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# Minimal Clinically Important Difference, Substantial Clinical Benefit, and Patient Acceptable Symptom State of Outcome Measures Relating to Shoulder Pathology and Surgery: a Systematic Review

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## Abstract

**Purpose of the Review** To provide a comprehensive summary of available literature on the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptom state (PASS) of patient-reported outcome measures (PROMs) for various shoulder conditions and outcomes and to identify factors that influence these metrics.

**Recent Findings** Over the past 2 years, there has been an increasing interest in utilizing MCID, SCB, and PASS as a gauge to evaluate the success of an intervention for shoulder conditions. Efforts at calculating these thresholds have yielded multiple and inconsistent values and are further compounded by the proliferation of different PROMs in the shoulder literature.

**Summary** The MCID, SCB, and PASS values of shoulder PROMs vary widely with study-specific characteristics, including patient demographics, shoulder pathology, treatment, shoulder instrument, study methodology, and calculation method. The differences in these factors are not inconsequential and could lead to large discrepancies in threshold values. It is crucial that clinicians are mindful of these variables when designing future studies to calculate these metrics or when utilizing previously published values to determine the success of an intervention.

**Keywords** Minimal clinical important difference · Substantial clinical benefit · Patient acceptable symptom state · Shoulder · Outcomes

## Introduction

Integration of patients' perceptions into the effects of treatment has led to an increase in the utilization of patient-reported outcome measures (PROMs) in orthopedic research studies. These metrics allow for injury- or disease-specific evaluations of patient's conditions, factoring in pain, function, and other components. Most commonly, PROMs are compared between groups or over time to determine statistically significant differences or

changes; however, statistically significant changes in outcomes may not always equate to clinical significance [1, 2]. Because the meaning of absolute changes in PROMs is not readily obvious, specific thresholds, such as minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptom state (PASS), have been determined for outcome scores to more clearly convey clinical relevance.

The concept of MCID was first described by Jaeschke et al. and describes the minimum value over which a patient has determined his or her clinical outcome to be beneficial and meaningful [1]. Two common approaches of deriving MCID are distribution-based and anchor-based methods [3]. Distribution-based methods solely rely on the statistical characteristics of the instrument (e.g., standard error of measurement, effect size, standard deviation, or minimum detectable change) and are generally considered less informative because they do not reflect the patient's perspective [4, 5]. In contrast, anchor-based methods specify the patient's perception of improvement

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based off of an external criterion or anchor of pain or function. The relation between the anchor and the PROM is analyzed to establish the smallest change in score that best differentiates meaningful change to the patient [6].

Although the MCID is a key threshold that is being utilized with increasing frequency, it represents more of a floor value rather than a goal in terms of defining clinical success [7]. SCB represents the cutoff value for substantial improvement and is differentiated from MCID by identifying patients who responded "much better" rather than "somewhat better" on an external rating of change scale [6]. Another common metric for determining clinical success when utilizing PROMs is PASS, which is the score above which patients consider themselves well. The PASS is determined from the subset of patients who report that their current state of health is satisfactory after taking into account their activities of daily living, level of pain, and functional impairment [8].

Understanding the MCID, SCB, and PASS of shoulder pathologies is key for interpreting outcomes after treatment for various conditions. Although systematic reviews addressing MCID in shoulder PROMs are available, prior reviews limited their analyses to studies utilizing anchor-based methods or failed to perform a credibility assessment [9–11]. Furthermore, there are no reviews to date assessing the SCB or PASS of shoulder instruments. As such, the purpose of this systematic review is to provide a comprehensive summary of available literature on the MCID, SCB, and PASS for various shoulder conditions and outcomes.

## Methods

### Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were used in the design of this study (Fig. 1) [12]. A search was conducted using PubMed and Embase databases through May 26, 2020, to identify studies reporting the MCID, SCB, and PASS of all outcome measures pertaining to shoulder conditions. The full search criteria can be found in the Appendix. A total of 930 articles were identified after removal of duplicates. Inclusion criteria were articles pertaining to MCID, SCB, and PASS of outcome measures related to shoulder pathologies (rotator cuff tear, rotator cuff arthropathy, glenohumeral osteoarthritis, shoulder instability, superior labral anterior to posterior (SLAP) tear, biceps tendinitis, subacromial impingement, shoulder pain, acromioclavicular (AC) joint separation, rheumatic shoulder disease, proximal humerus fractures) or nonoperative or surgical treatment of shoulder conditions (physical therapy, rotator cuff repair, total shoulder arthroplasty (TSA), arthroscopic stabilization, etc.). Exclusion criteria included case reports, reviews, nonhuman studies, biomechanical studies, and scientific meeting abstracts or proceedings. Two authors (F.S. and S.A.) independently screened the titles, abstracts, and full texts. Any discrepancies in inclusion/exclusion were carried to the next round of screening to ensure thoroughness. References of each included study were further screened to capture any publications that may have eluded the original search queries. Fifty-five articles were found to be relevant, and an additional 5 articles were identified from article references.

**Fig. 1** The Preferred Reporting Items for Systematic Reviews and Meta-Analyses diagram of the literature search and study selection
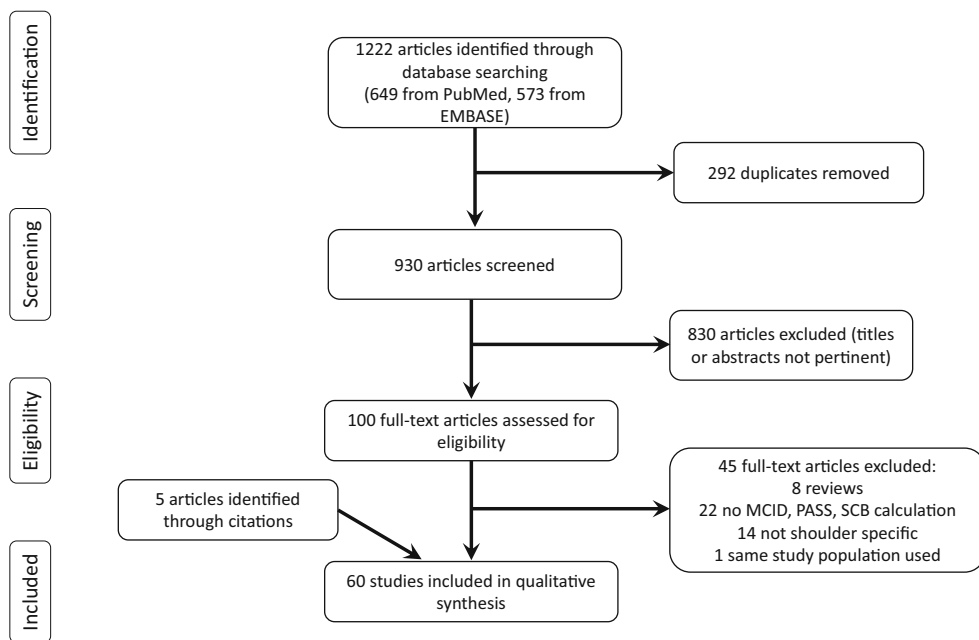
## Data Organization

Relevant data were extracted, including patient demographics, length of follow-up, type of pathology and intervention, anchor information, and calculation method. MCID, SCB, and PASS values were aggregated by PROM instrument, shoulder pathology, and intervention. Mean estimates and ranges were provided for outcome measures.

## Credibility Assessment

To assess the extent to which the methodology and performance of studies protect against misleading estimates of MCID and SCB, the credibility of these metrics was evaluated using previously published criteria [13]. A single criterion focusing on the correlation between change in the outcome measure and the anchor (e.g., global rating of change) was used. Values were considered to be credible if the correlation was greater than or equal to 0.4, whereas values were considered to be questionable if the correlation was less than 0.4 or if no correlation was reported [9].

## Results

A total of 60 articles were included in this review. Fifty-four (90%) studies reported MCID, nine (15%) calculated SCB, and 11 (18%) quantified PASS. Thirty-two different instruments were utilized; however, only 18 (56%) were reported more than once (Table 1). The sample size and minimum follow-up were highly variable for MCID, SCB, and PASS studies, ranging from 20 to 1568 patients and from 1 week to 24 months, respectively. Nearly all (96%) studies utilized an anchor-based method to calculate MCID; however, there were six different calculations used, including receiver operating characteristic (ROC) (50%), mean difference (24%), mean change (22%), mean change limit (9%), logistic regression (6%), and 75th percentile of the improved group (2%) (Table 2). Most studies used a single anchor that measured global/overall improvement (69%). Seven-point anchors were used most commonly (26%, range, 2–18 points). Distribution-based approaches were utilized less frequently (20%) to determine MCID, with one-half the standard deviation (82%) method being the most common.

For SCB, all studies utilized an anchor-based approach, but only ROC (67%) and mean difference (33%) calculations were used (Table 3). Most studies used a single anchor that measured global/overall improvement with 15-point anchors being the most common (56%, range 4–15 points). Similarly, all PASS studies utilized an anchor-based method assessing satisfaction with only ROC (73%) and 75th percentile of the satisfied group (45%) calculations being used (Table 4). A summary of mean MCID, SCB, and PASS values is shown in Tables 5, 6, 7 and 8. Of the 136 values reported, only 24.6% were considered to be credible.

Eleven studies calculated a MCID for rotator cuff repair with Constant (5 studies), ASES (4 studies), and SANE (3 studies) being the most commonly reported instruments. The mean MCID for Constant, ASES, and SANE using anchor-based methods were $10.9 \pm 11.0$ (range, 2.0–36.0), $17.8 \pm 8.0$ (range, 11.1–27.1), and $28.4 \pm 1.5$ (range, 27.3–29.4), respectively. Conversely, the mean MCID for Constant, ASES, and SANE using distribution-based methods were $6.6 \pm 2.8$ (range, 4.6–8.6), $19.3 \pm 10.7$ (range, 11.7–26.9), and $13.5 \pm 2.9$ (range, 11.8–16.9), respectively. Only one study reported on SCB for rotator cuff repair with mean values of 17.5, 5.5, and 29.8 for ASES, Constant, and SANE. One study reported on PASS for rotator cuff repairs with mean values of 86.7, 23.3, and 82.5 for ASES, Constant, and SANE.

Ten studies calculated a MCID for TSA with ASES (6 studies), SST (5 studies), and Constant (3 studies) being the most commonly reported instruments. The mean MCID for ASES, SST, and Constant using anchor-based methods were $16.0 \pm 9.0$ (range, 6.3–29.6), $2.9 \pm 1.0$ (range, 1.5–4.0), and $6.3 \pm 1.5$ (range, 5.1–8.0), respectively. Conversely, the mean MCID for ASES, SST, and Constant using distribution-based methods were $8.9 \pm 2.2$ (range, 6.5–11.8), 1.8, and $6.9 \pm 3.6$ (range, 4.3–9.4), respectively. Three studies reported on SCB for TSA with mean values of $23.9 \pm 8.8$ (range, 12.0–36.6) and $19.4 \pm 0.4$ (range, 19.1–19.6) for ASES and Constant, respectively. Three studies reported on PASS for TSA with mean values of $78.6 \pm 3.0$ (range, 76.0–81.9), $48.8 \pm 34.3$ (range 24.5–73.0), and $61.8 \pm 5.3$ (range, 58.0–65.5) for ASES, Constant, and SANE, respectively.

Other operative treatments were reported less frequently. Three studies calculated an MCID for arthroscopic shoulder stabilization. The MCID value for Rowe score was 9.7 and 5.6 for anchor-based and distribution-based calculations, respectively, whereas it was 8.5 for ASES. One study determined the MCID, SCB, and PASS values for biceps tenodesis. The anchor-based MCID values for ASES, Constant, and SANE was 16.3, 6.8, and 3.5, respectively. The SCB threshold was 16.8, 11.0, and 5.8, respectively, whereas the PASS was 59.6, 19.5, and 65.5, respectively. One study estimated the MCID for AC joint stabilization with cutoff for Constant, NPRS, and Taft being 16.6, 1.4, and 2.9, respectively. One study calculated the MCID for SLAP repair using two different methods. The mean MCID for OSIS, Rowe, and WOSI were $9.0 \pm 1.4$ (range, 8.0–10.0), $17.5 \pm 0.7$ (range, 17.0–18.0), and $510.0 \pm 83.4$ (range, 451.0–569.0), respectively.

There were nine studies that determined the MCID for nonoperative management of subacromial impingement and rotator cuff tears with WORC (3 studies), Constant (2 studies), and OSS (2 studies) being the most commonly reported measures. The mean MCID for WORC, Constant, and OSS using anchor-based methods were $343.6 \pm 94.3$ (range, 269.0–

**Table 1** Frequency of instruments reported

| Instrument | Abbreviation | No. Studies | Score range | |
|---|---|---|---|---|
| | | | Worse shoulder condition | Better shoulder condition |
| American Shoulder Elbow Surgeons | ASES | 18 | 0 | 100 |
| Constant-Murley | Constant | 16 | 0 | 100 |
| Disability of Arm, Shoulder, Hand | DASH | 9 | 100 | 0 |
| Shoulder Pain and Disability Index | SPADI | 9 | 100 | 0 |
| Single Alphanumeric Evaluation | SANE | 8 | 0 | 100 |
| Visual Analog Scale Pain | VAS Pain | 8 | 10 | 0 |
| Oxford Shoulder Scale | OSS | 7 | 0 | 48 |
| Simple Shoulder Test | SST | 7 | 0 | 12 |
| Numeric Pain Rating Scale | NPRS | 4 | 10 | 0 |
| Disability of Arm, Shoulder, Hand Short Version | QuickDASH | 4 | 100 | 0 |
| UCLA Shoulder Rating Scale | UCLA | 4 | 2 | 35 |
| Western Ontario Rotator Cuff Index | WORC | 4 | 2100 | 0 |
| Rowe Score | Rowe | 3 | 0 | 100 |
| Western Ontario Shoulder Instability Index | WOSI | 3 | 2100 | 0 |
| Global Shoulder Function | GSF | 2 | 0 | 10 |
| Oxford Shoulder Instability Score | OSIS | 2 | 0 | 48 |
| Patient-Specific Functional Scale | PSFS | 2 | 0 | 10 |
| Penn Shoulder Score | PSS | 2 | 0 | 100 |
| Bostrom Shoulder Movement Impairment Scale | Bostrom | 1 | 5 | 30 |
| Functional Shoulder Scale | FSS | 1 | 0 | 100 |
| Neer Function Score | Neer | 1 | 100 | 0 |
| Shoulder Function Index | SFInX | 1 | 0 | 100 |
| SF-12 Mental Component Score | SF-12 MCS | 1 | 0 | 100 |
| SF-12 Physical Component Score | SF-12 PCS | 1 | 0 | 100 |
| Shoulder Disability Questionnaire United Kingdom | SDQ-UK | 1 | 100 | 0 |
| Shoulder Disability Questionnaire Dutch | SDQ-NL | 1 | 100 | 0 |
| Shoulder Function Assessment Scale | SFA | 1 | 0 | 70 |
| Subjective Shoulder Value | SSV | 1 | 0 | 100 |
| Taft Score | Taft | 1 | 0 | 12 |
| VR-12 Mental Component Score | VR-12 MCS | 1 | 0 | 100 |
| VR-12 Physical Component Score | VR-12 PCS | 1 | 0 | 100 |
| Western Ontario Osteoarthritis Score | WOOS | 1 | 100 | 0 |

879.9), 18.5 ± 5.8 (range, 11.0–24.0), and 7.6 ± 3.5 (range, 4.0–12.2), respectively. Two studies reported on SCB for subacromial impingement with values of 11 and 21 for DASH and PSS, respectively. Similarly, two studies reported on PASS for subacromial impingement and rotator cuff tears managed nonoperatively with values of 21.3, 2.3, and 3.0 for Neer function score, NPRS, and VAS pain, respectively.

Nine studies calculated the MCID for physical therapy of nonspecific shoulder pain. The MCID for QuickDASH (3 studies) was 15.7 ± 8.4 (range, 8.0–27.8), whereas for SPADI (3

studies), it was 13.4 ± 6.1 (8.0–20.0). Although no studies on SCB were reported for nonspecific shoulder pain, the SANE and SPADI PASS threshold were 87 and 47.3 ± 1.5 (range, 46.2–48.3). Two studies calculated the MCID of physical therapy for shoulder instability. The MCID of OSIS was 5.3 ± 1.1 (range, 4.5–6.0) and SRQ was 5.0. One study reported on the SCB of physical therapy for shoulder instability with OSIS and SRQ cutoffs of 6.5 and 5.0, respectively. Only one study reported on the MCID of physical therapy for proximal humerus fractures with Constant, DASH, and OSS values of 11.6, 13.0, and 11.4.

**Table 2** Characteristics of studies reporting on MCID for shoulder patient-reported outcomes

| Study | Year | Instrument(s) | N | Follow-up (months) | Diagnosis | Treatment | Method | Domain | Calculation |
|---|---|---|---|---|---|---|---|---|---|
| Rysstad et al. [14] | 2020 | QuickDASH, PSFS | 106 | 3 | Shoulder pain | PT | Anchor | Global: 7 points | (1) ROC (2) Logistic regression |
| Tashjian et al. [15] | 2020 | ASES, SST, VAS Pain | 202 | 12 | RC tear | RC repair | Anchor | Global: 4 points | Mean difference |
| Berglund et al. [16] | 2019 | ASES, SANE, SST, VAS Pain | 534 | 24 | OA, RCA | TSA | Anchor | Satisfaction: 4 points | Mean difference |
| Berglund et al. [17] | 2019 | SST | 176 | 24 | RCA | TSA | Anchor | Satisfaction: 4 points | Mean difference |
| Cvetanovich et al. [6] | 2019 | ASES, Constant, SANE | 288 | 12 | RC tear | RC repair | Anchor, Distribution | Pain: 15 points | (1) ROC (2) ½ × SD |
| Gowd et al. [18] | 2019 | ASES, Constant, SANE | 207 | 12 | OA, RCA | TSA | Anchor, distribution | Pain: 15 points | (1) ROC (2) Distribution: not specified |
| Park et al. [19] | 2019 | ASES, Rowe | 216 | 12 | Shoulder instability | Arthroscopic stabilization | Anchor | Function: 15 points | Mean difference |
| Policastro et al. [20] | 2019 | ASES | 130 | – | Various shoulder pathologies | PT | Anchor | Global: 15 points | Mean difference |
| Puzzitiello et al. [21] | 2019 | ASES, Constant, SANE | 123 | 6 | Biceps tendinitis | Biceps tenodesis | Anchor, distribution | Pain: 15 points | (1) ROC (2) ½ × SD |
| Kc et al. [22] | 2019 | SPADI | 119 | – | Shoulder pain | PT | Anchor | Global: 7 points | ROC |
| Kc et al. [23] | 2019 | DASH | 121 | 1 | Shoulder pain | PT | Anchor | Global: 7 points | ROC |
| Xu et al. [24] | 2019 | Constant, OSS, UCLA | 327 | 24 | RC tear | RC repair | Anchor | Fulfillment: 7 points; Satisfaction: 6 points | Logistic regression |
| Braun et al. [25] | 2018 | WORC | 54 | 3 | RC tear | PT | Anchor | Global: 7 points | Logistic regression |
| Budtz et al. [26] | 2018 | QuickDASH | 261 | 3 | Shoulder pain | PT | Anchor | Global: 7 points | (1) ROC (2) Mean change +1.645 × SD |
| Gagnier et al. [27] | 2018 | ASES, WORC | 222 | 16 | RC tear | Operative, nonoperative | Anchor, distribution | Global: 5 points | (1) Mean change (2) ½ × SD |
| Gowd et al. [28] | 2018 | ASES, Constant | 89 | 12 | RC tear | RC repair | Anchor | Pain: 15 points | ROC |
| Koorevaar et al. [29] | 2018 | DASH | 144 | 12 | Various shoulder pathologies | Operative | Anchor | Global: 7 points | Mean change |
| Park et al. [30] | 2018 | Rowe, WOSI | 198 | 12 | Shoulder instability | Arthroscopic stabilization | Anchor | Function: 15 points | Mean difference |
| Simovitch et al. [31] | 2018 | ASES, Constant, GSF, SST, SPADI, UCLA, VAS pain | 466 | 24 | OA, RCA | TSA | Anchor, distribution | Global: 4 points | (1) Mean difference (2) ½ × SD |
| Stein et al. [32] | 2018 | Constant, NPRS, Taft | 73 | 24 | AC joint separation | AC stabilization | Anchor | Global: 6 points | Mean difference |
| Thigpen et al. [33] | 2018 | SANE | 212 | 3 | Various shoulder pathologies | Operative, nonoperative | Distribution | N/A | Distribution: not specified |

**Table 2** (continued)

| Study | Year | Instrument(s) | N | Follow-up (months) | Diagnosis | Treatment | Method | Domain | Calculation |
|---|---|---|---|---|---|---|---|---|---|
| Wessel et al. [34] | 2018 | WORC | 105 | 6 | Various shoulder pathologies | Operative, nonoperative | Anchor | Hindrance: 11 points | (1) ROC (2) Mean change +1.645 × SD |
| Zhou et al. [35] | 2018 | SANE, VR-12 | 160 | 16 | RC tear | Operative, nonoperative | Anchor, distribution | Global: 5 points | (1) Mean change (2) ½ × SD |
| Thoomes-de Graaf et al. [36] | 2017 | SPADI | 237 | 6.5 | Shoulder pain | PT | Anchor | Global: 7 points | ROC |
| Rysstad et al. [37] | 2017 | DASH | 50 | 4 | Subacromial impingement | PT | Anchor | Global: 3 points | ROC |
| Tashjian et al. [38] | 2017 | ASES, SST, VAS pain | 326 | 24 | OA, RCA | TSA | Anchor | Global: 4 points | Mean difference |
| van der Linde et al. [39] | 2017 | OSS, WOSI | 105 | 6 | Shoulder instability | PT | Anchor | Global: 7 points | ROC |
| Torrens et al. [40] | 2016 | Constant | 60 | 12 | RC tear, RCA | TSA | Anchor | Function: 15 points | ROC |
| van der Water [41] | 2016 | SFInX | 74 | 1.75 | Proximal humerus fractures | PT | Anchor, distribution | Global: 15 points | (1) Mean change (2) ½ × SD |
| Werner et al. [42] | 2016 | ASES | 490 | 24 | OA, RCA | TSA | Anchor | Global, work, activities: 5 points | Mean difference |
| Wong et al. [43] | 2016 | ASES, SF-12 | 107 | 12 | OA, RCA | TSA | Distribution | NA | ½ × SD |
| Christiansen et al. [44] | 2015 | Constant, OSS | 126 | 3 | Subacromial impingement | PT | Anchor | Global: 7 points | (1) ROC (2) Mean change +1.645 × SD |
| Iossifidis et al. [45] | 2015 | FSS | 119 | 6 | RC tear | RC repair | Anchor | Global: 5 points | Mean change |
| Negahban et al. [46] | 2015 | SPADI, DASH | 200 | 1 | Various shoulder pathologies | PT | Anchor | Global: 7 points | ROC |
| Castricini et al. [47] | 2014 | Constant | 27 | 24 | RC tear | RC repair | Anchor | Satisfaction: 3 points | Mean change |
| Holmgren et al. [48] | 2014 | Constant | 93 | 3 | Subacromial impingement, RC tear | PT | Anchor | Global: 5 points | (1) ROC (2) Mean change +1.645 × SD |
| Koehorst et al. [49] | 2014 | PSFS | 50 | 1.5 | Shoulder pain | PT | Anchor | Global: 11 points | ROC |
| Lundquist et al. [50] | 2014 | DASH | 59 | 8 | Various shoulder pathologies | PT | Anchor | Global: 7 points | ROC |
| Skare et al. [51] | 2014 | OSIS, Rowe, WOSI | 89 | 6 | SLAP tear | Operative, nonoperative | Anchor | Global: 4 points | (1) ROC (2) Mean change +1.645 × SD |
| van der Water [52] | 2014 | Constant, DASH, OSS, SSV, UCLA | 20 | 3 | Proximal humerus fractures | PT | Anchor, Distribution | Global: 15 points | (1) Mean change (2) ½ × SD |
| Kukkonen et al. [53] | 2013 | Constant | 776 | 3 | RC tear | RC repair | Anchor, Distribution | Global: 2 points | (1) Mean change (2) Mean difference (3) ROC (4) ½ × SD |

**Table 2** (continued)

| Study | Year | Instrument(s) | N | Follow-up (months) | Diagnosis | Treatment | Method | Domain | Calculation |
|---|---|---|---|---|---|---|---|---|---|
| van Kampen et al. [54] | 2013 | DASH, OSS, QuickDASH, SST | 164 | 6 | Various shoulder pathologies | Operative, nonoperative | Anchor | Function, pain: 7 points | Mean change |
| Christie et al. [55] | 2011 | Bostrom, Constant, DASH, OSS, SFA, SPADI, VAS pain | 100 | 12 | Rheumatic shoulder disease | Operative | Anchor | Global: 5 points | Mean change |
| Michener et al. [56] | 2011 | NPRS | 136 | 1 | Shoulder pain | PT | Anchor | PSS | ROC |
| Ekeberg et al. [57] | 2010 | OSS, SPADI, WORC | 121 | 6 | Subacromial impingement | Steroid injection | Anchor | Global: 18 points | (1) ROC (2) Mean change (3) Mean change +1.645 × SD |
| Roy et al. [58] | 2010 | SST | 120 | 6 | OA, RCA | TSA | Anchor | DASH | ROC |
| Tashjian et al. [59] | 2010 | ASES, SST | 81 | 1.5 | RC tear | PT | Anchor | Global: 4 points; Function, pain: 15 points | Mean difference |
| Mintken et al. [60] | 2009 | NPRS, QuickDASH | 101 | 1 | Shoulder pain | PT | Anchor | Global: 15 points | ROC |
| Tashjian et al. [61] | 2009 | VAS Pain | 81 | 6 | Subacromial impingement, RC tear | PT | Anchor | Global: 4 points | Mean difference |
| Moser et al. [62] | 2008 | OSIS, SRQ | 100 | 9 | Shoulder instability | PT | Anchor | Global: 5 points | ROC |
| Leggin et al. [63] | 2006 | PSS | 49 | 1 | Various shoulder pathologies | PT | Anchor | Global: 5 points | Mean change |
| Tubach et al. [8] | 2006 | Neer, NPRS | 252 | 0.25 | Subacromial impingement | NSAIDs | Anchor | Global: 15 points | 75th percentile |
| Paul et al. [64] | 2004 | SDQ-UK, SDQ-NL, SPADI, SRQ | 180 | 6 | Shoulder pain | Nonoperative | Anchor | Global: 7 points | ROC |
| Michener et al. [65] | 2002 | ASES | 59 | 1 | Various shoulder pathologies | PT | Anchor | Global: 5 points | ROC |

MCID, minimal clinically important difference; QuickDASH, Disability of Arm, Shoulder, Hand short version; PSFS, Patient-Specific Functional Scale; PT, physical therapy; ROC, receiver operating characteristic; ASES, American Shoulder and Elbow Surgeons; SST, Simple Shoulder Test; VAS, Visual Analog Scale; RC, rotator cuff; SANE, Single Alpha Numeric Evaluation; OA, osteoarthritis; RCA, rotator cuff arthropathy; TSA, total shoulder arthroplasty; SD, standard deviation; SPADI, Shoulder Pain and Disability Index; DASH, Disability of Arm, Shoulder, Hand; OSS, Oxford Shoulder Score; UCLA, UCLA Shoulder Rating Scale; WORC, Western Ontario Rotator Cuff Index; WOSI, Western Ontario Shoulder Instability Index; GSF, Global Shoulder Function; NPRS, Numeric Pain Rating Scale; VR-12, Veterans Rand 12; SFInX, Shoulder Function Index; SF-12, Short Form-12; FSS, Functional Shoulder Score; OSIS, Oxford Shoulder Instability Score; SSV, Subjective Shoulder Value; SFA, Shoulder Function Assessment Scale; SRQ, Shoulder Rating Questionnaire; PSS, Penn Shoulder Scale; SDQ-UK, Shoulder Disability Questionnaire United Kingdom; SDQ-NL, Shoulder Disability Questionnaire Dutch

**Table 3** Characteristics of studies reporting on SCB for shoulder patient-reported outcomes

| Study | Year | Instrument(s) | N | Follow-up (months) | Diagnosis | Treatment | Calculation | Domain | Method |
|---|---|---|---|---|---|---|---|---|---|
| Cvetanovich et al. [6] | 2019 | ASES, Constant, SANE | 288 | 12 | RC tear | RC repair | Anchor | Pain: 15 points | ROC |
| Gowd et al. [18] | 2019 | ASES, Constant, SANE | 207 | 12 | OA, RCA | TSA | Anchor | Pain: 15 points | ROC |
| Policastro et al. [20] | 2019 | ASES | 130 | – | Various shoulder pathologies | PT | Anchor | Global: 15 points | Mean difference |
| Puzzitiello et al. [21] | 2019 | ASES, Constant, SANE | 123 | 6 | Biceps tendinitis | Biceps tenodesis | Anchor | Pain: 15 points | ROC |
| Gowd et al. [28] | 2018 | ASES, Constant | 89 | 12 | RC tear | RC repair | Anchor | Pain: 15 points | ROC |
| Simovitch et al. [66] | 2018 | ASES, Constant, GSF, UCLA, SST, SPADI, VAS Pain | 1568 | 24 | OA, RCA | TSA | Anchor | Global: 4 points | Mean difference |
| Werner et al. [42] | 2016 | ASES | 490 | 24 | OA, RCA | TSA | Anchor | Global, work, activities: 5 points | Mean difference |
| Michener et al. [67] | 2013 | DASH, PSS | 74 | 3 | Subacromial impingement | PT | Anchor | Global: 13 points | ROC |
| Moser et al. [62] | 2008 | OSIS, SRQ | 100 | 9 | Shoulder instability | PT | Anchor | Global: 5 points | ROC |

SCB, Substantial Clinical Benefit; ASES, American Shoulder and Elbow Surgeons; SANE, Single Alpha Numeric Evaluation; RC, rotator cuff; ROC, receiver operating characteristic; OA, osteoarthritis; RCA, rotator cuff arthropathy; TSA, total shoulder arthroplasty; PT, physical therapy; GSF, Global Shoulder Function; UCLA, UCLA Shoulder Rating Scale; SST, Simple Shoulder Test; SPADI, Shoulder Pain and Disability Index; VAS, Visual Analog Scale; DASH, Disability of Arm, Shoulder, Hand; PSS, Penn Shoulder Scale; OSIS, Oxford Shoulder Instability Score; SRQ, Shoulder Rating Questionnaire

**Table 4** Characteristics of studies reporting on PASS for shoulder patient-reported outcomes

| Study | Year | Instrument(s) | N | Follow-up (months) | Diagnosis | Treatment | Calculation | Method |
|---|---|---|---|---|---|---|---|---|
| Cvetanovich et al. [6] | 2019 | ASES, Constant, SANE | 288 | 12 | RC tear | RC repair | Anchor | ROC |
| Gowd et al. [18] | 2019 | ASES, Constant, SANE | 207 | 12 | OA, RCA | TSA | Anchor | ROC |
| Puzzitiello et al. [21] | 2019 | ASES, Constant, SANE | 123 | 6 | Biceps tendinitis | Biceps tenodesis | Anchor | ROC |
| Tran et al. [68] | 2019 | SPADI | 304 | 6 | Shoulder pain | Operative, nonoperative | Anchor | (1) ROC (2) 75th percentile |
| Gowd et al. [28] | 2018 | ASES, Constant | 89 | 12 | RC tear | RC repair | Anchor | ROC |
| Chamberlain et al. [69] | 2017 | ASES, SST, VAS Pain | 326 | 24 | OA, RCA | TSA | Anchor | 75th percentile |
| Sciascia et al. [70] | 2017 | ASES, Constant, SANE, WOOS | 234 | 24 | OA | TSA | Anchor | ROC |
| O'Halloran et al. [71] | 2013 | SANE | 68 | NR | Shoulder pain | PT | Anchor | ROC |
| Christie et al. [55] | 2011 | Bostrom, Constant, DASH, OSS, SFAS, SPADI, VAS pain | 100 | 12 | Rheumatic shoulder disease | Operative | Anchor | (1) ROC (2) 75th percentile |
| Tashjian et al. [61] | 2009 | VAS Pain | 81 | 6 | Subacromial impingement, RC tear | PT | Anchor | 75th percentile |
| Tubach et al. [8] | 2006 | Neer, NPRS | 252 | 0.25 | Subacromial impingement | NSAID | Anchor | 75th percentile |

PASS, patient acceptable symptom state; ASES, American Shoulder and Elbow Surgeons; SANE, Single Alpha Numeric Evaluation; RC, rotator cuff; ROC, receiver operating characteristic; OA, osteoarthritis; RCA, rotator cuff arthropathy; TSA, total shoulder arthroplasty; SPADI, Shoulder Pain and Disability Index; SST, Simple Shoulder Test; VAS, Visual Analog Scale; WOOS, Western Ontario Osteoarthritis of the Shoulder; PT, physical therapy; DASH, Disability of Arm, Shoulder, Hand; OSS, Oxford Shoulder Score; SFAS, Shoulder Function Assessment Scale; NPRS; Numeric Pain Rating Scale; NSAID, nonsteroidal anti-inflammatory drug

**Table 5**  MCID values of shoulder assessment instruments for operative shoulder pathologies

| | Anchor MCID[a] | Anchor Credibility | Distribution MCID[a] |
|---|---|---|---|
| **Rotator cuff repair** | | | |
| Constant (n = 5) | 10.9 ± 11.0 (2.0–36.0) | | 6.6 ± 2.8 (4.6–8.6) |
| Castricini et al., 2014 [47] | 36.0 | Questionable | – |
| Cvetanovich etl al, 2019 [6] | 5.5 | Questionable | 4.6 |
| Gowd et al., 2018 [28] | 4.6 | Questionable | – |
| Kukkonen et al., 2013 [53] | Mean change: 10.4 Mean difference: 16.4 ROC: 2 | Questionable | 8.6 |
| Xu et al., 2019 [24] | Satisfaction: 6.3 Fulfillment: 6.1 | Questionable | – |
| ASES (n = 4) | 17.8 ± 8.0 (11.1–27.1) | | 19.3 ± 10.7 (11.7–26.9) |
| Cvetanovich et al., 2019 [6] | 11.1 | Questionable | 11.7 |
| Gagnier et al., 2018 [27] | 21.9 | Questionable | 26.9 |
| Gowd et al., 2018 [28] | 11.1 | Questionable | – |
| Tashjian et al., 2020 [15] | 27.1 | Questionable | – |
| SANE (n = 3) | 28.4 ± 1.5 (27.3–29.4) | | 13.5 ± 2.9 (11.8–16.9) |
| Cvetanovich et al., 2019 [6] | 29.4 | Questionable | 16.9 |
| Thigpen et al., 2018 [33] | – | – | 11.8 |
| Zhou et al., 2018 [35] | 27.3 | Questionable | 11.8 |
| WORC (n = 2) | 579.3 ± 257.3 (282.6–741.3) | | 588.7 |
| Gagnier et al., 2018 [27] | 282.6 | Questionable | 588.7 |
| Wessel et al., 2018 [34] | ROC: 714 Mean change limit: 741.3 | Credible | – |
| FSS (n = 1) | 24.7 | | – |
| Iossifidis et al., 2015 [45] | 24.7 | Questionable | – |
| OSS (n = 1) | 2.7 ± 0.1 (2.6–2.7) | | – |
| Xu et al., 2019 [24] | Satisfaction: 2.6 Fulfillment: 2.7 | Questionable | – |
| SST (n = 1) | 4.3 | | – |
| Tashjian et al., 2020 [15] | 4.3 | Questionable | – |
| UCLA (n = 1) | 2.8 ± 0.1 (2.7–2.9) | | – |
| Xu et al., 2019 [24] | Satisfaction: 2.9 Fulfillment: 2.7 | Questionable | – |
| VAS Pain (n = 1) | 2.4 | | – |
| Tashjian et al., 2020 [15] | 2.4 | Questionable | – |
| VR-12 MCS (n = 1) | 1.9 | | 6 |
| Zhou et al., 2018 [35] | 1.9 | Questionable | 6 |
| VR-12 PCS (n = 1) | 2.6 | | 4.9 |
| Zhou et al., 2018 [35] | 2.6 | Questionable | 4.9 |
| **Total shoulder arthroplasty** | | | |
| ASES (n = 6) | 16.0 ± 9.0 (6.3 ± 29.6) | | 8.9 ± 2.2 (6.5–11.8) |
| Berglund et al., 2019 [16] | 29.6 | Questionable | – |
| Gowd et al., 2019 [18] | 27.6 | Questionable | 9.1 |
| Simovitch et al., 2018 [31] | 13.6 | Questionable | 11.8 |
| Tashjian et al., 2017 [38] | 20.9 | Questionable | – |
| Werner et al., 2016 [42] | Work: 6.3 Activities: 9.1 Overall: 13.5 SF-12: 7.7 | Questionable | – |
| Wong et al., 2016 [43] | – | – | Function: 6.5 Pain: 8 |
| SST (n = 5) | 2.9 ± 1.0 (1.5–4.0) | | 1.8 |
| Berglund et al., 2019 [16] | 3.6 | Questionable | – |
| Berglund et al., 2019 [17] | 4 | Questionable | – |
| Roy et al., 2010 [58] | 3 | Credible | – |
| Simovitch et al., 2018 [31] | 1.5 | Questionable | 1.8 |
| Tashjian et al., 2017 [38] | 2.4 | Questionable | – |

**Table 5** (continued)

|  | Anchor MCID[a] | Anchor Credibility | Distribution MCID[a] |
|---|---|---|---|
| Constant (*n* = 3) | 6.3 ± 1.5 (5.1–8.0) |  | 6.9 ± 3.6 (4.3–9.4) |
| Gowd et al., 2019 [18] | 5.1 | Questionable | 4.3 |
| Simovitch et al., 2018 [31] | 5.7 | Questionable | 9.4 |
| Torrens et al., 2016 [40] | 8 | Questionable | – |
| SANE (*n* = 3) | 33.0 ± 5.9 (28.8–37.1) |  | 15.8 ± 3.3 (13.4–18.1) |
| Berglund et al., 2019 [16] | 37.1 | Questionable | – |
| Gowd et al., 2019 [18] | 28.8 | Questionable | 13.4 |
| Thigpen et al., 2018 [33] | – | – | 18.1 |
| VAS Pain (*n* = 3) | 2.1 ± 1.0 (1.4–3.3) |  | 1.6 |
| Berglund et al., 2019 [16] | 3.3 | Questionable | – |
| Simovitch et al., 2018 [31] | 1.6 | Questionable | 1.6 |
| Tashjian et al., 2017 [38] | 1.4 | Questionable | – |
| GSF (*n* = 1) | 1.4 |  | 1.4 |
| Simovitch et al., 2018 [31] | 1.4 | Questionable | 1.4 |
| UCLA (*n* = 1) | 8.7 |  | 3.6 |
| Simovitch et al., 2018 [31] | 8.7 | Questionable | 3.6 |
| SF-12 MCS (*n* = 1) | – |  | 5.7 |
| Wong et al., 2016 [43] | – | – | 5.7 |
| SF-12 PCS (*n* = 1) | – |  | 5.4 |
| Wong et al., 2016 [43] | – | – | 5.4 |
| SPADI (*n* = 1) | 20.6 |  | 14.1 |
| Simovitch et al., 2018 [31] | 20.6 | Questionable | 14.1 |
| | | | |
| Arthroscopic shoulder stabilization | | | |
| Rowe (*n* = 2) | 9.7 |  | 5.6 |
| Park et al., 2019 [19] | 9.7 | Questionable | – |
| Park et al., 2018 [30] | – | – | 5.6 |
| ASES (*n* = 1) | 8.5 |  | – |
| Park et al., 2019 [19] | 8.5 | Questionable | – |
| WORC (*n* = 1) | 816.9 ± 210.9 (667.8–966.0) |  | |
| Wessel et al., 2018 [34] | ROC: 667.8<br>Mean change limit: 966 | Credible | – |
| WOSI (*n* = 1) | – |  | 151.9 |
| Park et al., 2018 [30] | – | Questionable | 151.9 |
| | | | |
| Various shoulder pathologies | | | |
| DASH (*n* = 2) | 12.7 ± 0.4 (12.4–13.0) |  | – |
| Koorevaar et al., 2018 [29] | 13 | Questionable | – |
| van Kampen et al., 2013 [54] | 12.4 | Questionable | – |
| OSS (*n* = 1) | 5.4 ± 0.9 (4.7–6.0) |  | – |
| van Kampen et al., 2013 [54] | Function: 6<br>Pain: 4.7 | Questionable | – |
| QuickDASH (*n* = 1) | 13.4 |  | – |
| van Kampen et al., 2013 [54] | 13.4 | Questionable | – |
| SST (*n* = 1) | 2.2 |  | – |
| van Kampen et al., 2013 [54] | 2.2 | Questionable | – |
| | | | |
| Biceps tenodesis | | | |
| ASES (*n* = 1) | 16.3 |  | 11 |
| Puzzitiello et al., 2019 [21] | 16.3 | Questionable | 11 |
| Constant (*n* = 1) | 6.8 |  | 3.8 |
| Puzzitiello et al., 2019 [21] | 6.8 | Questionable | 3.8 |
| SANE (*n* = 1) | 3.5 |  | 15.2 |
| Puzzitiello et al., 2019 [21] | 3.5 | Questionable | 15.2 |
| | | | |
| AC joint stabilization | | | |
| Constant (*n* = 1) | 16.6 |  | – |
| Stein et al., 2018 [32] | 16.6 | Questionable | – |
| NPRS (*n* = 1) | 1.4 |  | – |

**Table 5** (continued)

| | Anchor MCID[a] | Anchor Credibility | Distribution MCID[a] |
|---|---|---|---|
| Stein et al., 2018 [32] | 1.4 | Questionable | – |
| Taft (n = 1) | 2.9 | | – |
| Stein et al., 2018 [32] | 2.9 | Questionable | – |
| | | | |
| SLAP repair | | | |
| OSIS (n = 1) | 9.0 ± 1.4 (8.0–10.0) | | |
| Skare et al., 2014 [51] | ROC: 10 | Credible | – |
| | Mean change limit: 8 | | |
| Rowe (n = 1) | 17.5 ± 0.7 (17.0–18.0) | | |
| Skare et al., 2014 [51] | ROC: 17 | Credible | – |
| | Mean change limit: 18 | | |
| WOSI (n = 1) | 510.0 ± 83.4 (451.0–569.0) | | |
| Skare et al., 2014 [51] | ROC: 569 | Credible | – |
| | Mean change limit: 451 | | |
| | | | |
| Rheumatic disease | | | |
| Bostrom (n = 1) | 2.3 | | – |
| Christie et al., 2011 [55] | 2.3 | Questionable | – |
| Constant (n = 1) | 16.6 | | – |
| Christie et al., 2011 [55] | 16.6 | Questionable | – |
| DASH (n = 1) | 10.1 | | – |
| Christie et al., 2011 [55] | 10.1 | Questionable | – |
| OSS (n = 1) | 6.9 | | – |
| Christie et al., 2011 [55] | 6.9 | Questionable | – |
| SFA (n = 1) | 12.9 | | – |
| Christie et al., 2011 [55] | 12.9 | Questionable | – |
| SPADI (n = 1) | 21.3 | | – |
| Christie et al., 2011 [55] | 21.3 | Questionable | – |

[a] Data expressed as mean ± SD (range)

MCID, minimal clinically important difference; ROC, receiver operating characteristic; ASES, American Shoulder and Elbow Surgeons; SANE, Single Alpha Numeric Evaluation; WORC, Western Ontario Rotator Cuff; FSS, Functional Shoulder Scale; OSS, Oxford Shoulder Scale; SST, Simple Shoulder Test; UCLA, UCLA Shoulder Rating Scale; VAS, Visual Analog Scale; VR-12 MCS, Veterans Rand-12 Mental Component Score; VR-12 PCS, Veterans Rand-12 Physical Component Score; GSF, Global Shoulder Function; SF-12 MCS, Short Form-12 Mental Component Score; SF-12 PCS, Short Form-12 Physical Component Score; SPADI, Shoulder Pain and Disability Index; WOSI, Western Ontario Shoulder Instability; DASH, Disability of the Arm, Shoulder, Hand; QuickDASH, Disability of the Arm, Shoulder, Hand short version; NPRS, Numeric Pain Rating Scale; OSIS, Oxford Shoulder Instability Score; SFA, Shoulder Function Assessment

# Discussion

The MCID, SCB, and PASS allow for interpretation of PROMs and are important to understand when treating various shoulder conditions. Our review demonstrates that the MCID, SCB, and PASS values vary widely with study-specific characteristics, including patient demographics, shoulder pathology, treatment, shoulder instrument, study methodology, and calculation method. Furthermore, in our appraisal of the literature, approximately 75% of the MCID, SCB, and PASS values were found to have questionable credibility or were not credible due to inadequate reporting. These differences have made interpretation of these metrics increasingly difficult and may potentially undermine the results of

studies that utilize these thresholds as a basis for measuring a successful outcome.

One factor contributing to the variability in MCID, SCB, and PASS for the same outcome instrument is the shoulder pathology and treatment. For instance, arthroscopic rotator cuff repairs had larger MCID thresholds for ASES, SANE, WORC, SST, and VAS pain compared to physical therapy for rotator cuff tears. This finding is not unexpected given that patient expectations are likely higher when the intervention is more expensive and riskier [48, 72]. Additionally, patients undergoing rotator cuff repair also required greater improvements compared with patients undergoing TSA in order for their improvement to be considered clinically meaningful. These differences may be explained by the generally younger patient population undergoing rotator cuff repair compared to

**Table 6**  MCID values of shoulder assessment instruments for nonoperative shoulder pathologies

| | Anchor MCID[a] | Anchor credibility | Distribution MCID[a] |
|---|---|---|---|
| **Subacromial impingement/rotator cuff tear** | | | |
| WORC (n = 3) | 450.8 ± 253.4 (269.0–879.9) | | – |
|   Braun et al., 2018 [25] | 300 | Questionable | – |
|   Ekeberg et al., 2010 [57] | ROC: 269.0 | Credible | – |
| | Mean change limit: 324.3 | | |
|   Wessel et al., 2018 [34] | ROC: 480.9 | Credible | – |
| | Mean change limit: 879.9 | | |
| Constant (n = 2) | 18.5 ± 5.8 (11.0–24.0) | | – |
|   Christiansen et al., 2015 [44] | ROC: 11 | Credible | – |
| | Mean change limit: 22.1 | | |
|   Holmgren et al., 2014 [48] | ROC: 17 | Credible | – |
| | Mean change limit: 24 | | |
| OSS (n = 2) | 7.6 ± 3.5 (4.0–12.2) | | – |
|   Christiansen et al., 2015 [44] | ROC: 6 | Credible | – |
| | Mean change limit: 12.2 | | |
|   Ekeberg et al., 2010 [57] | ROC: 4 | Credible | – |
| | Mean change limit: 8.1 | | |
| ASES (n = 1) | 15.2 ± 2.8 (12.0–16.9) | | |
|   Tashjian et al., 2010 [59] | Function: 12.0 | Questionable | – |
| | Pain: 16.9 | | |
| | Overall: 16.7 | | |
| DASH (n = 1) | 4.4 | | – |
|   Rysstad et al., 2017 [37] | 4.4 | Credible | – |
| Neer (n = 1) | 15.1 | | – |
|   Tubach et al., 2006 [8] | 15.1 | Questionable | – |
| NPRS (n = 1) | 3.4 | | – |
|   Tubach et al., 2006 [8] | 3.4 | Questionable | – |
| SANE (n = 1) | – | | 14 |
|   Thigpen et al., 2018 [33] | – | – | 14 |
| SPADI (n = 1) | 22.3 ± 3.3 (20.0–24.6) | | – |
|   Ekeberg et al., 2010 [57] | ROC: 20 | Credible | – |
| | Mean change limit: 24.6 | | |
| SST (n = 1) | 2.2 ± 0.1 (2.1–2.3) | | – |
|   Tashjian et al., 2010 [59] | Function: 2.1 | Questionable | – |
| | Overall: 2.3 | | |
| VAS pain | 1.4 | | – |
|   Tashjian et al., 2009 [61] | 1.4 | Questionable | – |
| | | | |
| **Shoulder pain** | | | |
| QuickDASH (n = 3) | 15.7 ± 8.4 (8.0–27.8) | | – |
|   Budtz et al., 2018 [26] | ROC: 13.6 | Questionable | – |
| | Mean change limit: 27.8 | | |
|   Mintken et al., 2009 [60] | 8 | Credible | – |
|   Rystaad et al., 2020 [14] | 13.6 | Credible | – |
| SPADI (n = 3) | 13.4 ± 6.1 (8.0–20.0) | | – |
|   Thoomes-de Graaf et al., 2017 [36] | 20 | Credible | – |
|   Paul et al., 2004 [64] | 8 | Credible | – |
|   Kc et al., 2019 [22] | 12.3 | Credible | – |
| NPRS (n = 2) | 1.7 ± 0.8 (1.1–2.2) | | – |
|   Michener et al., 2011 [56] | 2.2 | Questionable | – |
|   Mintken et al., 2009 [60] | 1.1 | Questionable | – |
| PSFS (n = 2) | 1.7 ± 0.5 (1.3–2.0) | | – |
|   Koehorst et al., 2014 [49] | 1.3 | Credible | – |
|   Rysstad et al., 2020 [14] | 2 | Credible | – |
| DASH (n = 1) | 11.2 | | – |
|   Kc et al., 2019 [23] | 11.2 | Credible | – |
| SDQ-NL (n = 1) | 14 | | – |
|   Paul et al., 2004 [64] | 14 | Credible | – |
| SDQ-UK (n = 1) | 4 | | – |
|   Paul et al., 2004 [64] | 4 | Credible | – |
| SRQ (n = 1) | 13 | | – |
|   Paul et al., 2004 [64] | 13 | Credible | – |

**Table 6** (continued)

| | Anchor MCID[a] | Anchor credibility | Distribution MCID[a] |
|---|---|---|---|
| **Various shoulder pathologies** | | | |
| ASES (n = 2) | 7.2 ± 1.1 (6.4–7.9) | | – |
| Michener et al., 2002 [65] | 6.4 | Credible | – |
| Policastro et al., 2019 [20] | 7.9 | Credible | – |
| DASH (n = 2) | 18.6 ± 9.7 (11.7–25.4) | | – |
| Lundquist et al., 2014 [50] | 11.7 | Credible | – |
| Negahban et al., 2015 [46] | 25.4 | Credible | – |
| PSS (n = 1) | 11.4 | | – |
| Leggin et al., 2006 [63] | 11.4 | Credible | – |
| SPADI (n = 1) | 14.9 | | – |
| Negahban et al., 2015 [46] | 14.9 | Credible | – |
| **Shoulder instability** | | | |
| OSIS (n = 2) | 5.3 ± 1.1 (4.5–6.0) | | – |
| Moser et al., 2008 [62] | 4.5 | Questionable | – |
| van der Linde et al., 2017 [39] | 6.0 | Credible | – |
| SRQ (n = 1) | 5.0 | | – |
| Moser et al., 2008 [62] | 5.0 | Questionable | – |
| WOSI (n = 1) | 294.0 | | – |
| van der Linde et al., 2017 [39] | 294.0 | Credible | – |
| **Proximal humerus fractures** | | | |
| Constant (n = 1) | 11.6 | | 5.4 |
| van der Water et al., 2014 [52] | 11.6 | Questionable | 5.4 |
| DASH (n = 1) | 13.0 | | 8.1 |
| van der Water et al., 2014 [52] | 13.0 | Questionable | 8.1 |
| OSS (n = 1) | 11.4 | | 5.1 |
| van der Water et al., 2014 [52] | 11.4 | Questionable | 5.1 |
| SFInX (n = 1) | 10.3 | | 11.7 |
| van der Water et al., 2016 [41] | 10.3 | Questionable | 11.7 |
| SSV (n = 1) | 26.6 | | 12.1 |
| van der Water et al., 2014 [52] | 26.6 | Questionable | 12.1 |
| UCLA (n = 1) | 2.4 | | 2.0 |
| van der Water et al., 2014 [52] | 2.4 | Questionable | 2.0 |
| **Adhesive capsulitis** | | | |
| SANE (n = 1) | – | | 17.5 |
| Thigpen et al., 2018 [33] | – | – | 17.5 |

[a] Data expressed as mean ± SD (range)

MCID, minimal clinically important difference; WORC, Western Ontario Rotator Cuff; OSS, Oxford Shoulder Score; ASES, American Shoulder and Elbow Surgeons; DASH, Disability of Arm, Shoulder, and Hand; NPRS, Numeric Pain Rating Scale; SANE, Single Alpha Numeric Evaluation; SPADI, Shoulder Pain and Disability Index; SST, Single Shoulder Test; VAS, Visual Analog Scale; QuickDASH, Disability of Arm, Shoulder, and Hand short version; PSFS, Patient-Specific Functional Scale; SDQ-NL, Shoulder Disability Questionnaire Dutch; SDQ-UK, Shoulder Disability United Kingdom; SRQ, Shoulder Rating Questionnaire; PSS, Penn Shoulder Scale; OSIS, Oxford Shoulder Instability Score; WOSI, Western Ontario Shoulder Instability; SFInX, Shoulder Function Index; SSV, Subjective Shoulder Value; UCLA, UCLA Shoulder Rating Scale

TSA and the differing expectations in pain and function after shoulder surgery between the two groups [15]. Furthermore, smaller differences may be clinically significant when symptoms are more severe, as evidenced by lower preoperative outcome scores in TSA patients compared to those undergoing rotator cuff repair [15, 38, 48]. In the present review, nine (15%) studies had also grouped patients with different shoulder conditions and treatments, including operative and nonoperative, together [20, 29, 33, 34, 46, 50, 54, 63, 65]. The MCID values derived from these studies may not be applicable to studies focused on a specific condition or treatment.

The heterogeneity of calculation methods used to derive MCID, SCB, and PASS also contributes to the wide range of values observed. Six different anchor-based approaches were used in 96% of studies, whereas only one distribution-based approach was used in 20% of studies. The decreased popularity of distribution-based methods may be due to the fact that they are generally considered less informative than anchor-based estimates because they rely on the statistical properties of a distribution rather than the patient's perception of improvement [73]. Beaton et al. also showed in a cohort of patients with shoulder pain undergoing physical therapy that the thresholds for defining

**Table 7**  SCB values for shoulder instruments

| | SCB[a] | Anchor credibility |
|---|---|---|
| Rotator cuff repair | | |
| ASES ($n = 1$) | 17.5 | |
|   Cvetanovich et al., 2019 [6] | 17.5 | Questionable |
| Constant ($n = 1$) | 5.5 | |
|   Cvetanovich et al., 2019 [6] | 5.5 | Questionable |
| SANE ($n = 1$) | 29.8 | |
|   Cvetanovich et al., 2019 [6] | 29.8 | Questionable |
| | | |
| Total shoulder arthroplasty | | |
| ASES ($n = 3$) | $23.8 \pm 8.8$ (12.0–36.6) | |
|   Gowd et al., 2019 [18] | 20.7 | Questionable |
|   Simovitch et al., 2018 [66] | 31.5 | Questionable |
|   Werner et al., 2016 [42] | Work: 22.3 | Questionable |
| | Activities: 20.2 | |
| | Overall: 36.6 | |
| | SF-12: 12.0 | |
| Constant ($n = 2$) | $19.4 \pm 0.4$ (19.1–19.6) | |
|   Gowd et al., 2019 [18] | 19.6 | Questionable |
|   Simovitch et al., 2018 [66] | 19.1 | Questionable |
| GSF ($n = 1$) | 3.1 | |
|   Simovitch et al., 2018 [66] | 3.1 | Questionable |
| SANE ($n = 1$) | 50.2 | |
|   Gowd et al., 2019 [18] | 50.2 | Questionable |
| SPADI ($n = 1$) | 45.4 | |
|   Simovitch et al., 2018 [66] | 45.4 | Questionable |
| SST ($n = 1$) | 3.4 | |
|   Simovitch et al., 2018 [66] | 3.4 | Questionable |
| UCLA ($n = 1$) | 12.6 | |
|   Simovitch et al., 2018 [66] | 12.6 | Questionable |
| VAS Pain ($n = 1$) | 3.2 | |
|   Simovitch et al., 2018 [66] | 3.2 | Questionable |
| | | |
| Biceps tenodesis | | |
| ASES ($n = 1$) | 16.8 | |
|   Puzzitiello et al., 2019 [21] | 16.8 | Questionable |
| Constant ($n = 1$) | 11 | |
|   Puzzitiello et al., 2019 [21] | 11 | Questionable |
| SANE ($n = 1$) | 5.8 | |
|   Puzzitiello et al., 2019 [21] | 5.8 | Questionable |
| | | |
| Subacromial impingement (nonoperative) | | |
| DASH ($n = 1$) | 11 | |
|   Michener et al., 2013 [67] | 11 | Questionable |
| PSS ($n = 1$) | 21 | |
|   Michener et al., 2013 [67] | 21 | Questionable |
| | | |
| Shoulder instability (nonoperative) | | |
| OSIS ($n = 1$) | 6.5 | |
|   Moser et al., 2008 [62] | 6.5 | Questionable |
| SRQ ($n = 1$) | 5 | |
|   Moser et al., 2008 [62] | 5 | Questionable |
| | | |
| Various shoulder pathologies (nonoperative) | | |
| ASES ($n = 1$) | 9.2 | |
|   Policastro et al., 2019 [20] | 9.2 | Credible |

[a] Data expressed as mean ± SD (range)

SCB, Substantial Clinical Benefit; ASES, American Shoulder and Elbow Surgeons; SANE, Single Alpha Numeric Evaluation; GSF, Global Shoulder Function; SPADI, Shoulder Pain and Disability Index; SST, Simple Shoulder Test; UCLA, UCLA Shoulder Rating Scale; VAS, Visual Analog Scale; DASH, Disability of Arm, Shoulder, and Hand; PSS, Penn Shoulder Scale; OSIS, Oxford Shoulder Instability Scale; SRQ, Shoulder Rating Questionnaire

**Table 8** PASS values for shoulder instruments

|  | PASS[a] |
|---|---|
| **Rotator cuff repair** | |
| ASES ($n = 2$) | 86.7 |
|   Cvetanovich et al., 2019 [6] | 86.7 |
|   Gowd et al., 2018 [28] | 86.7 |
| Constant ($n = 2$) | 23.3 |
|   Cvetanovich et al., 2019 [6] | 23.3 |
|   Gowd et al., 2018 [28] | 23.3 |
| SANE ($n = 1$) | 82.5 |
|   Cvetanovich et al., 2019 [6] | 82.5 |
| | |
| **Total shoulder arthroplasty** | |
| ASES ($n = 3$) | 78.6 ± 3.0 (76.0–81.9) |
|   Chamberlain et al., 2017 [69] | 76.0 |
|   Gowd et al., 2019 [18] | 81.9 |
|   Sciascia et al., 2017 [70] | 78.0 |
| Constant ($n = 2$) | 48.8 ± 34.3 (24.5–73.0) |
|   Gowd et al., 2019 [18] | 24.5 |
|   Sciascia et al., 2017 [70] | 73.0 |
| SANE ($n = 2$) | 61.8 ± 5.3 (58.0–65.5) |
|   Gowd et al., 2019 [18] | 65.5 |
|   Sciascia et al., 2017 [70] | 58.0 |
| SST ($n = 1$) | 8.4 |
|   Chamberlain et al., 2017 [69] | 8.4 |
| VAS Pain ($n = 1$) | 1.5 |
|   Chamberlain et al., 2017 [69] | 1.5 |
| WOOS ($n = 1$) | 18.0 |
|   Sciascia et al., 2017 [70] | 18.0 |
| | |
| **Biceps tenodesis** | |
| ASES ($n = 1$) | 59.6 |
|   Puzzitiello et al., 2019 [21] | 59.6 |
| Constant ($n = 1$) | 19.5 |
|   Puzzitiello et al., 2019 [21] | 19.5 |
| SANE ($n = 1$) | 65.5 |
|   Puzzitiello et al., 2019 [21] | 65.5 |
| | |
| **Rheumatic disease** | |
| Bostrom ($n = 1$) | 19.3 ± 1.1 (18.5–20.0) |
|   Christie et al., 2011 [55] | ROC: 18.5<br>75th Percentile: 20 |
| Constant ($n = 1$) | 43.0 ± 1.4 (42.0–44.0) |
|   Christie et al., 2011 [55] | ROC: 44.0<br>75th Percentile: 42 |
| DASH ($n = 1$) | 43.0 ± 0.1 (42.9–43.0) |
|   Christie et al., 2011 [55] | ROC: 43.0<br>75th Percentile: 42.9 |
| OSS ($n = 1$) | 27.0 ± 1.3 (26.0–27.9) |
|   Christie et al., 2011 [55] | ROC: 27.9<br>75th Percentile: 26.0 |
| SFA ($n = 1$) | 49.3 ± 4.3 (46.2–52.3) |

**Table 8** (continued)

|  | PASS[a] |
|---|---|
|   Christie et al., 2011 [55] | ROC: 46.2<br>75th Percentile: 52.3 |
| SPADI ($n = 1$) | 37.4 ± 5.2 (33.7–41.0) |
|   Christie et al., 2011 [55] | ROC: 41.0<br>75th Percentile: 33.7 |
| | |
| **Subacomial impingement/rotator cuff tear (nonoperative)** | |
| Neer ($n = 1$) | 21.3 |
|   Tubach et al., 2006 [8] | 21.3 |
| NPRS ($n = 1$) | 2.3 |
|   Tubach et al., 2006 [8] | 2.3 |
| VAS Pain ($n = 1$) | 3 |
|   Tashjian et al., 2009 [61] | 3.0 |
| | |
| **Shoulder pain (nonoperative)** | |
| SANE ($n = 1$) | 87.0 |
|   O'Halloran et al., 2013 [71] | 87.0 |
| SPADI ($n = 1$) | 47.3 ± 1.5 (46.2–48.3) |
|   Tran et al., 2019 [68] | ROC: 48.3<br>75th Percentile: 46.2 |

[a] Data expressed as mean ± SD (range)

PASS, patient acceptable symptom state; ASES, American Shoulder and Elbow Surgeons; SANE, Single Alpha Numeric Evaluation; SST, Simple Shoulder Test; VAS, Visual Analog Scale; WOOS, Western Ontario Osteoarthritis of the Shoulder; DASH, Disability of Arm, Shoulder, Hand; OSS, Oxford Shoulder Score; SFA, Shoulder Function Assessment; SPADI, Shoulder Pain Disability Index; NPRS, Numeric Pain Rating Scale

an important response to treatment differed depending on the technique used [74]. Furthermore, these differences were not inconsequential and could have profound effects on the interpretation of responder-type analysis. These findings were corroborated by Kukkonen et al. who demonstrated an eightfold difference in MCID of Constant score between mean difference method and ROC analysis in 781 patients undergoing arthroscopic rotator cuff repair [53]. Similarly, multiple studies that calculated MCID values utilizing both ROC analysis and the mean change limit method for a variety of shoulder pathologies also showed differences up to 54% [26, 34, 44, 48, 51, 57]. All calculations methods also run the risk of classifying patients as meaningfully improved when the changes in their scores fall within the measurement errors of the data set. To this end, measurement errors, such as the minimal detectable change (MDC), should be reported in conjunction with the MCID, SCB, or PASS values to help differentiate meaningful from random change [75].

In addition to the calculation method, MCID, SCB, or PASS values vary based on the type of anchor used, the definition used for the anchor, and the patient groups being studied [73]. Prior studies have demonstrated that domain-specific questions have

higher construct validity as anchors for determining clinically important differences than global transition questions [76]. Despite this, 69% of the studies utilized global ratings of change anchors that focused on overall improvement. Ideally, for questionnaires like ASES which consists of pain and function domains, the external anchor should ask about changes in pain and function. Another source of variation among studies is how MCID, SCB, and PASS are defined. Multiple studies defined unchanged and minimally improved groups differently with 20 (37%) studies incorporating any improvement beyond unchanged (e.g., "completely recovered" or "very great deal better") into minimally improved groups [14, 22, 23, 25, 26, 34, 36, 37, 39, 44, 46, 48–51, 53, 60, 62, 64]. This may incorrectly increase MCID values, as those levels of improvement reflect substantial clinical benefit rather than minimal clinical improvement. Conversely, eight (15%) studies incorporated patients who did worse (e.g., "much worse" or "very great deal worse") into the unchanged group [14, 25, 46, 49, 53, 62, 64, 65]. Although the number of patients who did worse after treatment is less, this classification may falsely lower the mean score of the unchanged group and thereby incorrectly increase MCID and SCB values. Furthermore, six (11%) studies measured MCID as any small change, be it improvement or deterioration, compared to the unchanged group [19, 30, 40, 41, 52, 59]. This does not represent a measure of beneficial change, and future studies should be mindful of this discrepancy when deciding to utilize a previously published MCID value.

Although both SCB and PASS have been described for nearly two decades, their reporting in literature has severely lagged behind that of MCID [7, 8, 62, 77]. Among studies with the same cohort, SCB values were approximately 1.6-fold greater than MCID values for arthroscopic rotator cuff repair and 1.7- to 2.7-fold greater than MCID values for TSA [6, 18, 31, 42, 66]. Simovitch et al. reported that a mean improvement of 30% of the total metric value would likely achieve SCB in seven outcome metrics among TSA patients [66]. Similarly, PASS values ranged from 67 to 87% of the total metric value for arthroscopic rotator cuff repair and 58 to 82% of the total metric value for TSA [6, 18, 69, 70]. Future studies calculating the MCID should include SCB and PASS estimates as they provide a spectrum of clinically meaningful outcomes that may be used to counsel patients regarding expectations after shoulder surgery.

While there are multiple studies evaluating the MCID, SCB, and PASS of rotator cuff repair and TSA, few studies have calculated the threshold values for other common shoulder procedures, such as arthroscopic shoulder stabilization, biceps tenodesis, AC joint stabilization, SLAP repair, and open reduction internal fixation of proximal humerus fractures. Currently, most studies on these treatments are limited to small case series performed at a single institution [19, 21, 32]. More studies with larger sample sizes need to be dedicated to these shoulder conditions and treatments, and thereafter, clinically meaningful values can be better established.

Thirty-two PROMs were identified in this review with ASES, Constant, and DASH being the most commonly reported instruments. Interestingly, 44% of the measures only had one study reporting MCID, SCB, or PASS values, suggesting that a large proportion of these outcome measures have not been adopted by the scientific community. The American Shoulder and Elbow Surgeons Value Committee has recently recommended the use of eight shoulder outcome instruments (ASES, OSS, SANE, VR-12, WORC, WOSI, WOOS, and PSS) based on freedom from clinician input, standardization, ease of use, and validation [78]. The Constant score, which was among the most frequently reported instruments in this review, was not recommended due to requiring clinician input to measure strength and motion and the poor standardization and precision of these measurements [79]. As such, continued efforts to utilize the recommended measures in patients with shoulder conditions may potentially limit the number of unnecessary MCID, SCB, and PASS values in future studies.

Despite being a comprehensive review of MCID, SCB, and PASS for shoulder outcome measures, this study is not without limitations. First, the included studies were so heterogeneous that the results varied widely and were difficult to integrate. Mean estimates and ranges for MCID, SCB, and PASS were presented, but future studies need to be cautious prior to utilizing a certain value. Researchers must consider the multitude of factors that affect these metrics, including patient characteristics, study size, pathology, intervention, length of follow-up, and calculation methods [80]. Second, the overwhelming majority of studies failed to report measurement errors, such as MDC, which makes it difficult to determine whether these thresholds are meaningful changes or simply due to random variation. Additionally, the criteria chosen to evaluate the credibility of the MCID, SCB, and PASS thresholds were stringent. Other factors that may contribute to the credibility include whether the anchor addresses the patient's perspective, the precision of the MCID estimate, and whether the threshold or difference between groups represented a small but important change [10]. Lastly, several studies determined MCID, SCB, and PASS values for different subgroups of their patient populations, such as anatomic versus reverse TSA. Only the overall results are presented here to enable comparison.

In conclusion, the present review provides both anchor-based and distribution-based estimates for MCID, SCB, and PASS of outcome instruments addressing patients with shoulder conditions. ASES, Constant, and DASH were the most frequently utilized instruments, whereas rotator cuff repair and TSA were the most commonly analyzed interventions. There were numerous methodological limitations of the primary studies that resulted in a wide range of values. Additionally, it was observed that there is a paucity of literature that reports the results for SCB and PASS estimates in patients with shoulder disorders. Information from this review

is vital for clinicians to appropriately establish patient expectations for recovery.

## Compliance with Ethical Standards

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