effect sizes at different postoperative time points and high ceiling effects of the PROMIS-UE instrument at the 1-year time point may limit its utility in the early postoperative phase and at long-term follow-up after rotator cuff repair. **Clinical Relevance:** The performance of the PROMIS-UE outcome measure after arthroscopic rotator cuff repair was investigated.

Patient-reported outcome measures (PROMs) have become an increasingly important tool in orthopaedic clinical practice and research. Because the main outcome measure in orthopaedics is quality of life, incorporation of patient input is an essential component in the evaluation of treatment outcomes.[1] In addition to

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the use of PROMs as tools in clinical care delivery, their widespread adoption has enabled researchers to better compare treatments against one another and to perform cost-effectiveness analysis.[2] However, such research is hampered by the large number of different PROMs currently in use, as well the variability in their individual effectiveness.[2,3] Within the field of shoulder and elbow surgery alone, there are more than a dozen commonly used PROMs, ranging from general shoulder assessments to disease-specific instruments.[1]

In an effort to create a more standardized approach to patient-centered outcome measurement, the National Institutes of Health has developed a set of tools known as the Patient-Reported Outcomes Measurement Information System (PROMIS). These tools measure patient health across 5 subdomains: Physical Function, Social Function, Pain, Fatigue, and Emotional Distress.[3] Through the use of computer adaptive testing, PROMIS instruments utilize a patient's responses to adaptively select questions from a large item bank. Each subsequent question is selected based on the patient's answer to the previous item and can vary from one patient to another. This adaptive ability allows PROMIS instruments to avoid redundancy in subsequent questions and deliver accurate outcome measurements while minimizing both response burden and troublesome floor and ceiling effects.[1] The PROMIS Upper Extremity (PROMIS-UE) instrument (version 2.0), which was created from a subset of the questions in the Physical Function subdomain, is of particular importance to the field of shoulder and elbow surgery. Because many legacy PROMs used in shoulder and elbow surgery combine a variety of different domains of health measurement into one tool, their ability to precisely detect changes in patients' physical function is diminished.[4] By focusing solely on upper-extremity physical function, the PROMIS-UE instrument can enable clinicians and researchers to more effectively measure outcomes and make treatment decisions. For this reason, there has been much research comparing the PROMIS-UE instrument with previously validated legacy instruments. Although a number of cross-sectional studies have shown that the PROMIS-UE instrument correlates well with legacy instruments,[5-22] there are few longitudinal studies that have shown the validity of the PROMIS-UE instrument for specific orthopaedic patient populations.[16,22-27]

The goal of this prospective longitudinal study was to assess the preoperative and postoperative performance of the PROMIS-UE outcome score in comparison to the American Shoulder and Elbow Surgeons (ASES) and Western Ontario Rotator Cuff Index (WORC) instruments in patients undergoing rotator cuff repair (RCR). We hypothesized that the PROMIS-UE instrument would correlate well with these legacy instruments in patients undergoing RCR and that it would be able to precisely capture changes in patient function while reducing response burden, avoiding any floor or ceiling effects.

Methods

This study was approved by the NYU Langone Health Institutional Review Board (No. s18-01216). All study patients provided informed consent prior to enrollment.

Study Design

This prospective, observational cohort study recruited 105 patients scheduled to undergo RCR surgery, of whom 14 were lost to follow-up. Study subjects were recruited from the outpatient orthopaedic surgery clinic at NYU Langone Health between March 2019 and December 2020. Potential subjects were identified by monitoring the upcoming surgery schedule. Subjects were considered for inclusion if they were scheduled to undergo RCR, were 18 years or older, had no other trauma to the arm or shoulder (eg, fracture or dislocation), and were willing and able to provide informed consent. Subjects were excluded if they were unable to communicate in English, if they did not complete the required preoperative PROMs, and if they did not complete either the 3- or 12-month follow-up surveys. Vulnerable subjects, such as prisoners or those with a mental handicap preventing their ability to provide informed consent, were not considered for enrollment. Consent for the study was obtained from all subjects in person during the preoperative office visit or, for those who did not have a preoperative clinic appointment, preoperatively on the day of surgery.

Data Collection

Subjects were asked to complete 3 PROMs preoperatively and postoperatively at 2 weeks, 6 weeks, 3 months, and 12 months. The outcome measures used in this study were the PROMIS-UE instrument (version 2.0), ASES instrument, and WORC instrument. Surveys were not checked for completeness until after study conclusion. Study data were collected online and managed using REDCap electronic data capture tools hosted at NYU Langone Health.[28,29] Links to complete the surveys were automatically sent to study subjects at the preoperative and postoperative time points using REDCap's built-in scheduling functionality. If a subject did not complete a survey on the day it was sent, reminder emails with a link to the survey were automatically sent daily for up to 5 days.

Outcome Measures

The PROMIS-UE instrument (version 2.0) is a subset of the PROMIS Physical Function computer adaptive test. It was designed to reliably measure upper-extremity physical function while eliminating floor and ceiling effects and reducing response burden

Table 1. Demographic Characteristics

Characteristic	Data (N = 91)
Age, mean (SD), yr	60.9 (10.4)
Sex	
Female	31 (34.1)
Male	60 (65.9)
Race	
American Indian or Alaska Native	0 (0)
Asian	2 (2.2)
Black or African American	9 (9.9)
White	77 (84.6)
>1 Race	2 (2.2)
Unknown or not reported	1 (1.1)
Ethnicity	
Hispanic or Latino	7 (7.7)
Not Hispanic or Latino	84 (92.3)
Unknown or not reported	0 (0)
BMI	
Mean (SD)	29.1 (6.01)
Median (minimum, maximum)	27.4 (20.4, 54.0)
Smoking status	
Never	59 (64.8)
Current	3 (3.3)
Former	29 (31.9)
Activity level	
Not active	5 (5.5)
Somewhat active	41 (45.1)
Very active	45 (49.5)
Hand dominance	
Right	81 (89.0)
Left	9 (9.9)
Ambidextrous	1 (1.1)
Tear size	
Small (<1 cm)	19 (20.9)
Medium (1-3 cm)	50 (54.9)
Large (>3 cm)	22 (24.2)

NOTE. Data are presented as number (percentage) unless otherwise indicated.

BMI, body mass index; SD, standard deviation.

through the use of computer adaptive testing.[1] The instrument is designed so that it has a mean score of 50 and standard deviation of 10 in the general population, with higher scores indicating better physical function.[27]

The ASES instrument is a general shoulder function assessment that includes 10 questions about function and 1 question about pain. Scores range from 0 to 100, with 50 points coming from the function section and 50 points coming from the pain section. The minimal clinically important difference for this instrument in patients with rotator cuff problems is reported to be 12 to 17 points.[1]

The WORC instrument is a rotator cuff–specific PROM. It includes 21 questions: 10 about physical symptoms, 4 about sports and recreation, 4 about lifestyle function, and 3 about emotional function. Each question is graded from 0 to 100, and the subscores are summed to yield a total score out of 2,100. On this scale, higher function is indicated by a lower overall score.[1] For purposes of comparison, this score can be converted into an index (or percentage) score (with a higher score indicating higher function) via the following equation: % Score = (2,100 − Total WORC score)/21. The minimal clinically important difference for the WORC score in patients with rotator cuff tears is estimated to be −282.6.[30]

Statistical Analysis

RStudio software (version 3.6.2; RStudio, Boston, MA) was used for all statistical analysis. The Pearson correlation coefficient was calculated between the PROMIS-UE scores and the scores on both legacy instruments at all time points. In addition, the correlation between the PROMIS-UE instrument and the Function subsection of the ASES instrument (ASES-Function) was calculated. The strength of correlation was graded using the following ranges previously defined for PROMs: excellent, $r > 0.7$; excellent-good, $r > 0.6$ to $r \leq 0.7$; good, $r > 0.3$ to $r \leq 0.6$; and poor, $r > 0.2$ to $r \leq 0.3$.[10,11] Change in mean outcome score versus baseline was assessed for each instrument, as well as the ASES-Function score, using a paired t test, and instrument responsiveness to change was measured using both the effect size (Cohen d) and the standardized response mean. Confidence intervals for the effect size and standardized response mean were estimated using bootstrap resampling (1,000 iterations). Values were defined as small (0.2), medium (0.5), or large (0.8).[25] For the ASES and WORC instruments, floor and ceiling effects were noted if more than 15% of subjects achieved scores at the minimum and maximum of the instrument's range, respectively.[14,31,32] Owing to the administration of the PROMIS-UE instrument as a computer adaptive test, its floor or ceiling effects were defined as more than 15% of subjects choosing the lowest or highest response value for each completed item.[27] Response burden for the PROMIS-UE instrument was calculated as the mean number of questions answered for all PROMIS-UE surveys across all time points. Response burden for the ASES and WORC instruments was assumed to be the total number of questions available for each instrument (11 and 21, respectively). $P < .05$ was considered statistically significant, with a Bonferroni-corrected P value of .0063 used to account for multiple comparisons.

An a priori power analysis was conducted to determine minimum sample size requirements. With α set at <.05 (based on the Bonferroni-corrected P value) and 80% power, a minimum of 74 subjects would be required to detect a correlation of 0.4 (moderate).

Results

Demographic Characteristics

A total of 91 subjects (61 men and 30 women) with a mean age of 60.4 years were included in the final

Table 2. Mean PROM Scores

		Postoperative		
	Preoperative (N = 91)	6 wk (n = 65)	3 mo (n = 86)	12 mo (n = 67)
PROMIS-UE score				
Mean (SD)	31.8 (7.41)	32.0 (6.36)	36.9 (6.55)	47.6 (9.35)
Median (minimum, maximum)	31.1 (14.7, 54.7)	32.4 (17.8, 45.0)	35.8 (23.0, 55.9)	47.9 (26.8, 61.0)
ASES score				
Mean (SD)	45.3 (18.8)	55.0 (18.4)	69.2 (17.0)	86.0 (17.4)
Median (minimum, maximum)	46.7 (5.00, 81.7)	58.3 (3.33, 90.0)	70.8 (25.0, 98.3)	91.7 (16.7, 100)
ASES-F score				
Mean (SD)	25.5 (9.52)	22.8 (9.98)	32.1 (9.80)	43.3 (7.63)
Median (minimum, maximum)	26.7 (5.00, 45.0)	21.7 (3.33, 45.0)	32.5 (10.0, 48.3)	46.7 (16.7, 50.0)
WORC score				
Mean (SD)	34.9 (19.3)	44.2 (17.5)	58.7 (21.5)	80.5 (20.6)
Median (minimum, maximum)	31.9 (3.76, 88.6)	45.3 (10.1, 91.7)	56.6 (15.4, 96.7)	85.8 (16.0, 100)

ASES, American Shoulder and Elbow Surgeons; ASES-F, American Shoulder and Elbow Surgeons Function subdomain; PROM, patient-reported outcome measure; PROMIS-UE, Patient-Reported Outcomes Measurement Information System Upper Extremity; SD, standard deviation; WORC, Western Ontario Rotator Cuff Index.

analysis of this study (86.7% follow-up). Demographic data are summarized in Table 1.

Mean Scores and Responsiveness to Change

Mean scores for each PROM are shown in Table 2, effect sizes are shown in Table 3, and box plots for each PROM are presented in Figures 1, 2, 3, and 4. For the PROMIS-UE instrument, there was a statistically significant change in scores relative to baseline at 3 and 12 months ($P < .001$) but not at 6 weeks ($P = .20$). The effect size was small at 6 weeks (0.16), medium to large at 3 months (0.71), and large at 12 months (1.98).

Both the ASES and WORC instruments showed statistically significant changes in scores relative to baseline at 6 weeks, 3 months, and 12 months ($P < .001$). Both instruments showed medium to large effect sizes at 6 weeks (0.60 and 0.59, respectively) and large effect sizes at 3 and 12 months (1.23 and 2.09, respectively, for the ASES instrument and 1.12 and 2.26, respectively, for the WORC instrument).

Correlation of PROMIS Scores With ASES and WORC Scores

Correlations between the PROMIS-UE instrument and the legacy PROMs are presented in Table 4. The correlations between the PROMIS-UE scores and the ASES, ASES-Function, and WORC scores were excellent at all time points, with the one exception of an excellent-good (0.68) correlation between the ASES and PROMIS-UE scores at 3 months. All correlations measured were statistically significant using a Bonferroni-corrected P value of .0063.

Floor and Ceiling Effects

Floor and ceiling effect calculations are shown in Table 5. None of the instruments exhibited floor effects at any time point. However, both the PROMIS-UE and ASES instruments were found to exhibit ceiling effects at 12 months (16.42% and 20.90%, respectively). No ceiling effects were noted for the WORC instrument at any time point.

Response Burden

The mean number of questions answered for each PROMIS survey completed was 5.62 (95% confidence interval, 5.31-5.92), a significant reduction in comparison to the fixed-length ASES (11 questions) and WORC (21 questions) surveys.

Discussion

Our longitudinal study results show that the PROMIS-UE instrument has an excellent-good to

Table 3. Effect Sizes of PROMs at Each Time Point Compared With Preoperative Baseline

	Effect Size (95% CI)		
	6 wk Postoperatively	3 mo Postoperatively	12 mo Postoperatively
PROMIS-UE score	0.16 (−0.08, 0.41)	0.71 (0.47, 0.95)	1.98 (1.57, 2.41)
ASES score	0.60 (0.33, 0.87)	1.23 (0.95, 1.51)	2.09 (1.67, 2.53)
ASES-F score	−0.20 (−0.45, 0.04)	0.62 (0.39, 0.86)	1.93 (1.53, 2.35)
WORC score	0.59 (0.33, 0.86)	1.12 (0.85, 1.39)	2.26 (1.82, 2.73)

ASES, American Shoulder and Elbow Surgeons; ASES-F, American Shoulder and Elbow Surgeons Function subdomain; CI, confidence interval; PROM, patient-reported outcome measure; PROMIS-UE, Patient-Reported Outcomes Measurement Information System Upper Extremity; WORC, Western Ontario Rotator Cuff Index.

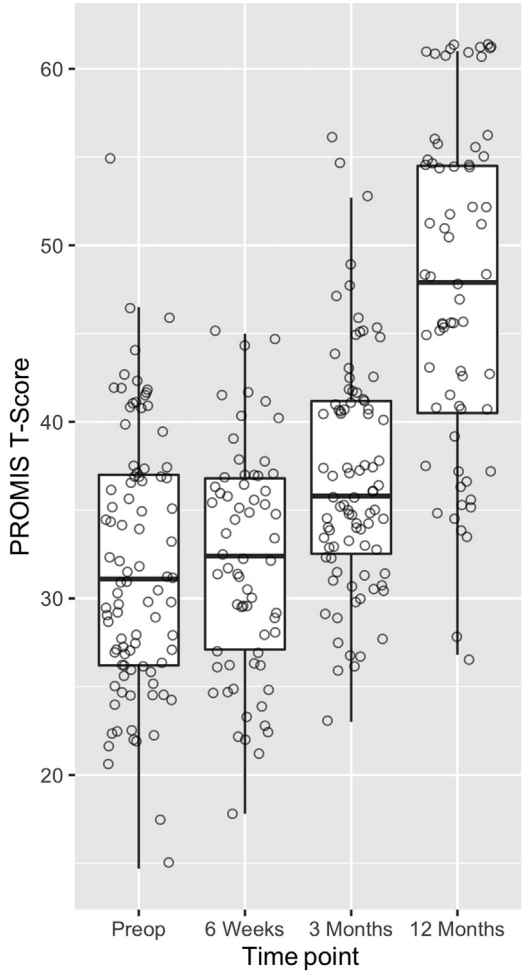

Fig 1. Box-and-whisker plot of Patient-Reported Outcomes Measurement Information System Upper Extremity (PROMIS-UE) scores at each time point. The box spans the range between the 25th and 75th percentile scores, and the black center line denotes the median. The upper and lower whiskers are bounded by the maximum and minimum values that are within 1.5 times the interquartile range from the 75th and 25th percentiles. Individual scores are displayed for each time point, with random left-right scattering introduced to aid readability. (Preop, Preoperative.)

excellent correlation with the ASES and WORC instruments both preoperatively and postoperatively while reducing patient response burden. These results are in line with the findings of cross-sectional studies comparing the PROMIS-UE instrument with legacy instruments in patients with rotator cuff pathology,[5,9,12,21] basilar thumb arthritis,[14] carpal tunnel is repeated later on with cubital tunnel syndrome, our apologies for writing such twice. shoulder pain,[10] adhesive capsulitis,[16] shoulder instability,[6] patients undergoing biceps tenodesis[19] or transhumeral amputation,[17] common elbow conditions requiring surgery,[15] and patients with carpal or cubital tunnel syndrome[13,18]; in addition to the hand patient population[20,33] and the general orthopaedic patient population.[7] The few longitudinal studies previously published have similarly shown that the PROMIS-UE instrument correlates with legacy instruments in patients with upper-extremity fractures,[26,27] idiopathic adhesive capsulitis,[16] and early carpometacarpal arthritis,[22] as well as patients undergoing shoulder instability repair,[25] total shoulder arthroplasty,[24] and surgical treatment for osteochondritis dissecans of the humeral capitellum.[23] Nicholson et al.[34] analyzed a similar population of patients with rotator cuff disorders as a subset in their study but compared the PROMIS Global-10 instrument with legacy outcome scores.

Our study showed that both the PROMIS-UE and ASES instruments exhibit ceiling effects at 12 months

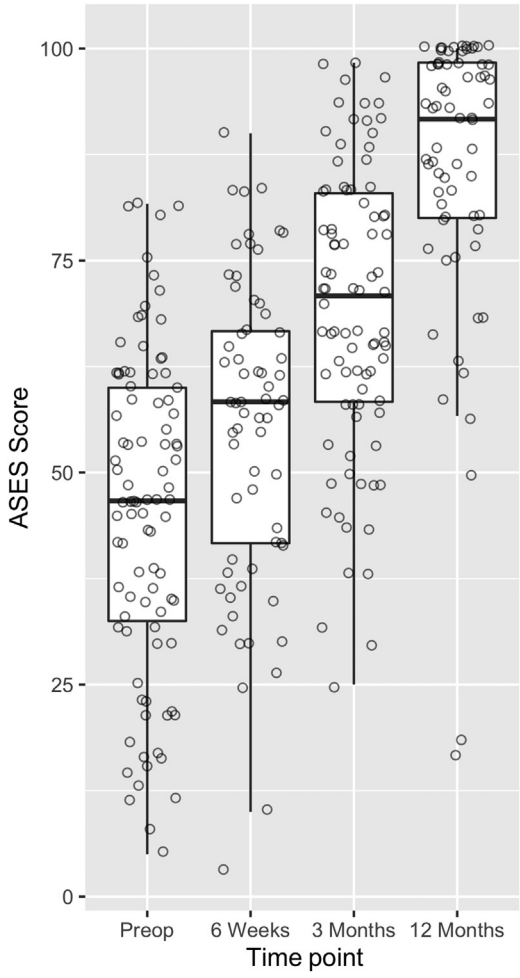

Fig 2. Box-and-whisker plot of American Shoulder and Elbow Surgeons (ASES) scores at each time point. The box spans the range between the 25th and 75th percentile scores, and the black center line denotes the median. The upper and lower whiskers are bounded by the maximum and minimum values that are within 1.5 times the interquartile range from the 75th and 25th percentiles. Individual scores are displayed for each time point, with random left-right scattering introduced to aid readability. (Preop, Preoperative.)

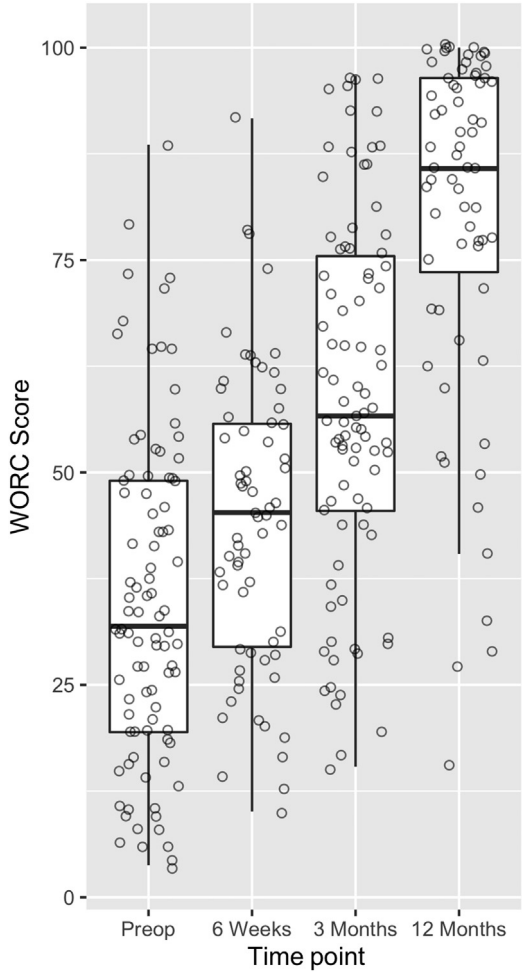

Fig 3. Box-and-whisker plot of Western Ontario Rotator Cuff Index (WORC) scores at each time point. The box spans the range between the 25th and 75th percentile scores, and the black center line denotes the median. The upper and lower whiskers are bounded by the maximum and minimum values that are within 1.5 times the interquartile range from the 75th and 25th percentiles. Individual scores are displayed for each time point, with random left-right scattering introduced to aid readability. (Preop, Preoperative.)

(16.42% and 20.90%, respectively) whereas the WORC instrument does not exhibit ceiling effects at any time point. Cross-sectional studies have reported differing ceiling effects, ranging from 0% for the PROMIS-UE and ASES instruments preoperatively in patients undergoing RCR to 10.82% for the PROMIS-UE instrument in the general hand patient population.[33] The PROMIS-UE score, which is a pure physical function score, starts showing increasing ceiling effects at 12 months, which correlates with the plateau of physical function after RCR. In contrast, the WORC score includes a mix of physical, lifestyle, and emotional functions, which may continue to show improvement beyond the 1-year mark without showing ceiling effects. Broughton et al.[23] and Kaat et al.[27] reported findings similar to our study findings with respect to high ceiling effects at long-term follow-up time points. These results indicate that the PROMIS-UE instrument can accurately measure physical function in patients with rotator cuff injury; however, owing to the high ceiling effects seen in patients with longer follow-up ($\geq$1 year), the WORC instrument may be a more sensitive outcome instrument in these situations. Regarding floor effects, 6 of the 7 previously cited longitudinal studies found no significant floor effects for the PROMIS-UE instrument, which is in line with our findings.[16,22,24-27]

Our results also indicate that although the PROMIS-UE instrument correlates well with the ASES and

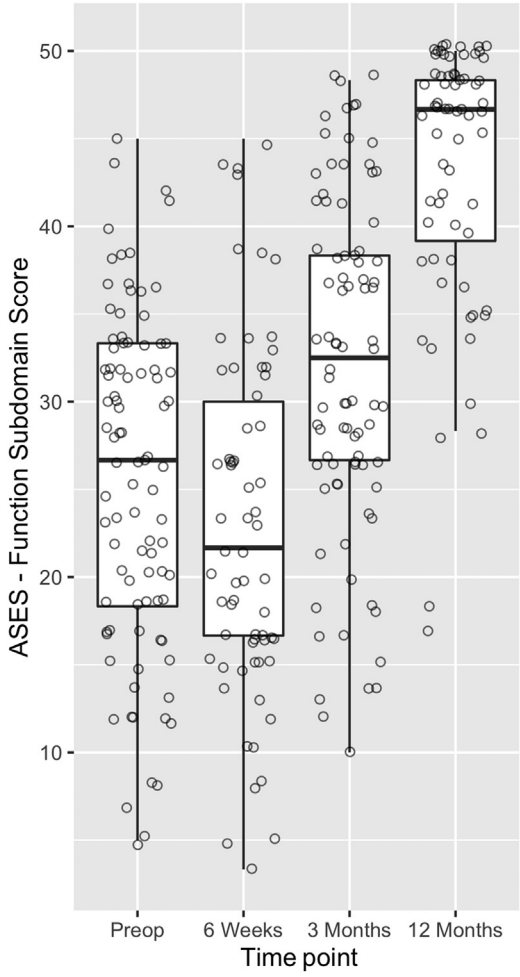

Fig 4. Box-and-whisker plot of American Shoulder and Elbow Surgeons (ASES)—Function subdomain scores at each time point. The box spans the range between the 25th and 75th percentile scores, and the black center line denotes the median. The upper and lower whiskers are bounded by the maximum and minimum values that are within 1.5 times the interquartile range from the 75th and 25th percentiles. Individual scores are displayed for each time point, with random left-right scattering introduced to aid readability. (Preop, Preoperative.)

Table 4. Pearson Correlation Coefficients Between PROMIS-UE Instrument and Legacy PROMs

		Postoperative		
	Preoperative	6 wk	3 mo	12 mo
ASES score	0.71 ($P < .001$)	0.72 ($P < .001$)	0.68 ($P < .001$)	0.73 ($P < .001$)
ASES-F score	0.73 ($P < .001$)	0.77 ($P < .001$)	0.80 ($P < .001$)	0.81 ($P < .001$)
WORC score	0.71 ($P < .001$)	0.71 ($P < .001$)	0.79 ($P < .001$)	0.77 ($P < .001$)

ASES, American Shoulder and Elbow Surgeons; ASES-F, American Shoulder and Elbow Surgeons Function subdomain; PROM, patient-reported outcome measure; PROMIS-UE, Patient-Reported Outcomes Measurement Information System Upper Extremity; WORC, Western Ontario Rotator Cuff Index.

WORC instruments postoperatively, there are some key differences in the longitudinal responsiveness of these instruments. The PROMIS-UE instrument showed a small effect size at 6 weeks, medium to large effect size at 3 months, and large effect size at 12 months. The ASES and WORC instruments, however, exhibited medium to large effect sizes at 6 weeks and large effect sizes at both 3 and 12 months. The reason for this difference is evident when we examine the mean scores in Table 2 and the box plots in Figures 1, 2, and 3. Unlike both the ASES and WORC scores, the PROMIS-UE score did not show a statistically significant change at 6 weeks. This finding is similar to the results for the ASES-Function subdomain, which showed no significant change at 6 weeks ($P = .106$) but showed statistically significant increases at 3 months and 12 months ($P < .001$). The difference in longitudinal responsiveness between the PROMIS-UE instrument and both the ASES and WORC instruments observed in this study highlights 2 important issues that make direct comparison between these PROMs difficult: First, each of these instruments measures a different combination of domains of patient health, and second, each differs in the weight it places on each domain when the overall score is calculated. Whereas the PROMIS-UE instrument exclusively measures upper-extremity physical function, the ASES and WORC instruments cover additional domains related to pain, emotion, work, recreation, and/or lifestyle. To complicate matters further, 50% of the total ASES score is determined by a single pain question on a visual analog scale, with the other 50% determined by a 10-question function section that also includes questions about work, leisure, and sleep. The WORC instrument, on the other hand, assigns approximately 48% of its score to pain/symptoms, 19% to sports/recreation/work, 19% to lifestyle, and 14% to emotion, with questions devoted solely to physical function dispersed throughout each subsection. Improvements in 1 domain of patient health, such as pain or range of motion, will therefore affect each score in unique ways. To highlight this difference, we also calculated the correlation between the PROMIS-UE instrument and the Function subdomain of the ASES instrument (ASES-Function). As shown in Table 3, the correlation between these 2 instruments was stronger at all time points than the correlation between the PROMIS-UE score and the total ASES score. Table 4 shows that the effect sizes calculated for both the PROMIS-UE and ASES-Function scores followed a similar pattern across the 3 postoperative time points, which can be visually confirmed in the score box plots in Figures 1 and 4, respectively.

Overall, the variation in the content of these particular PROMs—and of PROMs in general—makes it difficult for researchers to compare studies that use different PROMs with one another, and it makes it difficult for clinicians to use any single PROM score to obtain an accurate picture of how a patient is faring across all domains of health. This issue is in fact one of the main motivations for the development of the PROMIS tools by the National Institutes of Health, as well as why each PROMIS instrument is devoted to a single subdomain of patient health. However, it is not certain whether additional PROMIS instruments (pain interference or pain intensity, mobility, and global) are necessary to improve the responsiveness of the PROMIS-UE instrument compared with the ASES or WORC instrument for rotator cuff disorder or other musculoskeletal disorders. More research is needed to determine the efficacy of the other available PROMIS instruments in the RCR patient population, the best combination of instruments to administer to accurately capture patient health while minimizing response burden, and the minimal clinically important difference for each PROMIS instrument to better understand the clinical importance of changes in patient scores.

Limitations

There are a few limitations of our study. First, we did not compare the PROMIS score with every available shoulder outcome score, such as the Constant score or Simple Shoulder Test score. Although other outcome scores could have been added to the study, doing so could have increased the dropout rate and possibly skewed the results owing to responder fatigue. We selected the general shoulder ASES instrument and the rotator cuff–specific WORC instrument based on their well-established excellent validity, reliability, and responsiveness, as well as their ability to be entirely completed by subjects without the input of a physician

Table 5. Floor and Ceiling Effects of PROMIS-UE CAT, ASES, ASES-F and WORC Scores

	Preoperative		Postoperative					
			6 wk		3 mo		12 mo	
	Floor	Ceiling	Floor	Ceiling	Floor	Ceiling	Floor	Ceiling
PROMIS-UE score	1 of 91 (1.10)	0 of 91 (0.00)	0 of 65 (0.0)	0 of 65 (0.00)	0 of 60 (0.0)	0 of 86 (0.0)	0 of 86 (0.0)	11 of 86 (16.42)
ASES score	0 of 91 (0.0)	0 of 91 (0.0)	0 of 65 (0.0)	0 of 65 (0.0)	0 of 60 (0.0)	0 of 86 (0.0)	0 of 86 (0.0)	14 of 86 (20.90)
ASES-F score	0 of 91 (0.0)	0 of 91 (0.0)	0 of 65 (0.0)	0 of 65 (0.0)	0 of 60 (0.0)	0 of 86 (0.0)	0 of 86 (0.0)	15 of 86 (22.39)
WORC score	0 of 91 (0.00)	0 of 91 (0.0)	0 of 65 (0.0)	0 of 65 (0.0)	0 of 60 (0.0)	0 of 86 (0.0)	0 of 86 (0.0)	3 of 86 (4.48)

NOTE. Data are presented as number (percentage).
ASES, American Shoulder and Elbow Surgeons; ASES-F, American Shoulder and Elbow Surgeons Function subdomain; CAT, computer adaptive test; PROMIS-UE, Patient-Reported Outcomes Measurement Information System Upper Extremity; WORC, Western Ontario Rotator Cuff Index.

(as would be required by the physical examination section of the Constant score, for example).[1] Second, like all survey-based studies, this study has the potential to suffer from self-selection and/or response bias. Subjects were required to have access to a working email account (and a computer or phone) to participate in this study, so socioeconomic factors and advanced age could have limited participation and confounded our results. Although use of electronic administration is not generally thought to be a barrier to the use of PROMs, there is limited research in this area.[35] Third, the overall number of subjects included in this study is not large (N = 91). However, the power analysis showed that a sample size of 74 would be sufficient to detect an effect size of 0.4 between outcome scores. Fourth, we did not randomize the order in which subjects completed surveys, so responder fatigue can potentially skew the results. However, a previous study investigating PROMIS performance found no difference in results when randomizing the order of outcome instruments during survey responses.[5] Finally, in addition to undergoing RCR, some subjects underwent procedures such as biceps tenodesis and subacromial decompression, depending on the pathology present and surgeon preference. Although subgroup analysis of patients with and without additional procedures may show important differences, this comparison was not the intent of our study and therefore was not undertaken.

Conclusions

The PROMIS-UE instrument shows excellent correlation with the ASES instrument and a rotator cuff–specific outcome instrument—the WORC instrument—preoperatively and at 1 year after arthroscopic RCR. Variations in the measured effect sizes at different postoperative time points and high ceiling effects of the PROMIS-UE instrument at the 1-year time point may limit its utility in the early postoperative phase and at long-term follow-up after RCR.

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