

## Title: Development and Psychometric Testing of a Novel Scale for Shoulder Assessment

Seyedeh Zahra Mousavi, BS<sup>1</sup>; Rashelle Musci, PhD<sup>2</sup>; Brienna K. Buchanan, BS<sup>3</sup>; Uma Srikumaran, MD, MBA, MPH<sup>1</sup>

<sup>1</sup>Johns Hopkins University, Department of Orthopaedics, Baltimore, MD, USA

<sup>2</sup>Johns Hopkins University, School of Public Health, Baltimore, MD, USA

<sup>3</sup>Johns Hopkins University, School of Medicine, Baltimore, MD, USA

**INTRODUCTION:** Assessment of shoulder conditions and their impact on quality of life is essential in orthopedic care. Existing patient-reported outcome measures (PROMs) lack relevance to diverse populations, have complex scoring systems, suffer from ceiling effects, are lengthy, and have a high administrative burden. The Subjective Shoulder Scale (S3) is a novel PROM designed to address limitations of existing instruments by providing a comprehensive, efficient, and patient-centered evaluation across seven key domains.

**MATERIALS & METHODS:** Items were generated through a comprehensive review of existing PROMs and refined via input of an expert panel as well as patient feedback to cover seven domains: pain, range of motion, strength, stability, activities of daily living, sports and leisure, and mental well-being. After pretesting, test-retest reliability was evaluated in 100 patients by calculating Cronbach's alpha and the intraclass correlation coefficient (ICC). For construct validity, 124 patients undergoing various shoulder procedures completed both the S3 and the American Shoulder and Elbow Surgeons (ASES) questionnaire preoperatively and postoperatively; Pearson's correlation coefficients were calculated to examine the relationship between the two instruments. An exploratory factor analysis, using principal axis factoring with oblique rotation, was conducted to assess the latent structure of the S3. Lastly, responsiveness was determined by calculating the effect size and by establishing clinically meaningful thresholds for the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptom state (PASS).

**RESULTS:** The S3 demonstrated excellent readability with a FKG score of 6.8 corresponding to a 7th-grade reading level. Pretesting among 20 patients confirmed clarity, relevance, proper duration, and ease of use. In the full psychometric evaluation cohort of 224 patients (mean age  $58.76 \pm 12.41$  years; 50.45% female), the S3 exhibited excellent test-retest reliability with an intraclass correlation coefficient of 0.96 (95% CI: 0.94–0.97) and high internal consistency (Cronbach's  $\alpha = 0.93$ ). No floor or ceiling effects were observed. Exploratory factor analysis supported a unidimensional structure, with a single factor accounting for 65.2% of the total variance and individual item loadings ranging from 0.52 to 0.86. Convergent validity was established through a strong positive correlation with the American Shoulder and Elbow Surgeons (ASES) questionnaire ( $r = 0.71$ ,  $p < 0.001$ ). Responsiveness testing established the thresholds for MCID as 12.4 points, SCB at 19.9 points, and PASS ranging from 38 to 83 points.

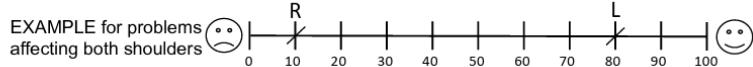
**DISCUSSION:** S3 is a reliable, valid, and responsive PROM that is effective in capturing impact of diverse shoulder conditions and patient-reported outcomes. By addressing potential weaknesses of existing questionnaires, S3 may enhance clinical assessments, facilitate personalized treatment planning to ultimately advance the quality of musculoskeletal healthcare by ensuring more efficient and meaningful patient evaluations.

## Subjective Shoulder Scale

Please rank your shoulder's condition with respect to the following categories.

If only one shoulder is problematic, indicate which shoulder:  Right  Left

If both shoulders are problematic, label each slash ("|") with "R" for right or "L" for left. See example.



Category		Make a single slash (" ") along the line	
Pain	Worst pain possible	0 10 20 30 40 50 60 70 80 90 100	No pain
Range of Motion	No range of motion	0 10 20 30 40 50 60 70 80 90 100	Full/Normal range of motion
Strength	No strength	0 10 20 30 40 50 60 70 80 90 100	Full/Normal strength
Stability	No stability (easily dislocated, feels "loose")	0 10 20 30 40 50 60 70 80 90 100	Normal stability
Activities of Daily Living (personal hygiene, dressing, sleeping, eating)	Unable to do	0 10 20 30 40 50 60 70 80 90 100	Able to perform all Activities of Daily Living
Work, Sports and Leisure Activities	Unable to do	0 10 20 30 40 50 60 70 80 90 100	Able to perform all desired activities
Effect of Shoulder Condition on Mental Well-being	Worse possible distress (anxiety, sadness, stress)	0 10 20 30 40 50 60 70 80 90 100	No distress
Overall Shoulder Assessment	Worse it could possibly be	0 10 20 30 40 50 60 70 80 90 100	Normal