Trauma Monthly 2026; 31(5): 2167-2182

10.30491/tm.2026.598773.1988

Trauma Monthly

Systematic Review

Outcome Measurement Instruments in Pelvic Ring Injuries: A Systematic Review of Psychometric Properties and Clinical Utility

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Received 2025-09-26 ; **Accepted** 2026-04-17; **Online Published** 2026-10-29

Abstract

Introduction: Pelvic ring injuries are associated with substantial morbidity and long-term disability, yet no standardized outcome measurement instruments exist to evaluate clinical and functional results. Studies use the Majeed Pelvic Score, Iowa Pelvic Score, Orlando Pelvic Score, and generic instruments such as the SF-36, SMFA, and PROMIS inconsistently, limiting comparability and hampering evidence synthesis. To systematically identify all outcome measurement instruments used to assess pelvic ring injuries and evaluate their psychometric properties, including validity, reliability, responsiveness, and interpretability, as well as their clinical utility, including feasibility, patient acceptability, and clinical relevance.

Method: A systematic review was conducted in accordance with PRISMA guidelines. We searched PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library from inception to August 2026. Studies evaluating one or more measurement properties of an outcome instrument used in a pelvic ring injury population were included. The COSMIN Risk of Bias checklist was used for quality assessment, and a modified GRADE approach was employed to grade the quality of evidence.

Result: Fifteen primary studies and five systematic reviews were included, evaluating eight outcome instruments. The Majeed Pelvic Score was the most frequently evaluated instrument (53% of studies), demonstrating good construct validity with the SF-36 physical component summary (r=0.65-0.82) and excellent reliability (ICC 0.92-0.96; Cronbach's α 0.91-0.99). However, significant limitations were identified across all pelvic-specific instruments, including ceiling effects, weak correlation with mental health domains (r=0.15-0.28), lack of standardized scoring methods, and absence of established minimal clinically important differences. The Iowa Pelvic Score and Orlando Pelvic Score lacked formal validation evidence. Generic instruments (SF-36, SMFA) demonstrated strong psychometric properties but limited specificity for pelvic-specific issues. PROMIS measures showed strong concurrent validity with the SMFA (r=-0.901) and high clinical utility because of their short administration time and computer-adaptive testing capability.

Conclusion : Despite widespread use of outcome measurement instruments in pelvic ring injury research, significant gaps exist in their psychometric properties and clinical utility. The Majeed Pelvic Score is the most extensively studied but has critical limitations. Content validity studies, standardized scoring methods, establishment of minimal clinically important differences, and development of a core outcome set for pelvic ring injury research are urgently needed.

Keywords: Pelvic ring injuries, pelvic fractures, outcome measurement instruments, patient-reported outcome measures, psychometric properties.

Introduction

Pelvic ring injuries represent a significant clinical challenge in trauma and orthopedic surgery, encompassing a broad spectrum of pathology that ranges from low-energy fragility fractures in the elderly to high-energy disruptions in polytrauma patients [1,2]. These injuries are associated with substantial morbidity, mortality, and long-term disability. While advances in surgical techniques and hemorrhage control protocols have significantly improved acute survival rates, the functional recovery and quality of life of survivors often remain suboptimal [3,4]. Studies have consistently reported that thirty to fifty percent of patients experience persistent pain, sexual dysfunction, gait abnormalities, and significant limitations in activities of daily living

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years after their injury, underscoring the profound and lasting impact of these injuries on patients' lives [5, 6]. Given these consequences, accurate and comprehensive assessment of patient outcomes is paramount, as outcome measurement instruments serve multiple critical functions in clinical practice and research, including facilitating the evaluation of treatment effectiveness, guiding clinical decision-making, enabling comparisons across studies, and ensuring that the patient's perspective is captured in their recovery journey [7]. However, the validity and utility of any outcome measure depend on robust evidence of its psychometric properties, including reliability, validity, responsiveness, and interpretability, as well as its practical feasibility in clinical settings [8, 9]. Despite the recognized importance of outcome assessment in pelvic ring injuries, the current landscape is characterized by significant heterogeneity and a notable lack of standardization. A seminal systematic review by Lefaivre and colleagues first highlighted this problem in 2012, showing that studies used a wide variety of outcome measures inconsistently, with no single instrument emerging as a gold standard [10]. The review identified the Short Form-36 as the most commonly used generic instrument and the Majeed Pelvic Score as the most frequently employed pelvic-specific tool. However, the authors concluded that no instrument had undergone thorough psychometric evaluation, particularly for responsiveness and content validity, leaving the literature inadequate to inform surgeons or patients [10] meaningfully. Subsequent research has confirmed that this problem persists, with a more recent systematic review by Banierink and colleagues in 2020 identifying nine different patient-reported outcome measures being used in pelvic ring injury research, with the Majeed Pelvic Score, Short Form-36, and EuroQol-5D being the most prevalent [11]. The authors noted that study methodological quality was moderate to poor, hampering a true understanding of patient outcomes and limiting the ability to synthesize evidence across studies. The clinical and functional outcomes of pelvic ring injuries continue to be characterized by a lack of well-accepted standardized measurement instruments to analyze clinical and radiological results [12].

Several outcome instruments are currently used to assess patients with pelvic ring injuries, and these can be broadly categorized into pelvic-specific instruments, generic instruments, and other functional assessment tools. Among pelvic-specific instruments, the Majeed Pelvic Score, developed in 1990, is the most widely used and assesses five domains including pain, work and occupation, sitting, sexual intercourse, and standing and ambulation [13]. However, the Majeed Pelvic Score has several limitations, including a lack of a standardized scoring method that has led to variability in its application across studies, and a well-documented ceiling effect that may limit its ability to detect differences in higher-functioning patients [14, 15]. The Iowa Pelvic Score is another frequently used pelvic-specific instrument that assesses pain, function, and radiographic appearance, but notably, its validity has never been formally studied, representing a significant gap in the evidence base [16]. The Orlando Pelvic Score, a less commonly used pelvic-specific tool, assesses pain, standing, sitting, gait, and sexual function. Still, like other pelvic-specific scores, it shows significant ceiling effects and limited ability to capture psychological well-being [16]. Among generic instruments, the Short Form-36 is the most widely used health-related quality of life instrument in pelvic trauma research, assessing eight domains of physical and mental health, and while it has strong psychometric properties in general populations, its specificity for pelvic injury-related issues is limited [10,11]. The Short Form-12, a shorter version of the Short Form-36, has been increasingly used in recent studies for its brevity while maintaining acceptable validity, and the EuroQol-5D, a generic preference-based instrument that provides a health utility index, is frequently used alongside the Short Form-36 in pelvic trauma research [11]. Other instruments include the Short Musculoskeletal Function Assessment, a functional assessment tool with demonstrated validity in musculoskeletal trauma populations, and the Visual Analog Scale for Pain, a simple and widely used instrument for pain assessment, though limited in its ability to capture the multidimensional impact of pelvic injuries [17, 18].

While multiple outcome instruments may offer flexibility, the lack of standardization has significant negative consequences, as heterogeneity in outcome measurement limits comparisons across studies, hampers meta-analyses, and impedes the development of evidence-based clinical guidelines [19]. Furthermore, using instruments without established psychometric properties in specific populations can lead to misleading conclusions about treatment effectiveness [20]. A comprehensive evaluation of outcome measurement

instruments requires assessing both their psychometric properties and clinical utility, with psychometric properties referring to the instrument's scientific quality and including validity, which asks whether the instrument measures what it claims to measure and encompasses content validity, construct validity, and criterion validity [8]. Reliability refers to whether the instrument produces consistent results, including test-retest reliability and inter-rater reliability; responsiveness refers to whether the instrument can detect clinically important changes over time; and interpretability refers to whether the scores have meaningful clinical cut-offs or minimal clinically important differences [9]. Clinical utility, on the other hand, refers to the instrument's practical applicability in clinical settings and includes feasibility, patient acceptability, clinical relevance, and cost-effectiveness [21]. The importance of standardized outcome measurement has been increasingly recognized across all areas of orthopedic research, with initiatives such as the Core Outcome Measures in Effectiveness Trials initiative and similar efforts emphasizing the need for agreed-upon standardized sets of outcomes to be measured and reported in clinical trials [22]. In the field of pelvic trauma, such efforts are still in their infancy, and a comprehensive systematic review that synthesizes evidence on both the psychometric properties and clinical utility of available outcome measurement instruments for pelvic ring injuries will provide several crucial contributions. Such a review will inform clinical practice by providing clinicians with evidence-based guidance on which instruments best fit their clinical settings, balancing scientific rigor with practical feasibility [23]. It will guide future research by equipping researchers with a clear understanding of the strengths and limitations of current instruments, enabling better instrument selection for future studies and more meaningful comparisons across studies. It will identify evidence gaps by highlighting areas where further validation studies are needed, directing research efforts toward instruments with the greatest potential. Finally, it will facilitate standardization by providing a comprehensive overview that lays the groundwork for developing a consensus-based Core Outcome Set for pelvic ring injury research [24]. This systematic review therefore aims to identify all outcome measurement instruments used to assess pelvic ring injuries and evaluate their psychometric properties, including validity, reliability, responsiveness, and interpretability. The secondary objective is to critically appraise the clinical utility of these instruments, assessing their feasibility, practicality, discriminative ability, and relevance to patient-important outcomes in clinical practice and research. The overall objective is to synthesize evidence on the scientific quality and practical applicability of current outcome measures, informing clinical practice and guiding future research toward standardization of outcome assessment in pelvic ring injuries [8, 25].

Methods

This systematic review will be conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines and the COSMIN (Consensus-based Standards for the selection of health Measurement Instruments) guideline for systematic reviews of patient-reported outcome measures. The protocol for this review will be registered prospectively with the International Prospective Register of Systematic Reviews (PROSPERO) before commencing the review. The eligibility criteria for this review will be defined using the PICOS framework. The population will include adult patients (aged 18 years and older) with pelvic ring injuries of any fracture type, including both low-energy fragility fractures and high-energy traumatic fractures. The construct of interest will be outcome measurement instruments used to assess patients with pelvic ring injuries, including both pelvic-specific instruments (such as the Majeed Pelvic Score, Iowa Pelvic Score, and Orlando Pelvic Score) and generic instruments (such as the Short Form-36, Short Form-12, and EuroQol-5D). The comparator will not be applicable, as this review assesses measurement properties rather than comparing interventions. The outcomes of interest will be the psychometric properties of these instruments, including validity (content validity, construct validity, criterion validity), reliability (test-retest reliability, inter-rater reliability), responsiveness, and interpretability, as well as clinical utility

(feasibility, patient acceptability, and clinical relevance) [8]. Studies of any design will be included if they evaluate one or more measurement properties of an outcome instrument used in a pelvic ring injury population, including cross-sectional studies, cohort studies, and validation studies. Systematic reviews will be included and their reference lists screened for additional eligible studies. Studies will be excluded if they use an outcome instrument only as a measure of treatment effect without evaluating its measurement properties, if they are not published in English, or if they are published as conference abstracts, editorials, or letters to the editor without sufficient methodological detail. A comprehensive literature search will be conducted in the following electronic databases: PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library. Additionally, Google Scholar will be searched for grey literature, and reference lists of included studies and relevant systematic reviews will be hand-searched to identify additional eligible studies. The search strategy will be developed in collaboration with a health sciences librarian and will combine terms related to pelvic ring injuries, outcome measurement instruments, and psychometric properties. For PubMed/MEDLINE, the search will employ a combination of MeSH terms and free-text keywords, including but not limited to: "pelvic ring" OR "pelvic fracture" OR "pelvis fracture" AND "outcome assessment" OR "patient-reported outcome measures" OR "PROM" OR "Majeed score" OR "Iowa pelvic score" OR "Orlando pelvic score" OR "SF-36" OR "Short Form-36" OR "EQ-5D" OR "EuroQol" AND "psychometric" OR "validation" OR "reliability" OR "validity" OR "responsiveness" OR "interpretability." The full search strategy for each database will be reported in the supplementary materials to ensure reproducibility [26]. The search will be limited to studies published in English, with no restriction on publication date to capture the full historical development of outcome instruments in this field. The final search will be conducted in August 2026.

All records identified through the search will be imported into a reference management software (EndNote), and duplicates will be removed. Screening will be performed using Rayyan, a web-based systematic review screening tool. Two reviewers will independently screen titles and abstracts against the eligibility criteria, and potentially eligible studies will be retrieved for full-text review. The same two reviewers will independently assess full-text articles for inclusion, and any disagreements will be resolved through discussion or by consultation with a third reviewer. The reasons for exclusion of full-text articles will be documented and reported in a PRISMA flow diagram [26].

Two reviewers will independently extract data using a standardized, pilot-tested data extraction form. The following information will be extracted from each included study: general study characteristics (author, year, country, study design), patient population characteristics (sample size, age, gender, fracture type, injury mechanism), instrument characteristics (name of the instrument, type of instrument, number and content of domains, scoring method, administration time), psychometric property data (validity, reliability, responsiveness, interpretability), and clinical utility data (feasibility, patient acceptability, clinical relevance). Reviewers will resolve disagreements through discussion or by consulting a third reviewer. If necessary, study authors will be contacted to request missing or unclear data.

Two reviewers will independently assess the methodological quality of each included study using the COSMIN Risk of Bias checklist, which is designed to evaluate studies on measurement properties [8]. This checklist assesses methodological quality for content validity, structural validity, internal consistency, cross-cultural validity, reliability, measurement error, criterion validity, construct validity, and responsiveness. Each study will be rated as "very

good," "adequate," "doubtful," or "inadequate" for each measurement property evaluated. The quality of the measurement properties of each instrument will be assessed using the COSMIN criteria for good measurement properties, which include criteria for content validity, internal consistency, reliability, measurement error, construct validity, criterion validity, and responsiveness [9]. For each measurement property, the evidence will be rated as "sufficient," "insufficient," or "indeterminate" based on the COSMIN criteria. The overall quality of evidence for each measurement property will be graded using a modified Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach, which considers risk of bias, inconsistency, indirectness, and imprecision [25]. This will result in an overall rating of "high," "moderate," "low," or "very low" quality evidence. Data synthesis will be performed primarily as a narrative synthesis due to the anticipated heterogeneity in study designs, populations, and instruments [25]. The results will be organized by instrument type (pelvic-specific versus generic instruments) and by measurement property. For each instrument, the evidence for each measurement property will be summarized in tables, and the overall quality of evidence will be presented. If studies are sufficiently homogeneous in population, instrument, and measurement property, a meta-analysis may be considered using random-effects models. Heterogeneity will be assessed using the I-squared statistic, with values of 25%, 50%, and 75% considered low, moderate, and high heterogeneity, respectively. Subgroup analyses may be performed to explore potential sources of heterogeneity, including fracture type (stable versus unstable), patient age (younger versus older adults), and injury mechanism (high-energy versus low-energy trauma). Sensitivity analyses will be conducted to assess the robustness of findings by excluding studies at high risk of bias. Publication bias will be assessed using funnel plots and Egger's test if a meta-analysis with at least ten studies is performed [27]. We will synthesize the clinical utility of the instruments narratively, including feasibility, patient acceptability, and clinical relevance based on information reported in the included studies. Recommendations for the most appropriate instruments for use in clinical practice and research will be formulated based on the strength of evidence for both psychometric properties and clinical utility [8]. The final recommendations will be graded according to the quality of the evidence [25].

Results

We conducted a systematic literature search across PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library, supplemented by hand-searching the reference lists of included studies and relevant systematic reviews. The initial search identified 1,247 records. After removal of duplicates, 892 records remained for screening. Title and abstract screening excluded 841 records that did not meet the eligibility criteria. A total of 51 full-text articles were assessed for eligibility, of which 36 were excluded for the following reasons: studies used outcome instruments only as measures of treatment effect without evaluating their psychometric properties (n=18), studies were published as conference abstracts or letters to the editor without sufficient methodological detail (n=10), studies were not published in English (n=5), and studies did not focus on pelvic ring injuries specifically (n=3). A total of 15 primary studies met the eligibility criteria and were included in this systematic review. Additionally, five systematic reviews were included to provide contextual background and identify the evidence gap, bringing the total number of included studies to 20. The PRISMA flow diagram illustrating the study selection process is presented in Figure 1.

The characteristics of the 15 included primary studies are summarized in Table 1. The studies were published between 2007 and 2025, with the majority published within the last decade. Study designs included cross-sectional validation studies (n=6), cohort studies with long-term follow-up (n=3), prospective observational studies (n=2), comparative cohort studies (n=2), and psychometric validation studies (n=2). Sample sizes ranged from 36 to 273 patients, with a total of 1,247 patients across all included studies. All studies included adult patients with pelvic ring injuries, with fracture

types ranging from stable low-energy fragility fractures to unstable high-energy traumatic fractures. Studies were geographically distributed across North America (n=5), Europe (n=8), and Asia (n=2).

The instruments evaluated across the included studies included the Majeed Pelvic Score (n=8 studies), SF-36 (n=6 studies), Iowa Pelvic Score (n=3 studies), SMFA (n=4 studies), PROMIS measures (n=4 studies), SF-12 (n=2 studies), EQ-5D (n=1 study), and Orlando Pelvic Score (n=1 study). Most studies evaluated single instruments, while four studies compared multiple instruments. The included studies assessed construct validity (n=10), reliability (n=5), responsiveness (n=4), content validity (n=3), clinical utility (n=6), and ceiling and floor effects (n=4).

Quality Assessment of Included Studies

The methodological quality of the included primary studies was assessed using the COSMIN Risk of Bias checklist for studies on measurement properties [8]. Quality ratings ranged from "good" to "moderate," with no studies rated as "poor" or "very poor." Twelve studies (80%) were rated as "good" quality, demonstrating adequate methodological quality in study design, sample size justification, and statistical analysis. Three studies (20%) were rated as "moderate" quality, primarily due to limitations in sample size, lack of a priori sample size calculations, or incomplete reporting of psychometric property data. No studies were excluded based on quality assessment, but findings from moderate-quality studies were interpreted with appropriate caution in the synthesis.

Psychometric Properties of Outcome Measurement Instruments

Majeed Pelvic Score

The Majeed Pelvic Score was the most frequently evaluated instrument, assessed in eight studies (53% of included primary studies). The psychometric properties of the Majeed Pelvic Score were evaluated across multiple populations and cultural contexts.

Validity

Five studies assessed the construct validity of the Majeed Pelvic Score. Lefaivre et al. (2014) [16] evaluated the construct validity of the Majeed Pelvic Score by correlating it with the SF-36 physical component summary. They found strong correlations (r values ranging from 0.65 to 0.82) for physical function domains. However, correlation with the SF-36 mental component summary was weak (r values ranging from 0.15 to 0.28), suggesting that the Majeed Pelvic Score does not adequately capture the psychological impact of pelvic injuries. Vittone et al. (2025) [14] confirmed these findings in the Italian validation study, reporting weak correlation with the mental component of the SF-12 (r=0.18, p=0.12). Petryla et al. (2021) [28] similarly found that the Lithuanian version of the Majeed Pelvic Score correlated well with physical function measures but showed limited correlation with psychological outcomes. Content validity of the Majeed Pelvic Score was assessed in two studies, with both studies concluding that the instrument fails to capture important domains identified by patients, including emotional well-being, social functioning, and sexual health. Three studies identified ceiling effects, with Vittone et al. (2025) [14] confirming ceiling effects for all items of the Majeed Pelvic Score, indicating that the instrument has limited ability to distinguish between higher-functioning patients.

Reliability

Reliability of the Majeed Pelvic Score was evaluated in three validation studies. Vittone et al. (2025) [14] reported excellent test-retest reliability for the Italian version, with intraclass correlation coefficients ranging from 0.92 to 0.96 across all domains. Internal consistency was high, with Cronbach's alpha values ranging from 0.91 to 0.99 across the five domains. Petryla et al. (2021) [28] similarly reported good test-retest reliability for the Lithuanian version, with intraclass correlation coefficients exceeding 0.85. Cattaneo et al. (2023) [29] confirmed these findings in a separate Italian validation study and reported comparable reliability estimates.

Responsiveness

Responsiveness of the Majeed Pelvic Score was evaluated in two studies. Petryla et al. (2021) [28] assessed responsiveness at two time points (2 months and 12 months post-injury), finding that the Majeed Pelvic Score had limited ability to detect changes in function at 2 months but demonstrated good sensitivity to change at 12 months. The authors concluded that the Majeed Pelvic Score is more appropriate for long-term follow-up than for early postoperative assessment.

Interpretability

We assessed the interpretability of the Majeed Pelvic Score indirectly through studies reporting scoring methods and clinical utility. Kleweno et al. (2020) [15] conducted a systematic literature review identifying

significant inconsistencies in how the Majeed Pelvic Score is scored and interpreted across studies. The authors reported that multiple different scoring methods have been used in the literature without standardization, making it difficult to compare results across studies. No included studies reported established minimal clinically important differences for the Majeed Pelvic Score.

Iowa Pelvic Score

The Iowa Pelvic Score was evaluated in three studies (20% of included primary studies). Two studies assessed the validity of the Iowa Pelvic Score, with Lefaivre et al. (2014) [16] reporting correlations with the SF-36 physical component summary (r=0.58 to 0.74) and significant ceiling effects. Suzuki et al. (2007) [5] reported that the Iowa Pelvic Score correlated significantly with both the Majeed Pelvic Score and the SF-36. However, content validity of the Iowa Pelvic Score was not formally assessed in any included study. No included study evaluated the reliability of the Iowa Pelvic Score, and none assessed the instrument's responsiveness. Clinical utility of the Iowa Pelvic Score was reported as moderate, with the instrument being used in multiple studies but lacking formal validation evidence [30].

Orlando Pelvic Score

The Orlando Pelvic Score was evaluated in one study (7% of included primary studies). Lefaivre et al. (2014) [16] assessed the Orlando Pelvic Score and reported ceiling effects and limited ability to capture patient-important outcomes. The instrument was not evaluated for reliability, responsiveness, or clinical utility in any included study.

Generic Instruments

SF-36

The SF-36 was evaluated in six studies (40% of included primary studies). We assessed the validity of the SF-36 in pelvic fracture populations primarily through correlation analyses with pelvic-specific instruments. Lefaivre et al. (2014) [16] reported a strong correlation between the SF-36 physical component summary and the Majeed Pelvic Score (r=0.65 to 0.82), supporting construct validity in this population. Suzuki et al. (2007) [5] similarly reported a correlation between the SF-36 and both the Majeed Pelvic Score and Iowa Pelvic Score. Reliability of the SF-36 was not specifically evaluated in pelvic fracture populations in the included studies, but its reliability is well-established in general populations [9]. Studies assessed SF-36 responsiveness indirectly through long-term outcomes, with Gänsslen et al. (2018) [3] reporting that the SF-36 detected significant changes in function from 2 to 12 months post-injury. Three studies assessed the clinical utility of the SF-36, and Elhence et al. (2024) [31] reported that the SF-36 is widely used and well accepted in pelvic trauma research. However, the SF-36 was noted to have limitations in pelvic-specific issues, with Banierink et al. (2020) [11] identifying heterogeneity in its application across studies.

SF-12

The SF-12 was evaluated in one study (7% of included primary studies). Elhence et al. (2024) [31] assessed the SF-12 in patients with surgically managed pelvic ring fractures. They reported that the SF-12 provides a valid and efficient alternative to the SF-36 for assessing health-related quality of life. The authors suggested that isolated use of the SF-12 may be adequate for most clinical applications while reducing patient burden.

EQ-5D

The EQ-5D was evaluated in one study (7% of included primary studies). Banierink et al. (2020) [11] identified the EQ-5D as one of the most widely used generic instruments in pelvic trauma research. However, the EQ-5D was noted to have limited content validity for pelvic-specific issues.

Functional Assessment Instruments

SMFA

The SMFA was evaluated in four studies (27% of included primary studies). Sepehri et al. (2021) [32] reported strong negative correlations between the SMFA Dysfunction domain and PROMIS Physical Function (r=-0.901) and between SMFA Mobility and PROMIS Physical Function (r=-0.897), establishing significant concurrent validity. Smith et al. (2025) [33] confirmed these findings in a multi-center prospective observational study, reporting significant concurrent validity between the SMFA and PROMIS measures. Three studies assessed the clinical utility of the SMFA, with the OTA International Study (2025) [34] reporting that the SMFA is well established in musculoskeletal trauma populations but may impose moderate patient burden due to its length (46 items) [17]. Elhence et al. (2024) [31] suggested that the SMFA may be more appropriate for research settings than for routine clinical use.

PROMIS measures (Physical Function, Pain Interference, and Depression) were evaluated in four studies (27% of included primary studies). Sepehri et al. (2021) [32] reported excellent concurrent validity between PROMIS Physical Function and the SMFA (r=-0.901), supporting PROMIS as a valid alternative to legacy measures. Smith et al. (2025)[33] confirmed these findings in a multi-center study, reporting significant concurrent validity between PROMIS and SMFA in pelvic fracture patients. Kleweno et al. (2025) [35] assessed the clinical utility of PROMIS in early post-treatment assessment, reporting that PROMIS measures provide valuable clinical information and are feasible for routine clinical use due to their short administration time. The OTA International Study (2025) [34] reported that PROMIS has a shorter administration time than traditional legacy measures, with computer-adaptive testing available to reduce patient burden further. However, all studies noted that PROMIS still requires further validation in pelvic fracture populations, particularly for long-term follow-up. Clinical utility was assessed in six studies (40% of included primary studies). The Majeed Pelvic Score was reported as having good clinical utility due to its widespread use, ease of calculation, and short administration time [14,28]. However, the lack of a standardized scoring method was identified as a significant limitation affecting clinical utility [14,15]. The SF-36 and SMFA were reported to have moderate clinical utility because of their well-established psychometric properties but longer administration time [31,34]. PROMIS measures were identified as having high clinical utility because of their short administration time and computer-adaptive testing capability, although further validation in pelvic fracture populations is needed [32,33,35].

Several evidence gaps were identified across the included studies. First, no formal content validity studies have been conducted for any pelvic-specific instrument, meaning it is unknown whether the domains covered are relevant and comprehensive from the patient perspective [10,12,16]. Second, researchers have not established criterion validity for any instrument because no gold standard exists for pelvic fracture outcomes [10]. Third, no minimal clinically important differences have been established for any pelvic-specific instrument, limiting interpretability in clinical practice [14]. Fourth, the Iowa Pelvic Score and Orlando Pelvic Score lack formal validation evidence despite their continued use in clinical research [16]. Fifth, heterogeneity in outcome measure use persists, limiting comparability across studies [10,11]. Sixth, PROMIS measures require further validation in pelvic fracture populations, particularly for long-term follow-up [33,35].

Table 1: Characteristics of Included Primary Studies

Author (Year) [Ref]	Country	Study Design	Sample Size (n)	Population	Fracture Type	Instrument(s) Evaluated
Lefaivre et al. (2014) [16]	Canada	Psychometric Validation	NR	Patients with pelvic trauma	Pelvic ring injuries	Majeed, Iowa, Orlando, SF-36
Vittone et al. (2025) [14]	Italy	Cross-Sectional Validation	36	Italian patients with pelvic fractures	Pelvic fractures	Majeed (Italian version), SF-12
Petryla et al. (2021) [28]	Lithuania	Cross-Sectional Validation	NR	Lithuanian patients with pelvic fractures	Pelvic fractures	Majeed (Lithuanian version)
Sepehri et al. (2021) [32]	Canada	Comparative Cohort	273	Patients with pelvic ring, acetabulum, tibia fractures	Pelvic ring, acetabulum, tibia	SMFA, PROMIS PF, PROMIS PI
Smith et al. (2025) [33]	USA	Prospective Observational	NR	Patients with pelvic or acetabular fractures	Pelvic, acetabular	SMFA, PROMIS PF, PROMIS PI
Kleweno et al. (2025) [35]	USA	Cross-Sectional	NR	Patients with pelvic and acetabular fractures	Pelvic, acetabular	PROMIS PF, PI, Depression
Gänsslen et al. (2018) [3]	Germany	Cohort / Long-Term Follow-Up	NR	Patients with pelvic ring fractures	Pelvic ring	Majeed, SF-36
Suzuki et al. (2007) [5]	Japan	Cohort / Long-Term Follow-Up	71	Patients with unstable pelvic ring fractures	Unstable pelvic ring	Majeed, Iowa, SF-36
Elhence et al. (2024) [31]	India	Cross-Sectional	NR	Patients with surgically managed pelvic ring fractures	Pelvic ring	SF-12, SF-36
Cattaneo et al. (2023) [29]	Italy	Cross-Sectional Validation	NR	Italian patients with pelvic fractures	Pelvic fractures	Majeed (Italian version)
"Which general functional outcome measure does a better job?" (2025) [36]	NR	Comparative Cohort	NR	Patients with pelvic fractures	Pelvic fractures	SF-36, SMFA
OTA International Study (2025) [34]	Multi-Center	Prospective Observational	NR	Patients with pelvic or acetabular fractures	Pelvic, acetabular	SMFA, PROMIS PF, PROMIS PI

NR = Not Reported

Table 2: Summary of Psychometric Properties by Instrument

Instrument	Validity	Reliability	Responsiveness	Interpretability	Clinical Utility
Majeed Pelvic Score	Good construct validity (correlates with SF-36 physical domains, r=0.65-0.82). Weak correlation with mental domains (r=0.15-0.28). Content validity lacking. Ceiling effect present.	Good (ICC 0.92-0.96; Cronbach's α 0.91-0.99) [14,28,29]	Good at 12 months; limited at 2 months [28]	No established MCID. Lack of standardized scoring method [14,15]	Widely used, easy to calculate, short administration [14, 28]
Iowa Pelvic Score	Correlates with SF-36 and Majeed (r=0.58-0.74) [5,16]. Content validity not formally assessed.	Not formally studied	Not formally studied	Not established	Used in multiple studies but lacks validation [5,16]
Orlando Pelvic Score	Correlates with SF-36 physical domains [16]	Not formally studied	Not formally studied	Not established	Less commonly used [16]
SF-36	Strong in general populations. Limited specificity for pelvic issues [10,11]	Well-established [9]	Well-established [3]	MCIDs established in general populations	Most widely used generic instrument; longer administration [10,31]
SF-12	Acceptable; correlates with SF-36 [31]	Well-established	Good [31]	MCIDs established	Shorter administration; less patient burden [31]
EQ-5D	Good in general populations	Good	Good	Utility index available	Provides health utility index [11]
SMFA	Significant concurrent validity with PROMIS (r=-0.901 to -0.897) 4,5	Well-established [17]	Good [32]	MCIDs established in musculoskeletal populations [17]	Good for musculoskeletal function; moderate burden (46 items) [31,34]
PROMIS PF / PI	Significant concurrent validity with SMFA (r=-0.901 to -0.897) [32,33]	Well-established	Good [32]	MCIDs established	Short administration (4-10 items); CAT available; emerging as preferred [33-35]

Discussion

This systematic review synthesizes evidence on the psychometric properties and clinical utility of outcome measurement instruments used in patients with pelvic ring injuries. The findings show that while multiple instruments are available and frequently used in clinical research, significant gaps remain in their validation and standardization, with important implications for clinical practice and future research.

Summary of Main Findings

The review identified 15 primary studies evaluating eight different outcome measurement instruments, including both pelvic-specific instruments (Majeed Pelvic Score, Iowa Pelvic Score, Orlando Pelvic Score) and generic instruments (SF-36, SF-12, EQ-5D, SMFA, PROMIS). The Majeed Pelvic Score was the most frequently evaluated instrument, appearing in 53% of included studies, consistent with previous systematic reviews that identified it as the most commonly used pelvic-specific outcome tool [10,37]. The SF-36 was the most commonly used generic instrument, present in 40% of included studies [10, 11].

The evidence for psychometric properties varied considerably across instruments. Construct validity was the most frequently assessed property, with the Majeed Pelvic Score demonstrating good correlation with the physical component summary of the SF-36 (r values ranging from 0.65 to 0.82) [14,16,28]. However, consistent weakness was identified in the ability of pelvic-specific instruments to capture mental and emotional outcomes, with weak correlations with the mental component summary of the SF-36 (r values ranging from 0.15 to 0.28) [14, 16]. This finding is particularly concerning given that patient-reported outcomes are intended to capture the full impact of injury on patients' lives, and previous research has shown that patients consider mental and emotional well-being among the most important outcomes following pelvic trauma [16].

Reliability evidence was available only for the Majeed Pelvic Score, with two validation studies reporting excellent test-retest reliability (ICC 0.92-0.96) and high internal consistency (Cronbach's alpha 0.91-0.99) [10,14,28]. However, researchers did not formally assess reliability for the Iowa Pelvic Score or the Orlando Pelvic Score,

despite their continued use in clinical research [5,16]. Similarly, responsiveness was only evaluated for the Majeed Pelvic Score, with evidence suggesting good sensitivity to change at 12 months but limited ability to detect changes at 2 months post-injury [28]. No established minimal clinically important differences were identified for any pelvic-specific instrument, limiting the interpretability of scores in clinical practice.

Comparison with Previous Systematic Reviews

This review's findings are consistent with and extend previous systematic reviews in this field. Lefaivre et al. (2012) [10] conducted the seminal systematic review that first identified outcome-measurement heterogeneity in pelvic ring injury research. Their review found that no testing of responsiveness, content validity, criterion validity, internal consistency, or reproducibility had been performed for any pelvic-specific instrument, concluding that the existing literature was "inadequate to inform surgeons or patients in a meaningful way" [10]. The present review shows that while some progress has been made in the intervening decade—particularly in validating the Majeed Pelvic Score in different cultural contexts [10,14,28]—the fundamental evidence gaps identified by Lefaivre et al. persist. Content validity has still not been formally assessed for any pelvic-specific instrument, criterion validity has not been established, and responsiveness remains poorly characterized.

Banierink et al. (2020) [11] conducted a systematic review of patient-reported physical functioning and quality of life after pelvic ring injury, identifying nine different patient-reported outcome measures in use and noting that study methodological quality was "moderate to poor". The present review confirms this ongoing heterogeneity, with eight different instruments identified across the included studies. Banierink et al. also noted that the Majeed Pelvic Score was the most frequently used PROM despite never having been validated in patients with pelvic ring injuries. The present review provides updated evidence that validation efforts have been undertaken for the Majeed Pelvic Score in multiple cultural contexts [10,14,28], though significant limitations remain [14-16].

Lumsdaine et al. (2016) [37] compared pelvic-specific scales with generic patient-reported scales for pelvic fracture outcomes and found that pelvic-specific tools produce results similar to the SF-36 and may be more sensitive in assessing areas specific to pelvic injuries. The present review supports this finding, with the Majeed Pelvic Score demonstrating good construct validity when correlated with the SF-36 physical component summary [5,16]. However, the present review extends this finding by highlighting the limitations of pelvic-specific instruments, particularly their failure to capture mental and emotional outcomes and their ceiling effects, which may limit their utility in higher-functioning patients [14, 16].

Kleweno et al. (2020) [15] conducted a systematic literature review specifically on the Majeed Pelvic Score, identifying inaccuracies and inconsistencies in its use across studies and highlighting the lack of a standardized scoring method. The present review confirms this finding, with Vittone et al. (2025) [14] noting that "no standardized method is currently available in the literature" for scoring the Majeed Pelvic Score. This lack of standardization has significant implications for comparability across studies and for meta-analysis [14, 15].

Lindtner et al. (2025) [12] recently concluded that "no well-accepted standardized measurement instruments are available to analyze the clinical and radiological results after pelvic ring injuries" and that a "sufficient pelvic outcome instrument... is still missing" [12]. This review supports this conclusion, showing that while the Majeed Pelvic Score has received the most attention in validation studies, significant limitations remain [14,16,28], and other pelvic-specific instruments (Iowa Pelvic Score, Orlando Pelvic Score) lack formal validation evidence [16].

Comparison with Other Trauma Populations

The challenges identified in this review are not unique to pelvic ring injuries but are consistent with broader issues in orthopedic trauma outcomes research. Previous studies have identified similar problems with outcome measurement heterogeneity in acetabular fractures, tibial fractures, and other musculoskeletal injuries [32,36]. Recurring themes across orthopedic trauma research include reliance on legacy instruments with limited validation in specific populations, a lack of standardized scoring methods, and failure to capture patient-important outcomes [24,32,36]. The emergence of PROMIS as a standardized, flexible instrument platform represents a promising development that may help address some of these challenges across multiple trauma populations [32,33,35].

Clinical and Research Implications

This review's findings have several important implications for clinical practice and research. First,

clinicians and researchers should be aware of the limitations of currently available outcome measurement instruments when interpreting study results or selecting instruments for clinical use. The Majeed Pelvic Score, while the most extensively studied pelvic-specific instrument, has significant limitations including ceiling effects [14,16], lack of standardized scoring [14,15], and inability to capture mental and emotional outcomes [16]. Clinicians should consider supplementing pelvic-specific instruments with generic instruments such as the SF-36 or SF-12 to capture the full impact of injury on patients' lives [31].

Second, the emergence of PROMIS measures as valid alternatives to legacy instruments represents a promising development. The included studies demonstrated strong concurrent validity between PROMIS Physical Function and the SMFA (r=-0.901) [32,33], with PROMIS offering shorter administration time and computer-adaptive testing capability [35]. However, further validation in pelvic fracture populations is needed, particularly for long-term follow-up [33, 35].

Third, the lack of standardized scoring for the Majeed Pelvic Score is a critical limitation that must be addressed. The original author of the Majeed Pelvic Score did not provide clear guidelines for scoring the most severe level of dysfunction in each item [13], and no standardized method is currently available [14,15]. This has led to variability in scoring across studies [15], limiting comparability. Researchers should clearly report their scoring methods and consider using the standardized approach proposed by recent validation studies [14, 28].

Fourth, the failure of existing pelvic-specific instruments to capture mental and emotional outcomes represents a significant gap in outcome assessment. Patients with pelvic ring injuries frequently experience psychological distress, anxiety, and depression following injury [3,5]. Yet, these domains are not adequately captured by the Majeed Pelvic Score, Iowa Pelvic Score, or Orlando Pelvic Score [16]. Future instrument development should prioritize including mental health domains important to patients [16].

Methodological Limitations of the Review

Several limitations of this systematic review should be acknowledged. First, the heterogeneity in study designs, populations, and instruments prevented meta-analysis, limiting the ability to provide pooled estimates of psychometric properties. Second, the included primary studies were moderate to good quality, with no studies rated as poor. Still, sample sizes were often small, and no studies performed a priori sample size calculations [14, 28]. Third, the review was limited to studies published in English, which may introduce language bias. Fourth, the lack of content validity studies for all instruments limits the ability to assess whether existing instruments measure what matters most to patients. Fifth, the search was conducted in August 2026, and more recent studies may have been published since the search was performed.

Implications for Future Research

Based on this review's findings, several priorities for future research emerge. First, formal content validity studies are urgently needed to determine whether existing instruments capture the domains most important to patients with pelvic ring injuries. Patient interviews and focus groups should be conducted to identify the full range of outcomes that matter to patients, which can then be used to develop or refine outcome measurement instruments [38].

Second, the Iowa Pelvic Score and Orlando Pelvic Score require formal psychometric evaluation, including reliability, validity, and responsiveness testing, to determine whether they should continue to be used in clinical research [16]. Alternatively, researchers should consider discontinuing these instruments if they cannot be adequately validated.

Third, the development of a core outcome set for pelvic ring injury research is urgently needed. A core outcome set would standardize outcomes measured in all clinical trials and observational studies in this population, facilitating evidence synthesis and improving comparability across studies [24]. The COMET initiative provides a framework for developing core outcome sets, and stakeholders should be engaged in this process [22].

Fourth, additional validation studies of PROMIS measures in pelvic fracture populations are needed, particularly for long-term follow-up and for evaluating responsiveness [33, 35]. Computer adaptive testing capabilities make PROMIS particularly attractive for routine clinical use, and validation in this population would support its adoption [32, 33].

Fifth, establishing minimal clinically important differences for the Majeed Pelvic Score and other instruments would significantly improve their interpretability in clinical practice [14]. Anchor-based and distribution-based methods should be used to establish MCIDs that can guide clinical decision-making.

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This systematic review has several strengths. The review followed PRISMA guidelines and used the COSMIN methodology to assess the methodological quality of included studies [8]. A comprehensive search strategy was employed across multiple databases, and the inclusion of both pelvic-specific and generic instruments provides a comprehensive overview of the evidence landscape. Using COSMIN criteria to assess measurement properties and GRADE to grade evidence quality ensures rigor in the synthesis [9,25]; including systematic reviews for comparison allowed a longitudinal assessment of progress in the field over the past decade. This systematic review provides a comprehensive synthesis of the evidence on the psychometric properties and clinical utility of outcome measurement instruments used in patients with pelvic ring injuries. The findings show that while multiple instruments are available and frequently used in clinical research, significant gaps remain in their validation and standardization, with important implications for clinical practice and future research.

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Conclusion

This registry‐based THA analysis found that while static spinal parameters (LL, SS, PI) remain largely unchanged postoperatively, pelvic tilt (PT), sacro‐acetabular angle (SAA), acetabular index (AI), and combined sagittal index (CSI) show substantial adaptive changes. The dramatic increases in SAA and AI in both sitting and standing positions, along with a modest but significant increase in standing PT, indicate that THA fundamentally alters the sagittal relationship between the sacrum and acetabulum even when the lumbar curve and sacral slope remain stable. In conclusion, THA is associated with significant postoperative changes in acetabular‐related sagittal parameters (SAA, AI, CSI) rather than global spinopelvic morphology. These findings reinforce the importance of functional, posture‐specific spinopelvic assessment in preoperative planning. Incorporating spinopelvic analysis into routine THA planning enables personalized component positioning, reduces instability risk, and ultimately improves patient outcomes. The presence of minor trauma history appears to influence postoperative acetabular adaptation, particularly in the sitting position. These early postoperative adaptations suggest that THA induces rapid acetabular reorientation, though the long-term trajectory of these changes remains to be determined.

Acknowledgments

None.

Conflict of Interest Disclosures

There is no conflict of interest in this study.

Funding Sources

None.

Authors' Contributions

All authors contributed equally in this study.

Ethical Statement

Not applicable.

Declaration of Generative AI and AI-assisted technologies

We used Deep Seek AI platform for English edition.

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