Patient Resilience Does Not Conclusively Affect Clinical Outcomes Associated With Arthroscopic Surgery but Substantial Limitations of the Literature Exist

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Purpose: To determine whether low resilience is predictive of worse patient-reported outcomes (PROs) or diminished improvements in clinical outcomes after joint preserving and arthroscopic surgery. **Methods:** A comprehensive search of PubMed, Medline, Embase, and Science Direct was performed on September 28, 2022, for studies investigating the relationship between resilience and PROs after arthroscopic surgery in accordance with the Preferred Reported Items for Systematic Reviews and Meta-analyses guidelines. **Results:** Nine articles (level II-IV studies) were included in the final analysis. A total of 887 patients (54% male, average age 45 years) underwent arthroscopic surgery, including general knee (n = 3 studies), ACLR-only knee (n = 1 study), rotator cuff repair (n = 4 studies), and hip (n = 1 study). The Brief Resilience Scale was the most common instrument measuring resilience in 7 of 9 studies (78%). Five of 9 studies (56%) stratified patients based on high, normal, or low resilience cohorts, and these stratification threshold values differed between studies. Only 4 of 9 studies (44%) measured PROs both before and after surgery. Three of 9 studies (33%) reported rates of return to activity, with 2 studies (22%) noting high resilience to be associated with a higher likelihood of return to sport/duty, specifically after knee arthroscopy. However, significant associations between resilience and functional outcomes were not consistently observed, nor was resilience consistently observed to be predictive of subjects' capacity to return to a preinjury level of function. **Conclusions:** Patient resilience is inconsistently demonstrated to affect clinical outcomes associated with joint preserving and arthroscopic surgery. However, substantial limitations in the existing literature including underpowered sample sizes, lack of standardization in stratifying patients based on pretreatment resilience, and inconsistent collection of PROs throughout the continuum of care, diminish the strength of most conclusions that have been drawn. **Level of Evidence:** Level IV, systematic review of level II-IV studies.

Patients' responses to illness and disease are multifactorial and predicated upon biological, physiological, sociodemographic, *and* psychological factors. Substantial research has shown the predictive effect that mental health, emotional well-being, and coping have on patients' recovery trajectory and long-term physical illness.[1-3] There are specific psychological traits and qualities that affect individuals' interactions

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with stimuli, situations, and stressors. Stress affects patients in different ways, and *how* patients respond to stressful circumstances is largely governed by their capacity to cope with discomfort and adapt to difficult circumstances. For example, the psychological traits affecting recovery after anterior cruciate ligament (ACL) injury and ACL reconstruction (ACLR) have been described in general terms; yet the specific impact of patients' unique psychological traits and, in some cases, psychological dysfunction, on recovery and return to sport have not been fully elucidated.[4,5] A systematic review of the psychological predictors of ACLR outcomes noted a consistent relationship between patients' self-confidence, optimism, and motivation to recover from surgery.[5] Whether a patient feels "confident" in their post-ACLR knee and, ultimately, likely to return to his or her preinjury level of activity is unique to one's own psychological makeup.[4,5]

Resilience, defined by the American Psychological Association as the ability to "adapt well in the face of adversity, trauma, tragedy, threats or significant sources of stress," has been recognized as a unique trait that may impact one's overall state of health.[6] Higher levels of resilience have been associated with increased self-esteem, life satisfaction, and diminished symptoms of depression.[7,8] Among several adult cohorts, higher levels of resilience correlated with improved physical function.[9,10] Thus high resilience (or low resilience) may represent an important and clinically underappreciated prognostic factor in patients' response to treatments that requires further investigation. Additionally, because there is convincing evidence to suggest that resilience may be modifiable through cognitive behavioral therapy, a clearer understanding of the relationship between resilience and outcomes after arthroscopic surgery is necessary. If the preponderance of evidence does, in fact, demonstrate that varying degrees of patient resilience can be consequential, this would represent an unexplored opportunity to pursue targeted therapeutic interventions to improve clinical outcomes after arthroscopic surgery.[11]

There is a limited number of reports that have investigated the relationship between resilience with clinical outcomes and return to physical activity and sport following orthopaedic surgical interventions; the majority of available literature investigating the intersection of orthopaedics and resilience investigates patients recovering from spinal cord injury and spine surgery, orthopaedic trauma, and total joint arthroplasty. Among these cohorts, increased levels of resilience have been associated with improved physical function after surgery.[12-15] To date, however, it remains unknown whether resilience affects patients' responses to arthroscopic surgery, specifically with regard to return to physical activity and sport, and this represents a conspicuous knowledge gap worthy of further investigation. The purpose of the this systematic review was to determine whether low resilience is predictive of worse patient-reported outcomes (PROs) and diminished improvements in clinical outcomes after arthroscopic surgery. It was hypothesized that low pre-treatment resilience would be an independent predictor of worse functional outcomes following arthroscopic surgery, and that high pre-treatment resilience would be an independent predictor of improved rates of return to sport following arthroscopic surgery.

Methods

Search Strategy

The methods of this systematic review were guided by the Preferred Reported Items for Systematic Reviews and Meta-analyses (PRISMA) statements for standardization of systematic reviews. The protocol was registered through the PROSPERO database (CRD42022345653). A database search was performed across PubMed, Medline, Embase, and Science Direct from the beginning of their archives through July 8, 2022, and repeated on September 28, 2022, to ensure the inclusion of studies published since the original search, using a variation of the phrase "arthroscopic or ACL reconstruction and resilience and outcomes or satisfaction." The combined search across all 4 databases is further detailed in Appendix Table 1. The complete PRISMA checklist is outlined in Appendix Table 2.

Study Screening

The 2 senior authors (A.J.S. and A.B.) independently reviewed all titles, abstracts, and full-text articles during each stage of the screening process. It was determined a priori that any discrepancies in the screening process would be reconciled by deliberation between the 2 senior authors.

Assessment of Study Eligibility

Studies met inclusion criteria if they were therapeutic human studies written in the English language and reported on measures of patient resilience and reported clinical outcomes, including various PROs, pain, or return to sport (RTS). Level I through Level IV studies were eligible for inclusion in the setting of arthroscopic joint-preserving surgery of all major joints including knee, shoulder, and hip. Conference abstracts, book chapters, editorial commentaries, and review articles were excluded, as well as articles that did not directly compare resilience to functional outcomes and studies that did not objectively assess resilience. All references of the included studies were further reviewed for any potential additional studies that may be relevant to the search topic.

Data Abstraction

Two reviewers (M.T.D. and D.J.C.) independently gathered study data into a single spreadsheet (Microsoft Excel version 2021; Microsoft, Redmond, WA). For all studies included in the final review, the following data were collected: author(s), year of publication, date of publication, study year, study site, population size, level of evidence, inclusion and exclusion criteria, follow-up time, age, sex, body mass index, tobacco use, procedures performed, concomitant mental health conditions, resilience scores, resilience stratification groups, preoperative and postoperative resilience scores, preoperative and postoperative PROs, RTS rates, complications, and study limitations.

Quality Assessment

Two reviewers (M.T.D. and D.J.C.) independently graded overall study quality according to the Methodological Index for Non-randomized Studies (MINORS) criteria.[16] Each MINORS criteria were graded by a score of 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate), with a maximum score of 16 for noncomparative studies and 24 for comparative studies. To evaluate agreement between the 2 independent reviewers, the intraclass correlation coefficient (ICC) was calculated for the MINORS criteria. Agreement was characterized according to the following thresholds: ICC >0.9 considered to be excellent agreement, 0.75 to 0.9 considered to be good agreement, 0.5 to 0.75 considered to be moderate agreement, and <0.5 considered to be poor agreement.[17] Additionally, κ was used to evaluate inter-rater agreement between the 2 independent reviewers for each round of the screening including title, abstract, and full-text screens. This was characterized according to the following thresholds: $\kappa >$ 0.61 considered to be substantial agreement, 0.21 to 0.6 considered to be moderate agreement, and <0.21 considered to be slight agreement.[17]

Statistical Analysis

Data from each study was extracted using Microsoft Excel (version 2021; Microsoft) and reported as means and standard deviations or ranges, when available. Pooled statistics, including weighted means and standard deviations, were not reported because the included studies were nonrandomized and found to have substantial limitations. All data are presented in a descriptive format because of heterogeneous patient populations and differences in study reporting/outcome stratification (i.e., high- vs low-resilience cohorts).

Results

Search and Study Characteristics

A comprehensive search of the literature yielded a total of 51 studies, with 9 studies meeting criteria for inclusion in the final analysis (Fig 1). There was complete agreement between the two independent reviewers during all phases of the review, including the title (κ = 1.0), abstract (κ = 1.0), and full-text (κ = 1.0) review phases. Table 1 provides a complete outline of the included study designs. The comparative studies[15,18-21] (n = 5) demonstrated MINORS scores ranging from 16.5 to 22, whereas the noncomparative studies[22-25] (n = 4) demonstrated MINORS scores ranging from 10 to 12.5. There was an excellent agreement between the 2 independent reviewers with respect to the MINORS criteria, with an ICC of 0.99.

Patient Demographics and Surgical Procedures

A total of 887 patients were included, being 54% male with a mean age of 45 years (range, 19 to 61 years). The mean follow-up ranged from 5.8 to 13 months. Arthroscopic surgical procedures performed included general knee arthroscopy (n = 3 studies),[15,19,22] ACLR-only knee arthroscopy (n = 2 studies),[15,24] arthroscopic rotator cuff repair (RCR) (n = 4 studies),[20,21,23,25] and hip arthroscopy (n = 1 study).[18] Refer to Table 1 for a detailed description of patient demographics and procedures performed. Drayer et al.[15] included results from patients undergoing both general knee arthroscopy and ACL-only knee arthroscopy.

Patient Resilience Scoring

The Brief Resilience Scale (BRS) was the most used instrument for measuring resilience, which was implemented in 7 of 9 studies (78%). Other scales of resilience included the Life Orientation Test-Revised and the Connor-Davidson Resilience Score (CD-RISC), implemented in the studies by Porter et al.[23] and Wojahn et al.,[22] respectively (Table 2). Seven of 9 studies (78%) measured patient resilience before surgery,[15,18-22,25] whereas 3 of these 7 studies repeated patient resilience scores after surgery.[15,21,25] Four of the included studies measured resilience before surgery only, which was not repeated in the postoperative setting.[18-20,22] Two studies (22%) measured patient resilience in the postoperative setting only.[23,24]

Four of 9 studies (56%) stratified patients into resilience quartiles based on high, normal, or low resilience for the BRS scale (Fig 2).[15,18,19,24] Resilience quartiles were stratified based on standard deviation, but without an otherwise objective criteria for defining meaningful differences in resilience. Importantly, Chavez et al.[19] also included normal resilience patients in their "low" resilience cohort because of the low numbers of patients in their cohort. Among the studies stratifying patients into cohorts based on resilience, there were no associations found with resilience and age, sex, or graft type in the setting of ACLR.[18,24]

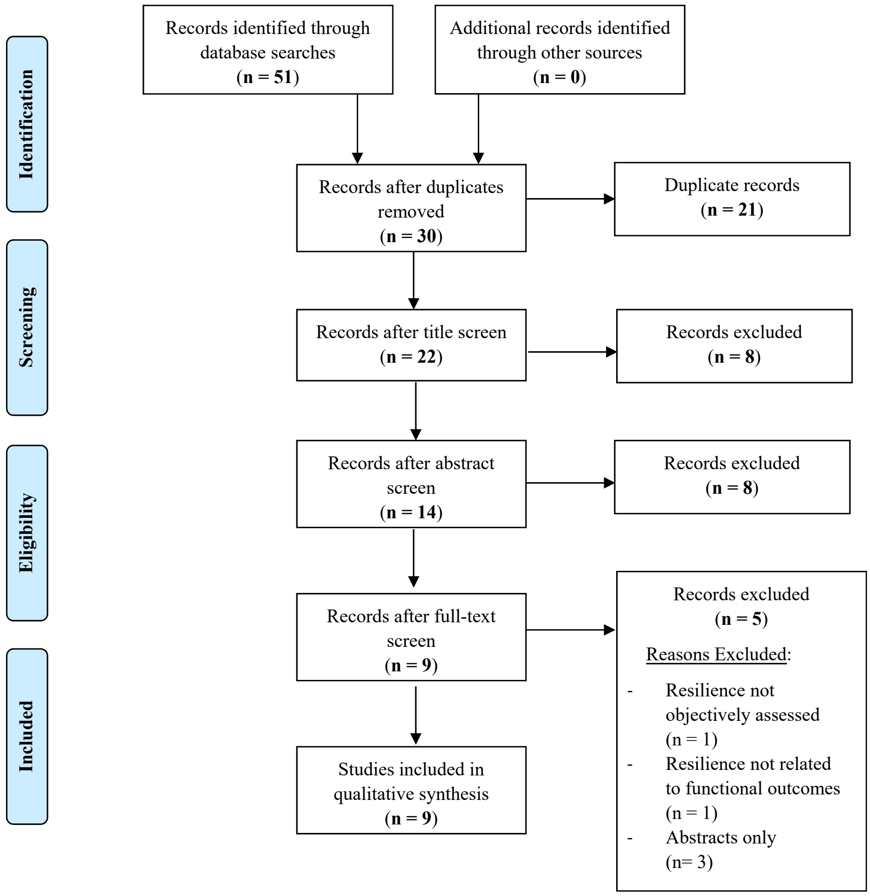

Fig 1. Preferred Reporting items for Systematic Review and Meta-Analyses (PRISMA) flow diagram for search characteristics.

Concomitant Mental Health Disorders

Four of 9 studies (44%) broadly report on the incidence of concomitant mental health conditions diagnosed before surgery, including anxiety, depression, and psychiatric medication usage.[18,19,22,25] Two of these studies further investigate an association of concomitant mental health disorders with patient resilience.[18,25] Refer to Table 3 for a complete description of preoperative mental health conditions explored.

Silverman et al.[18] and Wilson et al.[25] explored the effects of patient-reported history of anxiety or depression obtained before surgery, with patient resilience before joint-preserving hip arthroscopy and arthroscopic RCR, respectively. Silverman et al.[18] found an association of anxiety and depression with lower preoperative resilience, with a mean BRS score of 20.5 $\pm$ 4.399 in patients with a reported history of anxiety or depression, which was more than 3 points lower than those with no recorded history (P = .039).[18] Wilson et al.[25] compared BRS scores, Patient-Reported Outcomes Measurement System (PROMIS) score and legacy PROs, measured both before surgery and again at 3 and 6 months after surgery among patients with (56%) and without (44%) a history of anxiety or depression. There was no difference in BRS scores before surgery (P = .303), at 3-month follow-up (P = .2518), or at 6-month follow-up (P = .1662) among patients with and those without a history of anxiety or depression.

Clinical Outcomes

There was substantial heterogeneity in PROs reported among the included studies with no single PRO being reported across all 9 studies. Only 4 of the 9 studies (44%) measured PROs both before and after surgery.[15,18,19,25] Two studies (22%) measured postoperative PROs only,[23,24] and 3 studies (33%) measured preoperative PROs only.[20-22] A complete description of preoperative and postoperative PRO is provided in Table 4. In the setting of non-ACLR general knee arthroscopy, Drayer et al.[15] used a dichotomized grouping of BRS resilience scores based on high and low resilience in a group of 50 active duty patients and demonstrated that higher resilience scores were associated with significantly greater improvements in outcomes after surgery as compared to low resilience.[15] Among the high resilience BRS patient cohort, increase in postoperative PROs from preoperative baseline was demonstrated in Veterans Rand 12-item

Table 1. Study Characteristics and Baseline Patient Demographic Information

Reference	Year	LoE	Study Design	MINORS Score	Study Period	Subjects	Time Follow-Up (mo)	Rate Follow-Up	Age (y)	Sex		Surgery Performed
										M	F	
Beletsky et al.[20]	2019	III	Retrospective cohort study	20	NR	122	NA	NA	53.6 ± 11.5	71	51	Primary arthroscopic RCR: all full-thickness tears
Chavez et al.[19]	2020	II	Prospective cohort study	22	2017−2019	175	Min 3	132 (75%)	48 ± 11.5	54	78	Knee arthroscopy: meniscectomy (117), chondroplasty (109), meniscal repair (16), synovectomy (1), lose body removal/cyst debridement (16)
Drayer et al.[15]	2020	III	Retrospective cohort study	17	2017	50	Min 6	NA	34.2 (HR) 36.2 (LR)	42	8	Knee arthroscopy: ACL (21), meniscus repair (5), meniscus debridement (20), MUA with HWR (2), loose body excision (1), HTO (1)
Hines et al.[21]	2022	III	Retrospective cohort study	16.5	2016−2019	119	Min 12	100 (84%)	61 ± 10	71	48	Primary arthroscopic RCR: small tear, ≤3 cm (75), large tear, >3 cm (44)
Porter et al.[23]	2021	III	Retrospective cohort study	10	2014	49	NR	NR	55 ± 7.9	28	21	Primary arthroscopic RCR: partial- (22) or full-thickness (27) tears
Silverman et al.[18]	2021	II	Prospective cohort study	18	NR	40	5.8	24 (60%)*	40 ± 15	23	17	Primary hip arthroscopy: labral repair (29), labral debridement (6), labral reconstruction (2), debridement/ psoas release after THA (3)
Wilson et al.[25]	2020	II	Prospective cohort study	12.5	2017−2019	98	Min 6	76 (78%) at 3 months 68 (69%) at 6 months	60.8 (26-80)	45	55	Isolated arthroscopic RCR
Wojahn et al.[22]	2018	IV	Prospective observational study	12	2016−2017	221	Min 1.4	191 (86%)	46.2 (14-76)	114	107	Primary knee arthroscopy: meniscal repair (13), partial meniscectomy (170), debridement (5), chondroplasty (19), loose body removal (14)
Zhang et al.[24]	2021	IV	Prospective cohort study	11.5	NR	71	13 ± 5.6	56 (79%)	19 (14-43)	30	26	ACL reconstruction with autograft ± meniscal reconstruction: BTB (44), HS (5), QT (7)

ACL, anterior cruciate ligament; BTB, bone-tendon bone; BRS, Brief Resilience Scale; HS, hamstring; HR, high resilience; HTO, high tibial osteotomy; HWR, hardware removal; LoE, level of evidence; LR, low resilience; MUA, manipulation under anesthesia; NA, not applicable; NR, not reported; QT, quadriceps tendon; RCR, rotator cuff repair.

Data are n or n (%), or mean ± standard deviation or mean (range) unless noted otherwise.

*Distinguished as Early Recovery group (lost to early follow-up suspected because of full recovery achieved and no longer requiring routine postoperative care).

Table 2. Characterization of Patient Resilience Scales With Preoperative and Postoperative Scores

Reference	Resilience Measure	Resilience Measure Collection Time Period	Stratification Groups (n)	Threshold Values	Scoring Scale	Preoperative Resiliency Scores (mean)	Postoperative Resilience Scores (mean)	Method of Stratification	Notes
Beletsky et al.[20]	BRS*	Preoperatively collected	NA	NA	1-5	3.7 ± 0.8 (WC) 3.9 ± 0.7 (non-WC)	NA	NA	Patients were further stratified by WC status — WC (n = 32) vs non-WC (n = 90).
Chavez et al.[19]	BRS*	Preoperatively collected	HR: 45 LR-NR: 87	HR: 4.31-5 LR-NR: 1-4.3	1-5	NA	NA	Based on deviation from mean	Only 5 patients in LR group, so LR-NR stratification groups combined for statistical analysis.
Drayer et al.[15]	BRS*	Preoperatively collected; collected again after surgery (time not specified)	HR: 41 LR: 9	HR: ≥24 LR: <24	6-30	27.0 (HR) 18.6 (LR) $P < .001$	25.8 (HR) 18.6 (LR) $p < .001$	Not described	Mean preoperative and postoperative resilience scores were different between BRS stratification groups ($p < .001$).
Hines et al.[21]	BRS*	Preoperative collected; collected again 6 and 12 months after surgery	NA	NA	6-30	23.5 ± 4.9 (SCB met) 23.5 ± 4.4 (SCB not met) $P = .97$	NA	NA	Patients were further stratified by meeting ASES score SCB† — ASES SCB met (n = 51) vs ASES SCB not met (n = 68)
Porter et al.[23]	LOT-R	Retrospectively collected from postoperative scores (time not specified)	HR: 19 Moderate: 25 Mild: 5 LR: 0	HR: 19-24 Moderate: 13-18 Mild: 7-12 LR: 0-6	0-24	NA	NA	Based on deviation from mean[11]	
Silverman et al.[18]	BRS*	Collected before surgery	HR: 14 NR: 12 LR: 14	HR: ≥25 NR: 22-24 LR: ≤21	6-30	NA	NA	Use of quartiles based on deviation from mean	No difference between patient resilience and age or sex.
Wojahn et al.[22]	CD-RISC	Collected before surgery	NA	NA	0-40	33.1 (13-40)	NA	NA	
Wilson et al.[25]	BRS*	Collected before surgery; collected again 3 and 6 months after surgery	NA	NA	6-30	23.5 (12-30)	NA	NA	
Zhang et al.[24]	BRS*	Collected 6 months after surgery	HR: 12 NR: 35 LR: 9	HR: 28-30 NR: 19-27 LR: ≤18	6-30	NA	23.5 ± 4.2	Within ±1 SD from mean	No difference in age, sex, or graft type choice for ACLR among resilience cohorts ($P > .5$).

ACLR, anterior cruciate ligament reconstruction; ASES, American Shoulder and Elbow Surgeons; BRS, Brief Resilience Scale; CD-RISC, Connor-Davidson Resilience Scale; HR, high resilience; LOT-R, Life Orientation Test-Revised; LR, low resilience; NA, not applicable/not reported; NR, normal resilience; SCB, substantial clinical benefit; WC, Workers' Compensation.

Data are n or n (%), or mean ± standard deviation or mean (range) unless noted otherwise.

*Six-item Likert scoring scale.

†Threshold of 87 at 6 months after surgery.

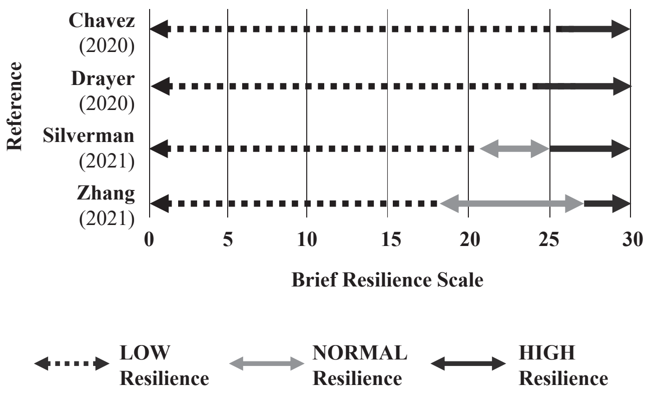

Fig 2. Patient stratification into low-, normal-, or high-resilience cohorts based on Brief Resilience Scale score across included studies.

(VR-12) physical ($P < .001$), VR-12 mental ($P = .007$), PROMIS physical function ($P < .001$), Visual Analogue Scale (VAS) pain (<0.002), Knee Injury and Osteoarthritis Outcome Score (KOOS) ($P = .003$), and International Knee Documentation Committee ($P < .001$) scores. There were no PROs found to have a significant increase from preoperative baseline to 6-month postoperative follow-up among the low-resilience BRS patient cohort. Interestingly, the low-resilience cohort had worse preoperative baseline PROMIS-43 scores, except physical function, when compared to preoperative baseline PROMIS-43 scores in the high-resilience cohort. Conversely, Chavez et al.[19] found no significant differences between preoperative and postoperative PROs (VR-12 physical and mental scores, KOOS scores, Single Assessment Numeric Evaluation scores, patient satisfaction and pain control) among patients with high or low-normal resilience based on BRS stratification.[19] On primary assessment of opioid consumption after knee arthroscopy, Wojahn et al.[22] found no association between PROMIS scores, VAS pain scores or preoperative resilience based on CD-RISC measurement tool with amount of opioid consumption after surgery.

Of the 3 studies that implemented BRS scores to assess patient resilience in the setting of arthroscopic RCR, none of these studies further stratified patients into resilience cohorts. Hines et al.[21] found no association with preoperative BRS score and ability to meet ASES threshold for subclinical benefit (SBC) at the 6-month postoperative follow-up ($P = .97$). Beletsky et al.[20] noted a weak correlation between PROMIS upper extremity scores and BRS scores ($r = .29$). Wilson et al. [25] found no correlation between preoperative baseline BRS scores with concurrently obtained legacy PROs. However, there was a significant correlation between concurrently obtained postoperative BRS and PROMIS scores, but not with BRS and legacy PRO scores, at both 3- and 6-month follow-up. The lone study pertaining to hip arthroscopy reported better PROs both before and after surgery compared to the low-resilience group in terms of Modified Harris Hip Score, Hip Outcome Score, and VAS pain scores.

Three of 9 (33%) studies reported on rates of return to physical activity (Table 5), sport or military duty after arthroscopic surgery based on patient resilience.[15,18,24] Of all 50 active-duty service members, Drayer et al.[15] reported that 2.3% of patients in the high-resilience cohort versus 22.2% of patients in the low-resilience cohort changed their military occupation specialty by the 6-month postoperative visit after arthroscopic knee surgery ($P = .024$).[26] Zhang et al.[24] reported no difference in median time to RTS after ACLR with autograft with or without meniscal reconstruction based on BRS resilience cohort ($P = .78$).[24] Furthermore, whereas 71% of patients returned to sport at any level after 9 months, only 64% of patients returned to their preinjury level of play. Silverman et al.[18] noted that patients with higher resilience were able to return to activity earlier when evaluated at the 6-month postoperative window after hip arthroscopy ($P = .017$).[18]

Discussion

The most important finding of this study is that the available literature has not conclusively demonstrated resilience to be an independent predictor of clinical outcomes associated with joint preserving and arthroscopic surgery. As such, neither of the hypotheses were proven. However, in our view, these principal findings are more so a function of the substantial limitations of the studies included in this analysis rather than a clear reflection of compelling data. To more conclusively determine whether patient resilience truly drives clinical outcomes associated with arthroscopic surgery, emphasis should be placed on the necessity for prospective, longitudinal cohort studies focused on measuring patient resilience at standardized, predetermined timepoints to describe the effect, if any, of resilience on the following: patients' response to injury before intervention; functional outcomes at final follow-up; and the trajectory of patients' recovery from intervention through postoperative recovery and rehabilitation. Additionally, the measurement of patient resilience across a continuum of care would further elucidate whether this parameter itself changes over time: *Is resilience a constant trait or can it change over time as a function of the circumstances surrounding a treatment course*? If the latter case is true, studies that only assess resilience at 1 post-treatment timepoint may be of limited utility.

Several reports have investigated the relationship between resilience and functional outcomes associated with surgical treatments in the setting of orthopaedic trauma and total joint arthroplasty. Collectively, these studies have shown an association with higher

Table 3. Summary of Concomitant Mental Health Conditions Reported

Reference Reporting Mental Health Conditions	Mental Health Condition	Preoperative Mental Health Data	Association of Mental Health Condition with Postoperative Outcomes
Chavez et al.[19]	PHQ-2	PHQ-1: Little interest or pleasure in doing things Not at all: 80 (61%) Several days: 31 (23%) More than half days-every day: 21 (16%) PHQ-2: feeling down, depressed, or hopeless Not at all: 94 (72%) Several days: 27 (21%) More than half days-every day: 10 (7%)	PHQ-2 scores were reported before surgery but not compared to resilience cohorts or postoperative functional outcomes.
Silverman et al.[18]	Patient-reported history of anxiety or depression	Mean BRS: 20.5 ± 4.399 in cohort with history of anxiety or depression (>3 points lower than those with no recorded history), $p=0.039$	A reported history of anxiety or depression was associated with lower resilience.
Wojahn et al.[22]	Psychiatric medication usage (type unspecified)	No: 173 (78.3%) Yes: 39 (17.6%) Not reported: 9 (4.1%)	No association seen with preoperative psychiatric medication use and postoperative opioid consumption.
Wilson et al.[25]	Patient-reported history of anxiety or depression	Yes: 55 (56.1%) No: 43 (43.9%) Baseline: BRS: 22.49 (with anxiety and depression) vs 24.25 (without anxiety or depression), $P = .303$ 3 months after surgery: BRS: 22.65 (with anxiety and depression) vs 24.7 (without anxiety or depression), $P = .2518$ PROMIS-10 (physical): 12.5 (with anxiety and depression) vs 14.52 (without anxiety or depression), $P = .0034$ PROMIS-10 (mental): 13.13 (with anxiety and depression) vs 16.07 (without anxiety or depression), $P = .002$ 6 months after surgery: BRS: 21.69 (with anxiety and depression) vs 24.32 (without anxiety or depression), $P = .1662$ ASES: 72.97 (with anxiety and depression) vs 80.29 (without anxiety or depression), $P = .3815$ PROMIS-10 (physical): 13.31 (with anxiety and depression) vs 15.52 (without anxiety or depression), $P = .0076$ PROMIS-10 (mental): 13.67 (with anxiety and depression) vs 16.31 (without anxiety or depression), $P = .0029$	No significant difference in resilience scores at any time among patients with a mental health diagnosis and those without. Significant difference in both the physical and mental components of the PROMIS-10 at 3 and 6 months between patients with mental health diagnoses and those without.

ASES, American Shoulder and Elbow Surgeons; BRS, Brief Resilience Scale; NR, not reported; PHQ-2, 2-item Patient Health Questionnaire; PROMIS, Patient-Reported Outcome Measurement Information System.

Data are n or n (%), or mean ± standard deviation or mean (range) unless noted otherwise.

resilience and superior physical function after surgery.[12-14,27,28] Among 152 patients with a hip fracture treated with surgery, Lim et al.[29] observed a positive correlation between preoperative resilience and higher physical function subscale scores on the Short Form-36 instrument. Resnick et al.[12] noted a similar relationship between resilience, as measured by a modified Resilience Scale, and physical activity level among 258 patients 2 months after hip fracture surgery.[12] Using BRS results collected prospectively in 153 patients undergoing total knee arthroplasty, Magaldi et al.[30] observed significant correlations between resilience and overall physical and mental health but also, interestingly, noted no similar relationship between resilience and KOOS, Joint Replacement. Although individual studies did show positive correlations, the current analysis did not consistently observe an apparent effect of resilience on clinical outcomes across the entire cohort that has previously been suggested in the orthopaedic literature. This discrepancy is likely due

Table 4. Summary of Patient-Reported Outcomes Based on Measured Resilience

Reference	Surgery Performed	Primary Outcome	PROs Collected	Preoperative PRO Scores	Postoperative PRO Scores	ΔPRO Scores (pre-post)	Major Conclusions
Beletsky et al.[20]	Arthroscopic RCR	PROs, floor/ceiling effects	PROMIS UE, ASES, SANE, QuickDASH, Constant-Murley, SF-12, VR-12	PROMIS UE 29.3 ± 7.0 (WC) / 32.4 ± 6.7 (non-WC) Constant-Murley 11.2 ± 6.6 (WC) / 13.2 ± 6.4 (non-WC) QuickDASH 58.1 ± 19.7 (WC) / 45.0 ± 20.4 (non-WC) SF-12 Physical: 34.8 ± 7.0 (WC) / 35.9 ± 8.1 (non-WC) Mental: 44.9 ± 10.7 (WC) / 52.3 ± 11.3 (non-WC) VR-12 Physical: 35.5 ± 7.3 (WC) / 38.1 ± 8.8 (non-WC) Mental: 47.6 ± 11.3 (WC) / 55.3 ± 10.9 (non-WC) SANE 33.9 ± 25.7 (WC) / 34.1 ± 23.8 (non-WC) ASES 45.0 ± 20.9 (WC) / 54.5 ± 24.9 (non-WC)	NR	NR	PROMIS UE demonstrated a range of correlative strengths with legacy PROs (r = .25-.77, all P < .01) − strongest was QuickDash (r = .77) and weakest was BRS (r = .29). When comparing correlation of PROMIS UE with legacy PROs, non-WC patients maintained same strength of correlation between PROMIS UE among all PROs. WC patients were more likely associated with the maximum BRS score (P < .01), SF-12 (P < .01), and VR-12 (P < .01), and the minimum SANE score (P < .01).
Chavez et al.[19]	Knee arthroscopy	PROs, satisfaction with pain control	VR-12, KOOS, SANE, VAS	VR-12 Physical: 33.64 (HR) / 33.95 (NR-LR), P = .8521 Mental: 54.45 (HR) / 51.52 (NR-LR), P = .1444 KOOS Symptoms: 47.33 (HR) / 53.61 (NR-LR), P = .0514 Pain: 47.95 (HR) / 52.71 (NR-LR), P = .1524 ADL: 59.09 (HR) / 63.15 (NR-LR), P = .2715 QoL: 21.29 (HR) / 26.08 (NR-LR), P = .1269 SANE 38.66 (HR) / 42.81 (NR-LR), P = .2822 VAS 5.34 (HR) / 4.59 (NR-LR), P = .1220	VR-12 Physical: 42.92 (HR) / 44.47 (NR-LR), P = .5164 Mental: 55.89 (HR) / 53.86 (NR-LR), P = .2544 KOOS Symptoms: 76.22 (HR) / 75.46 (NR-LR), P = .8178 Pain: 76.29 (HR) / 78.65 (NR-LR), P = .5059 ADL: 83.49 (HR) / 85.46 (NR-LR), P = .5460 QoL: 54.35 (HR) / 57.05 (NR-LR), P = .5874 SANE 66.67 (HR) / 71.12 (NR-LR), P =.4187 VAS 2.09 (HR) / 1.95 (NR-LR), P = .7578	VR-12 Physical: 9.29 (HR) / 10.52 (NR-LR), P = .5887 Mental: 1.45 (HR) / 2.34 (NR-LR), P = .6769 KOOS Symptoms: 28.90 (HR) / 21.84 (NR-LR), P = .0615 Pain: 28.34 (HR) / 25.94 (NR-LR), P = .4837 ADL: 24.40 (HR) / 22.31 (NR-LR), P = .5552 QoL: 33.06 (HR) / 30.97 (NR-LR), P = .6501 SANE 28.04 (HR) / 28.30 (NR-LR), P = .9641 VAS −3.25 (HR) / −2.64 (NR-LR), P = .2431	No significant findings between preoperative resilience groups and postoperative PROs.

(continued)

Table 4. Continued

Reference	Surgery Performed	Primary Outcome	PROs Collected	Preoperative PRO Scores	Postoperative PRO Scores	ΔPRO Scores (pre-post)	Major Conclusions
Drayer et al.[15]	Knee arthroscopy	PROs, change in MOS	VR-12, PROMIS-43, IKDC, KOOS	VR-12 Physical: 35.6 (HR) / 31.1 (LR), $P = .042$ Mental: 58.8 (HR) / 42.5 (LR), $P = .001$ PROMIS-43 Physical Function: 34.2 (HR) / 36.3 (LR), $P = .112$ Anxiety: 43.9 (HR) / 56.7 (LR), $P = .005$ Depression: 40.8 (HR) / 51.3 (LR), $P = .022$ Fatigue: 42.5 (HR) / 58.2 (LR), $P \leq .001$ Sleep: 50.1 (HR) / 57.8 (LR), $P = .002$ Social: 38.6 (HR) / 47.6 (LR), $P = .002$ Pain: 58.4 (HR) / 63.7 (LR), $P = .004$ IKDC −1.79 (HR) / −2.51 (LR), $P = .047$ KOOS Symptoms: 54.8 (HR) / 54.0 (LR), $P = .898$ Pain: 57.3 (HR) / 54.0 (LR), $P = .639$ ADL: 69.2 (HR) / 59.9 (LR), $P = .236$ Sport: 31.9 (HR) / 32.2 (LR), $P = .977$ QoL: 26.4 (HR) / 23.1 (LR), $P = .489$ Short Form: 63.0 (HR) / 58.4 (LR), $P = .301$	VR-12 Physical: 42.3 (HR) / 35.5 (LR), $P = .085$ Mental: 53.5 (HR) / 41.6 (LR), $P = .014$ PROMIS-43 Physical Function: 30.2 (HR) / 34.3 (LR), $P = .087$ Anxiety: 44.4 (HR) / 60.3 (LR), $P = .004$ Depression: 41.6 (HR) / 58.1 (LR), $P = .004$ Fatigue: 45.1 (HR) / 58.6 (LR), $P = .001$ Sleep: 52.6 (HR) / 62.5 (LR), $P = .017$ Social: 36.2 (HR) / 47.6 (LR), $P < .001$ Pain: 53.0 (HR) / 58.2 (LR), $P = .228$ IKDC −0.905 (HR) / −2.22 (LR), $P = .008$ KOOS Symptoms: 64.2 (HR) / 51.9 (LR), $P = .112$ Pain: 70.9 (HR) / 55.7 (LR), $P = .030$ ADL: 82.1 (HR) / 65.2 (LR), $P = .055$ Sport: 50.3 (HR) / 32.2 (LR), $P = .029$ QoL: 42.9 (HR) / 30.8 (LR), $P = .053$ Short Form: 72.1 (HR) / 62.5 (LR), $P = .040$	VR-12 Physical: 6.7, $P < .001$ (HR) 4.4, $P = .202$ (LR) Mental: −5.3, $P = .007$ (HR) −0.9, $P = .411$ (LR) PROMIS-43 Physical Function: −4.0, $P < .001$ (HR) −2.0, $P = .281$ (LR) Anxiety: 0.5, $P = .727$ (HR) 3.6, $P = .418$ (LR) Depression: 0.8, $P = .299$ (HR) 6.8, $P = .143$ (LR) Fatigue: 2.6, $P = .137$ (HR) 0.4, $P = .915$ (LR) Sleep: 2.5, $P = .095$ (HR) 4.7, $P = .172$ (LR) Social: −2.4, $P = .105$ (HR) 0.0, $P = .988$ (LR) Pain: −5.4, $P < .002$ (HR) −5.5, $P = .133$ (LR) IKDC 0.88, $P < .001$ (HR) 0.29, $P = .392$ (LR) KOOS Symptoms: 9.4, $P = .003$ (HR) −2.1, $P = .669$ (LR) Pain: 13.6, $P < .001$ (HR) 1.7, $P = .813$ (LR) ADL: 12.9, $P < .001$ (HR) 5.3, $P = .475$ (LR) Sport: 18.4, $P = .001$ (HR) 0.0, $P = 1.0$ (LR) QoL: 16.5, $P < .001$ (HR) 7.7, $P = .303$ (LR) Short Form: 9.1, $P < .001$ (HR) 4.1, $P = .328$ (LR)	Higher resiliency before surgery was associated with improved postoperative PROs at 6 months. Higher improvement in PROs from preoperative to postoperative evaluation seen in the higher-resilience group.

(continued)

Table 4. Continued

Reference	Surgery Performed	Primary Outcome	PROs Collected	Preoperative PRO Scores	Postoperative PRO Scores	ΔPRO Scores (pre-post)	Major Conclusions
Hines et al.[21]	Arthroscopic RCR	PROs	ASES, VR-12 (mental)	Comparison of preoperative PROs to SCB threshold: VR-12 (mental): SCB not met (50.1 ± 12.0) vs SCB met (57.3 ± 9.24), $P = .001$ ASES: Small tears: (31 [41%]) SCB met (94 ± 3.0) vs (44 [59%]) SCB not met (73.0 ± 2.0) Large tears: (20, 45%) SCB met (93 ± 3.0) vs (24 [55%] SCB not met (85.0 ± 3.0)	NR	NR	Higher preoperative resilience scores were not predictive of subjects achieving ASES SCB.*
Porter et al.[23]	Arthroscopic RCR	PROs	ASES, SST	NR	ASES Function: 46.22 ± 1.49 (HR) / 44.19 ± 1.61 (moderate) / 34.99 ± 7.87 (mild) / N/A (LR), $P = .048$ Pain: 44.47 ± 1.98 (HR) / 41.6 ± 1.82 (moderate) / 27.00 ± 6.44 (mild) / N/A (LR), $P = .003$ Combined: 90.69 ± 3.12 (HR) / 85.79 ± 3.04 (moderate) / 61.99 ± 14.08 (mild) / N/A (LR), $P = .005$ SST 10.84 ± 0.47 (HR) / 10.40 ± 0.47 (moderate) / 6.80 ± 2.08 (mild) / N/A (LR), $P = .009$	NR	Higher resilience scores correlated with higher ASES and SST PROs.
Silverman et al.[18]	Hip arthroscopy	PROs	mHHS, HOS, VAS	mHHS 54.6 ± 13.4 (HR) / 47.9 ± 16.0 (NR) / 40.4 ± 12.0(LR), $P = .007$ HOS Daily: 0.680 ± 0.140 (HR) / 0.601 ± 0.230 (NR) / 0.491 ± 0.176 (LR), $P = .004$ Sport: 0.414 ± 0.270 (HR) / 0.403 ± 0.296 (NR) / 0.228 ± 0.205 (LR), $P = .055$ VAS 14.9 ± 3.66 (HR) / 14.6 ± 4.94 (NR) / 18.7 ± 4.91 (LR), $P = .029$	mHHS 76.6 ± 9.9 (HR) / 67.7 ± 26.4 (NR) / 61.2 ± 19.3 (LR), $P = .014$ HOS Daily: 0.903 ± 0.081 (HR) / 0.908 ± 0.095 (NR) / 0.727 ± 0.299 (LR), $P = .045$ Sport: 0.730 ± 0.237 (HR) / 0.830 ± 0.167 (NR) / 0.560 ± 0.453 (LR), $P = .258$ VAS 9.6 ± 6.0 (HR) / 14.1 ± 15.3 (NR) / 18.8 ± 13.4 (LR), $P = .027$	mHHS 21.9 (HR) / 19.8 (NR) / 20.8 (LR) HOS Daily: 0.222 (HR) / 0.306 (NR) / 0.236 (LR) Sport: 0.316 (HR) / 0.427 (NR) / 0.332 (LR) VAS −5.3 (HR) / −0.5 (NR) / 0.1 (LR)	Higher-resilience group had significantly better PROs than the lower-resilience group both before and at 6 months after surgery (except HOS-sport).

(continued)

Table 4. Continued

Reference	Surgery Performed	Primary Outcome	PROs Collected	Preoperative PRO Scores	Postoperative PRO Scores	ΔPRO Scores (pre-post)	Major Conclusions
Wilson et al.[25]	Arthroscopic RCR	PROs	PROMIS-10, ASES, SANE, VAS	PROMIS-10 (baseline) 27.5 (17-38) ASES (baseline) 44.1 (0-88.3) SANE (baseline) 46.3 (0-90) Correlation of preoperative BRS and PROs (concurrently obtained): ASES: $r = .0669$, $P = .7293$ PROMIS-10: $r = .1259$, $P = .5384$ SANE: $r = .1365$, $P = .497$ VAS: $r = -.0305$, $P = .8325$	Correlation of 3-month postoperative BRS and PROs (concurrently obtained): ASES: $r = .0417$, $P = .8223$ PROMIS-10: $r = .5657$, $P = .0025$ SANE: $r = .1754$, $P = .4868$ VAS: $r = -.1023$, $P = .6604$ Correlation of 6-month postoperative BRS and PROs (concurrently obtained): ASES: $r = .1865$, $P = .466$ PROMIS-10: $r = .5308$, $P = .0025$ SANE: $r = .1216$, $P = .6683$ VAS: $r = -.2115$, $P = .0025$	Correlation of baseline BRS to 3 months postoperative PROs: ASES: $r = .0414$, $P = .8313$ PROMIS-10: $r = .3763$, $P = .009$ SANE: $r = .1069$, $P = .6639$ VAS: $r = .057$, $P = .7697$ Correlation of baseline BRS to 6 months postoperative PROs: ASES: $r = .1233$, $P = .6266$ PROMIS-10: $r = .2439$, $P = .262$ SANE: $r = .0698$, $P = .7544$ VAS: $r = -.1602$, $P = .5022$	No significant correlations observed between preoperative resilience and 3 and 6-month ASES. There was a significant, but weak correlation between preoperative resilience and 3-month PROMIS-10 and concurrent BRS and PROMIS-10 at 3 months and 6 months.
Wojahn et al.[22]	Knee arthroscopy	PROs, opioid usage	PROMIS, VAS	PROMIS Function: 41.1 (20.0-73.0) Anxiety: 47.4 (32.9-71.6) Depression: 43.6 (34.0-68.7) Pain: 60.1 (38.6-75.3) VAS 39.5 (0-100)	NR	NR	No association of preoperative PROs or resilience scores with increased opioid consumption after surgery.
Zhang et al.[24]	ACL reconstruction	PROs, return to sport	SANE	NR	SANE 94.2 (HR) / 89.2 (NR) / 92.8 (LR)	NR	Resilience was not significantly associated with return to sport. When adjusted for resilience, age and sex, SANE score predicted return to sport at 9 months.

ADL, Activities of Daily Living; ASES, American Shoulder and Elbow Surgeons; BRS, Brief Resilience Scale; DASH, Disabilities of the Arm, Shoulder and Hand; HOS, Hip Outcome Score; PRO, Patient-Reported Outcomes; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Sore; MOS; Military Occupational Specialty; mHHS, Modified Harris Hip Score; PROMIS, Patient-Reported Outcome Measurement Information System; RCR, Rotator Cuff Repair; QoL, Quality of Life; SANE, Single Assessment Numeric Evaluation; SCB, substantial clinical benefit; SF-12, 12-Item Short Form Survey; SST, Simple Shoulder Test; UE, upper extremity; VAS, Visual Analog Scale; VR-12, Veteran's Rand 12-Item Health Survey; WC, Workers' Compensation.

Data are n or n (%), or mean ± standard deviation or mean (range) unless noted otherwise. NR, not reported.

*Threshold of 87 at 6 months after surgery.

Table 5. Characterization of Patient Return to Activity Based on Resilience

Reference Reporting Return to Activity	Parameters	Athletes	Rate of Return to Sport (per each BRS stratification group)	Notes
Drayer et al.[15]	Change in MOS* (6 months after surgery)	50 (all active duty)	2.3% (HR) / 22.2% (LR) $P = .024$	There was a lower rate of changing MOS secondary in patients with high resilience.
Silverman et al.[18]	Return to physical activity† (6 months after surgery)	NR	100% (HR) / 82% (NR) / 57% (LR) $P = .017$	Patients with higher resilience were able to return to activity earlier at 6 months after surgery.
Zhang et al.[24]	Return to recreational or competitive sport‡	56	Median time to RTS (months): HR: 7.2 (3-10) NR: 7.3 (3-15) LR: 7.1 (7-9) $P = .78$ Overall RTS (all BRS cohorts): Median time to RTS (months): 7.2 (3.2-15.4) 71% RTS by 9 months (any level) 64% RTS by 9 months (prior level of play) 10 patients returned to different sport 11 patients did not RTS by 9 months RTS 9 months after surgery: 8/12 (HR) / 25/35 (NR) / 7/9 (LR) RTS 12 months after surgery: 9/12 (HR) / 27/35 (NR) / 7/9 (LR) RTS 9 months after surgery by level of play (compared to preinjury level): Lower level: 0% 0/12 (HR) / 6%, 2/35 (NR) / 22%, 2/9 (LR) Same level: 58% 7/12 (HR) / 66%, 23/35 (NR) /22%, 2/9 (LR) Higher level: 17%, 2/12 (HR) / 11%, 4/35 (NR) / 33%, 3/9 (LR) Did not return: 25% 3/12 (HR) / 17%, 6/35 (NR) / 22%, 2/9 (LR)	No difference in RTS at 9 months after surgery when comparing resiliency group ($P = .84$). High resilience BRS cohort trended towards higher level of RTS status ($P = .06$). Patients in whom RTS by 9 months demonstrated a trend of a higher mean SANE score of 92.7, compared to a mean of 85.7 in those whom it did not RTS ($P = .08$) When adjusted for age, sex and BRS, SANE score was a significant predictor of RTS at 9 months ($P = .01$).

BRS, Brief Resilience Scale; HR, high resilience; LR, low resilience; MOS, military occupation specialty; NR, normal resilience; RTS, return to sport; SANE, Single Assessment Numeric Evaluation.

Data are n or n (%), or mean ± standard deviation or mean (range) unless noted otherwise. NR, not reported.

*Correlates to return to sport in service members.[11]

†Assessed based on responses indicating whether patients had begun to attempt activity on the Hip Outcome Score sport scale.

‡RTS evaluation included return to practice or competition at any level and return to a different sport was acceptable.

to the heterogenous study population across arthroscopic surgery, as well as heterogenous methodology used across the included studies in this systematic review.

The 3 studies representing the largest proportion of patients undergoing a similar surgical procedure (38.3%) that investigated resilience in the setting of RCR did not observe a significant relationship between measured resilience and PRO.[20,21,25] Among the 3 studies that assessed for an effect of resilience on return to sport or preinjury level of activity, the results were similarly mixed and, at best, somewhat substantiated a modulatory effect of resilience in this respect.[15,18,24] However, substantial variations in the patient populations (military vs civilians), the underlying diagnoses (ACL tears, meniscus, and chondral injuries vs nonarthritic hip pain), and the procedures performed (knee arthroscopy vs hip arthroscopy) diminish the strength of any attempt to generalize a convincing relationship between resilience and these particular outcomes.

Four instruments for objectively measuring resilience in musculoskeletal disease have been used in the literature, with the CD-RISC[31,32] and BRS[33,34] being 2 of most commonly used instruments.[35,36] A systematic review by Windle et al.[35] identified 19 different self-reported resilience measures, with the 6-item BRS, 25-item CD-RISC, and 37-item Resilience Scale for Adults instruments receiving the highest psychometric ratings, including validity, consistency, reproducibility, and responsiveness. The 25-item CD-RISC has been the most frequently cited in the medical literature and includes questions on personal competence, trust/tolerance/strengthening effects of stress, acceptance of change and secure relationships, control, and spiritual influences.[35] The CD-RISC 10, a shorter, 10-question survey version that allows for the efficient measurement of resilience and mitigates the likelihood of respondent fatigue, may be an optimally designed instrument given its practicality, reliability, and validity.[37] Interestingly, the CD-RISC was not the most used instrument among the studies included in the current analysis. Instead, results of the BRS, a 6-item Likert-scale questionnaire, were most frequently reported among studies relevant to clinical outcomes related to arthroscopic surgery. Given the lack of comparative studies assessing differences in the performance of the BRS and CD-RISC 10 or CD-RISC 25, it is not possible to deem one instrument to be superior to the other. Further studies using the same measurement tools would aid in allowing a more comprehensive comparative analysis.

Apart from the potential prognostic utility of resilience, there is compelling evidence to suggest that resilience may be a modifiable trait suitable for targeted intervention.[38] In a systematic review and meta-analysis of 11 randomized controlled trials, Joyce et al.[11] determined that interventions centered around cognitive behavioral therapy and mindfulness training have a moderate positive effect of resilience. Given the fact that resilience appears to be a malleable trait, future investigations into the utility of such interventions may be worthwhile in uncovering avenues for improving clinical outcomes.

Limitations

The limitations of the current analysis are manifold and stem largely from the heterogeneity and low quality of evidence reported in the small number of included studies. Although most studies assessed resilience with the BRS, consensus with regard to the superiority of the BRS over the CD-RISC is lacking. However, the more salient issue and conspicuous weakness of the existing literature pertains to the fact that across the included studies, patients were not uniformly stratified according to their measured levels of resilience. Stated in another way, the “low-resilience,” “normal-resilience,” and “high-resilience” cohorts of several of the included studies were not consistently defined by the same ranges of measured resilience. This fact obviates the potential for performing meaningful comparisons and precludes a better understanding of what is “normal” resilience. Additionally, the large heterogeneity of arthroscopic procedures and associated PROs compared across the included studies limited direct comparison and generalizability of clinical outcomes. As discussed by Cote et al.,[39] pooling low evidence from heterogenous studies creates an unacceptably high risk for bias and can result in misinterpretation.[40] Future studies must use a more standardized method for stratifying resilience to accommodate statistical analyses that are more likely to discern whether significant relationships exist among several parameters of interest. Additionally, predetermined standardized intervals for measuring resilience and PROs, including collection of a preoperative baseline with postoperative benchmarks based on expected recovery trajectory, could minimize potential confounding variables and allow for more meaningful ability to investigate net change in PROs over time as a function of resilience. Studies that did not report both preoperative and postoperative PRO limit the conclusive value in investigating net change in PROs over time as a direct correlation to resilience. Last, the studies included in this systematic review are relatively small and lack sufficient sample size to allow the estimated effects of resilience to be adjusted for confounding factors (i.e., severity of underlying pathology, magnitude of pretreatment disability). Understanding these limitations is quite valuable because it informs an appreciation for the lack of consistency in reporting resilience in the literature and provides an opportunity for improved evaluation and study moving forward.

Conclusion

Patient resilience has inconsistently demonstrated to affect clinical outcomes associated with joint preserving and arthroscopic surgery. However, substantial limitations in the existing literature including underpowered sample sizes, lack of standardization in stratifying patients based on pretreatment resilience and inconsistent collection of PROs throughout the continuum of care, diminish the strength of most conclusions that have been drawn.

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Appendix Table 1. Database Search Strategy: Search Date: July 8, 2022 / September 28, 2022

	No.	Searches	Results
PubMed			
	1	Arthroscopy OR Arthroscopic	46,472
	2	ACL OR (ACL Reconstruction) OR (anterior cruciate ligament)	32,856
	3	#1 OR #2	72, 065
	4	Resilience OR Resiliency	55,020
	5	Outcomes OR Satisfaction	3,119,075
	6	#3 AND #4 AND #5	21
Medline			
	1	(Arthroscopy OR Arthroscopic).mp	40,585
	2	(ACL OR "ACL Reconstruction" OR "anterior cruciate ligament").mp	29,321
	3	#1 OR #2	64,483
	4	(Resilience OR Resiliency).mp	40,808
	5	(Outcomes OR Satisfaction).mp	1,407,962
	6	#3 AND #4 AND #5	8
Embase			
	1	"Arthroscopy" OR "Arthroscopic"	67,093
	2	"ACL" OR "ACL Reconstruction" OR "anterior cruciate ligament"	40,145
	3	#1 OR #2	96,042
	4	"Resilience" OR "Resiliency"	52,424
	5	"Outcomes" OR "Satisfaction"	1,984,935
	6	#3 AND #4 AND #5	14
ScienceDirect			
	1	Arthroscopy OR Arthroscopic	60,301
	2	ACL OR "ACL Reconstruction" OR "anterior cruciate ligament"	65,245
	3	#1 OR #2	111,216
	4	Resilience OR Resiliency	237,051
	5	Outcomes OR Satisfaction	4,932,150
	6	#3 AND #4 AND #5	8

Appendix Table 2. PRISMA Checklist

Section/Topic	Item No.	Checklist Item	Page No. Reported
Title			
Title	1	Identify the report as a systematic review.	Page 1
Abstract			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 1-2
Introduction			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 2-4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 4
Methods			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 5
Information sources	6	Specify all databases, registers, websites, organizations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 5, Appendix 1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 4-5, Figure 1
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 6
	10b	List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.	Page 7

(continued)

Appendix Table 2. Continued

Section/Topic	Item No.	Checklist Item	Page No. Reported
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis [item no. 5]).	Page 6-7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 6-7
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	NA
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 6-7
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 6-7
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
Results			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 7, Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 7, Figure 1
Study characteristics	17	Cite each included study and present its characteristics.	Page 7-8, Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 7, Table 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Table 1-5
Results of syntheses	20a	For each synthesis, briefly summarize the characteristics and risk of bias among contributing studies.	Page 7, Table 1
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias because of missing results (arising from reporting biases) for each synthesis assessed.	NA

(continued)

Appendix Table 2. Continued

Section/Topic	Item No.	Checklist Item	Page No. Reported
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
Discussion			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 13-17
	23b	Discuss any limitations of the evidence included in the review.	Page 17
	23c	Discuss any limitations of the review processes used.	Page 17
	23d	Discuss implications of the results for practice, policy, and future research.	Page 13-17
Other information			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	CRD42022345653
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	PROSPERO
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	NA
Competing interests	26	Declare any competing interests of review authors.	NA
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	