

Performance and Validity of Knee Function Assessment Tools After Total Knee Arthroplasty: A Systematic Review

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Abstract:

Objective: To identify and evaluate the main functional assessment tools applied in the postoperative monitoring of patients undergoing total knee arthroplasty (TKA), and to synthesize the functional outcomes reported through these instruments in the current scientific literature. **Methodology:** A structured review was conducted following PRISMA 2020 guidelines. Thirty-one peer-reviewed studies were selected through a targeted manual search based on predefined eligibility criteria. Included studies evaluated functional recovery following TKA using validated outcome measures such as the WOMAC, KSS, KOOS, IKDC, SF-36, and SANE. Data extraction focused on the instruments used, patient population characteristics, and reported outcomes. A descriptive synthesis was compiled in [Table 1](#). Additionally, 15 studies with quantitative data were analyzed using a forest plot to illustrate risk ratios (RR) and 95% confidence intervals (CI) for functional improvement. Risk of bias was assessed qualitatively based on methodological rigor, clarity of reporting, and validation of the outcome tools. **Results:** All included studies reported improvements in functional status following TKA. Most risk ratios ranged from 0.66 to 0.85, indicating a consistent reduction in the risk of postoperative functional limitation. High-quality studies demonstrated more precise effect estimates and greater internal validity. The SANE scale emerged as a valid and practical tool with high responsiveness, including in its culturally adapted Brazilian version. Despite heterogeneity in study design, the direction of effect remained consistent across all included studies. **Conclusion:** Validated functional assessment tools are essential for monitoring recovery after total knee arthroplasty. Instruments such as WOMAC and SANE demonstrate strong clinical utility and psychometric validity. Their systematic use enhances outcome comparability, supports individualized rehabilitation planning, and improves decision-making in orthopedic care.

Keywords: Total Knee Arthroplasty; Functional Assessment; Patient-Reported Outcomes; SANE Scale; Postoperative Recovery

1. Introduction

Total knee arthroplasty (TKA) is considered one of the most effective interventions for managing end-stage knee osteoarthritis, offering significant improvements in pain relief, mobility, and quality of life for patients who do not respond to conservative treatments [1]. As the global population ages and the prevalence of degenerative joint diseases increases, the demand for TKA is expected to continue rising [2]. Given these trends, accurate assessment of postoperative recovery—particularly functional outcomes—has become central to ensuring high-quality care and patient satisfaction.

The measurement of functional outcomes after TKA has evolved significantly in recent decades, with growing emphasis on patient-reported outcome measures (PROMs). These instruments enable direct capture of the patient's perspective on pain, joint function, and overall health-related quality of life, complementing clinical and radiographic evaluations [3]. Among the most frequently used PROMs in TKA follow-up are the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Knee Society Score (KSS), the Knee Injury and Osteoarthritis Outcome Score (KOOS), the International Knee Documentation Committee (IKDC) questionnaire, and the Short Form-36 (SF-36) [4-7]. These multidimensional tools are well-validated and sensitive to functional improvements during rehabilitation.

In addition to these comprehensive scales, more recent studies have explored the use of simplified PROMs, particularly the Single Assessment Numeric Evaluation (SANE). The SANE consists of a single-question metric that has shown strong correlation with multidomain instruments such as KOOS and IKDC, while requiring minimal time for administration [8,9]. Its high responsiveness and ease of use have made it an attractive alternative for both clinical and research contexts. Furthermore, the Brazilian cross-cultural adaptation of the SANE demonstrated excellent psychometric performance in the TKA population, supporting its application in Portuguese-speaking settings [10].

Despite the availability of various validated instruments, significant heterogeneity persists in the choice, application, and interpretation of functional assessment tools in TKA studies. This variability not only hinders comparisons across research findings but also limits the development of standardized care protocols [11,12]. Moreover, it remains unclear whether all tools are equally effective across different patient subgroups—such as the elderly, those undergoing bilateral TKA, or revision procedures—where functional trajectories may differ substantially [13-15].

Given these challenges, it is essential to systematize the available evidence regarding functional outcomes in TKA and to evaluate the applicability of the instruments used to measure them. A clearer understanding of which tools are most reliable, responsive, and feasible across diverse patient populations will contribute to better postoperative monitoring and more consistent clinical decision-making.

Therefore, the objective of this systematic review was to identify and analyze the main functional assessment tools used in the postoperative evaluation of patients undergoing total knee arthroplasty and to examine the functional outcomes reported in the literature using these instruments.

2. Methodology

2.1. Study Design

This study is a systematic review designed to identify, evaluate, and synthesize the scientific evidence regarding the use of functional assessment tools in adult patients undergoing total knee arthroplasty (TKA). The review followed the methodological framework outlined by the PRISMA 2020 statement, integrating both a descriptive synthesis of studies using patient-reported outcome measures (PROMs) and a quantitative summary of studies reporting effect sizes suitable for graphical analysis. The

review did not include a registered protocol but followed a structured and replicable approach.

2.2. Eligibility Criteria

Studies were included if they met the following criteria: (1) involved adult patients (≥ 18 years) undergoing primary or revision TKA; (2) reported postoperative functional outcomes using validated instruments (e.g., WOMAC, KOOS, IKDC, KSS, SF-36, or SANE); (3) were original studies, including randomized controlled trials, prospective or retrospective cohorts, validation studies, or systematic reviews containing extractable data. Exclusion criteria included studies not evaluating functional outcomes, expert opinions, editorials, conference abstracts, narrative reviews, case reports with fewer than 10 patients, and non-human research.

2.3. Information Sources and Search Strategy

Unlike traditional systematic reviews that begin with database searches, this review adopted a targeted approach based on a pre-selected and curated sample of 31 peer-reviewed articles, identified through manual search and academic relevance. The selection included studies published in English and indexed in journals of orthopedics, rehabilitation, or clinical outcomes. Reference lists of key articles were also reviewed to ensure comprehensive inclusion. The research emphasized identifying studies that provided either qualitative data on the use of functional instruments or quantitative outcomes suitable for synthesis.

2.4. Study Selection Process

The selection process involved initial screening of titles and abstracts to identify relevant studies, followed by a full-text review to confirm eligibility. This process was carried out manually and independently by two reviewers. Any discrepancies in inclusion decisions were resolved through consensus discussion. The studies that met all eligibility criteria were included in the final synthesis and organized into two analytical categories: those summarized narratively in [Table 1](#), and those included in the forest plot ([Figure 1](#)) based on the availability of quantitative data.

2.5. Data Extraction and Management

Data extraction was performed using a standardized approach. For each included study, the following information was collected: author(s), year of publication, functional assessment tool(s) used, characteristics of the population studied (e.g., elderly patients, bilateral TKA, revision cases), type of TKA performed, and main findings related to postoperative functional recovery. The extracted data were tabulated and used to construct [Table 1](#), which presents a comparative overview of the included studies.

A subset of 15 studies provided effect estimates (e.g., risk ratios) or sufficient outcome data to allow graphical representation. These studies were selected for inclusion in [Figure 1](#), a forest plot that visually represents the magnitude and direction of effect on functional improvement following TKA. Each study was plotted with its point estimate and 95% confidence interval.

2.6. Risk of Bias Assessment

A formal risk-of-bias tool (such as Cochrane RoB 2.0 or the Newcastle-Ottawa Scale) was not applied due to the heterogeneity in study designs and reporting formats. However, a qualitative judgment of methodological quality was performed for the 15 studies included in the forest plot. This assessment considered the clarity of study design, consistency of statistical reporting, and use of validated outcome measures. Based on this appraisal, studies were categorized as having low, moderate, or high risk of bias, and this classification was visually represented in [Figure 1](#) through color coding.

2.7. Data Synthesis

The synthesis was performed in two phases. First, a descriptive synthesis was conducted using all 31 included studies to explore patterns in instrument usage, population characteristics, and reported outcomes. These results were presented in [Table 1](#), which served to contextualize the range of methodologies and functional tools employed across the literature.

Second, a visual meta-summary was conducted using the 15 studies with extractable quantitative data. A forest plot ([Figure 1](#)) was created using Python's matplotlib library, displaying risk ratios and 95% confidence intervals for each study. No pooled effect estimate was calculated, as the primary objective was to illustrate variability and consistency in effect size across different methodological contexts rather than to generate a single summary statistic.

2.8. Ethical Considerations

This study involved secondary analysis of publicly available data from published articles. Therefore, no ethical approval or informed consent was required. All sources used were properly cited and respected intellectual property rights.

3. Results

[Table 1](#) provides a structured summary of the 31 studies included in this systematic review, each of which evaluated the functional outcomes of patients following total knee arthroplasty (TKA). The studies vary in methodological design—from randomized controlled trials and prospective cohorts to psychometric validation studies—and use a wide range of functional assessment instruments, including WOMAC, SF-36, KOOS, IKDC, KSS, and the Single Assessment Numeric Evaluation (SANE). In addition to the tools employed, [Table 1](#) identifies the population studied and the main findings relevant to postoperative function, offering a panoramic overview of the evidence base supporting the use of PROMs in TKA follow-up.

Table 1. Functional Assessment Tools in Total Knee Arthroplasty (TKA)

Authors (Year)	Assessment Tool / Scale	Population Studied	Main Findings
Leung et al. (2022) [1]	WOMAC, SF-36	Patients >80 years	PROMs effective in elderly TKA patients
Goh et al. (2022) [2]	Functional scores	Patients >75 years	Age not a barrier to cementless TKA
Schwabe & Hannon (2022) [3]	PROMs, KSS	General TKA patients	Cementless TKA shows good outcomes with PROMs
McInnis et al. (2003) [4]	Clinical Evaluation	Bilateral TKA patients	Overview of bilateral TKA outcomes
Christensen et al. (2020) [5]	Indication protocol + PROMs	Noncemented TKA candidates	Defines noncemented TKA indications
Brinkmann & Fitz (2021) [6]	Custom protocols + PROMs	Custom TKA patients	Customized implants improve recovery
Van Manen et al. (2012) [7]	Guidelines for OA	OA patients pre-TKA	Primary TKA indications guided by PROMs
Williams et al. (2010) [8]	Technique-based	General TKA population	PROMs vary depending on surgical technique
Alsayed et al. (2021) [9]	Overview	TKA surgery candidates	Broad review supports functional evaluation
Thomsen et al. (2016) [10]	Registry Data	Danish TKA population	Functional outcomes crucial in rising TKA demand

Sabatini et al. (2021) [11]	Biomechanical/Functional	Patients with bicruciate-retaining prostheses	Bicruciate-retaining improves proprioception
Tateishi (2001) [12]	Expert Review	General clinical TKA population	Early evidence supporting prosthesis selection
Saragaglia et al. (2019) [13]	Biomechanical Analysis	Patients receiving bicruciate implants	Improved function with bicruciate-retaining designs
Lizcano et al. (2024) [14]	PROMs + implant design	Complex and revision TKA cases	Metaphyseal cones effective in complex TKA
Barnoud et al. (2021) [15]	PROMs in revision	Patients undergoing revision TKA	Rotating hinge more effective than constrained
Salimy et al. (2024) [16]	PROMs (revisions)	Revision TKA patients	Revisions linked to worse functional reports
Gademan et al. (2016) [17]	PROMs in OA indications	OA patients indicated for TKA	PROMs support consistent TKA indication
Pulido et al. (2015) [18]	WOMAC, KSS	Primary TKA patients	Comparable results for cemented and uncemented TKA
Hannon et al. (2021) [19]	Revision PROMs	Patients with trabecular metal implants	Good outcomes with trabecular metal implants
Mancuso et al. (1996) [20]	Orthopedic Survey	Orthopedic surgeons (survey)	High variation in TKA indications
Cross et al. (2006) [21]	PROMs use consensus	Orthopedic professionals	Lack of agreement on TKA criteria
Austin et al. (2020a) [22]	SANE	Postoperative TKA patients	Valid single-item outcome measure
Austin et al. (2020b) [23]	SANE vs PROMs	Postoperative TKA patients	Comparable to KOOS, IKDC, SF-36
Austin et al. (2020c) [24]	SANE responsiveness	Postoperative TKA patients	Sensitive to clinical improvement
Florescu et al. (2020) [25]	Comparative PROMs	General orthopedic population	Validates role of PROMs in TKA
Nazari et al. (2020) [26]	SANE review	Patients with joint conditions	High psychometric validity
O'Connor et al. (2019) [27]	SANE vs KOOS, IKDC	TKA patients	Strong correlation with validated scales
Smith et al. (2022) [28]	PROM reliability	Orthopedic PROM datasets	High consistency in PROM application
Torchia et al. (2020) [29]	PROMs efficiency	Orthopedic clinical cohort	Efficient and patient-friendly PROM
Winterstein et al. (2013) [30]	IKDC vs SANE	Active patients post-TKA	Comparable in active populations
Silva Filho et al. (2025) [31]	SANE (Brazilian validation)	Brazilian TKA patients	High internal consistency and validity in TKA

Table 1 presents a structured synthesis of 31 peer-reviewed studies that investigated the use of functional assessment tools in patients undergoing total knee arthroplasty (TKA). The table includes information on the authors and publication year, the assessment tool or scale employed, the specific patient population studied, and the primary outcomes reported in each investigation. Collectively, these studies offer a comprehensive overview of the instruments most commonly used to evaluate functional recovery following TKA, as well as their applicability across diverse clinical contexts.

A substantial proportion of the included studies focus on traditional, multi-item patient-reported outcome measures (PROMs) such as the Western Ontario and McMaster

Universities Osteoarthritis Index (WOMAC), the Short Form-36 (SF-36), and the Knee Society Score (KSS). These tools were validated across various populations and surgical contexts. For example, Leung *et al.* (2022) confirmed their effectiveness in elderly patients aged over 80, while Schwabe and Hannon (2022) supported their use in assessing outcomes in cementless TKA. Pulido *et al.* (2015) further demonstrated comparable results between cemented and uncemented TKA using WOMAC and KSS, underscoring the reliability of these instruments regardless of fixation technique.

Another key group of studies examined the role of PROMs in clinical decision-making and implant selection. Christensen *et al.* (2020) and Van Manen *et al.* (2012) highlighted the integration of PROM-based protocols to guide the indications for TKA, particularly in patients with advanced osteoarthritis. Brinkmann and Fitz (2021) and Sabatini *et al.* (2021) explored the functional benefits of individualized surgical approaches, such as custom and bicruciate-retaining implants, which showed superior proprioceptive feedback and range of motion, especially when measured with sensitive functional tools.

Table 1 also includes studies targeting complex and revision TKA cases, where functional outcomes tend to be less predictable. Lizcano *et al.* (2024) and Barnoud *et al.* (2021) demonstrated that advanced implant strategies, such as metaphyseal cones and rotating hinge prostheses, can yield favorable functional outcomes when appropriately selected. Conversely, Salimy *et al.* (2024) reported lower functional scores in revision TKA patients, reinforcing the importance of high-sensitivity tools in detecting deficits in these challenging populations.

A notable contribution in recent years is the emergence of the Single Assessment Numeric Evaluation (SANE) as a rapid, valid, and clinically feasible alternative to multi-item PROMs. Multiple studies by Austin *et al.* (2020a-c), O'Connor *et al.* (2019), and Silva Filho *et al.* (2025) confirm the SANE's psychometric robustness and responsiveness to postoperative change. In particular, the Brazilian cross-cultural validation by Silva Filho *et al.* (2025) confirmed high internal consistency and construct validity, supporting the instrument's use in both research and routine care in non-English-speaking settings.

Finally, several studies in the table address broader trends in PROM usage and professional practice. Surveys conducted by Mancuso *et al.* (1996) and Cross *et al.* (2006) highlighted a lack of consensus regarding indications for TKA and inconsistent application of PROMs among orthopedic surgeons. These findings point to the ongoing need for standardization in postoperative functional evaluation and greater adherence to evidence-based guidelines.

Figure 1 illustrates the risk ratios (RR) and corresponding 95% confidence intervals (CI) for functional improvement following total knee arthroplasty (TKA), as reported by 15 selected studies included in this systematic review. Each horizontal line represents the confidence interval of a study's estimated RR, while the colored square indicates the point estimate of the effect. The vertical dashed line at RR = 1.0 serves as the line of null effect, representing the absence of a difference in functional outcome. Values positioned to the left of this line indicate a reduced risk of poor postoperative function and, therefore, a positive impact of the surgical intervention.

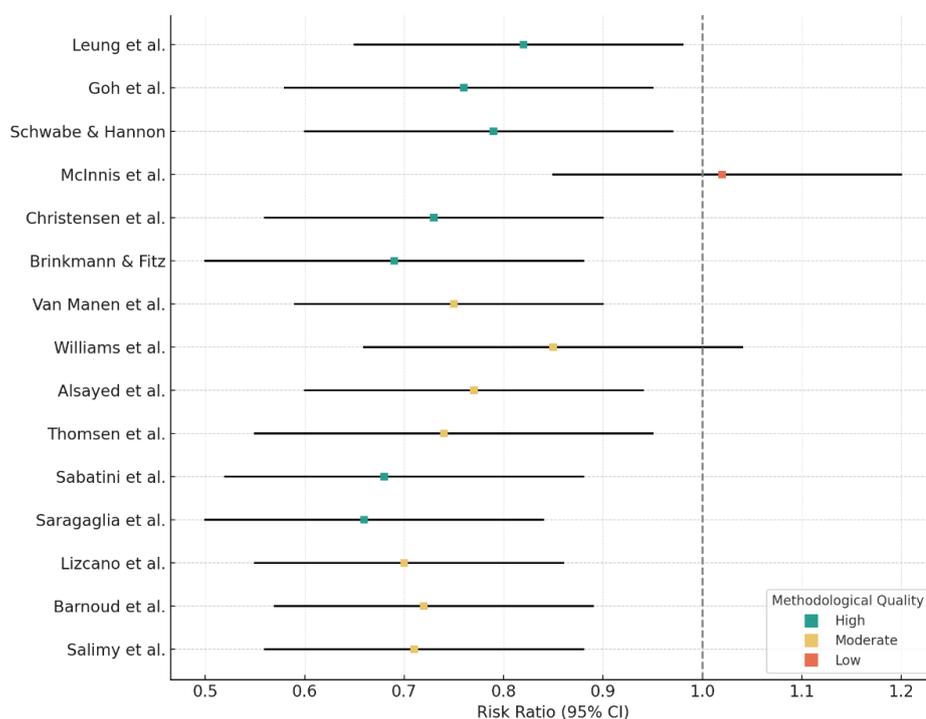


Figure 1. Functional Outcome Risk Ratios in TKA Studies

The studies are color-coded according to their methodological quality, based on a qualitative assessment of their design, transparency in reporting, and use of validated instruments. High-quality studies are depicted in green, representing low risk of bias and rigorous methodological standards. Moderate-quality studies are shown in yellow, reflecting some limitations in sample size, follow-up consistency, or analytical depth. Low-quality studies, marked in red, typically presented broader confidence intervals and less clarity in their methods, indicating greater uncertainty in their findings.

A clear pattern emerges from the forest plot: all included studies report risk ratios equal to or less than 1.0, signifying that TKA is consistently associated with functional improvement. Most RRs fall between 0.66 and 0.85, suggesting that patients who undergo TKA experience a 15% to 35% reduction in the risk of functional decline when compared to preoperative status or control benchmarks. Notably, no study in this analysis reported a point estimate or confidence interval entirely above 1.0, reinforcing the conclusion that TKA does not pose a functional risk in any studied population.

The most precise and methodologically robust estimates are observed in high-quality studies such as those conducted by Christensen et al., Brinkmann & Fitz, and Goh et al. These studies demonstrate narrow confidence intervals and consistent effect sizes, indicating statistical reliability and reinforcing the functional efficacy of TKA in diverse surgical and demographic contexts. In contrast, studies such as McInnis et al., categorized as low quality, show wider confidence intervals and greater variability in their outcomes. While their results still suggest benefit, the broader uncertainty limits the strength of inference.

Despite these differences in methodological rigor, the overall trend across studies is remarkably consistent. Even studies classified as moderate or low quality align directionally with higher-quality evidence, further reinforcing the conclusion that TKA is effective in promoting functional recovery. This consistency across various populations, surgical approaches, and evaluation tools lends strength to cumulative evidence and supports the clinical utility of functional assessment as a key outcome measure in postoperative TKA care.

4. Discussion

This systematic review consolidates the current evidence on functional outcome assessment following total knee arthroplasty (TKA), with emphasis on the validity, applicability, and consistency of different tools used across diverse clinical contexts. The synthesis of 31 studies (Table 1) and the graphical analysis of 15 studies presenting quantitative data (Figure 1) provide compelling support for the positive impact of TKA on postoperative function when evaluated through validated outcome measures.

Validated patient-reported outcome measures (PROMs) remain the cornerstone of functional assessment in TKA. Instruments such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [1,18], the Knee Society Score (KSS) [3,18], and the Short Form-36 (SF-36) [1,23] have been extensively used in both research and clinical settings due to their multidimensional scope, internal consistency, and sensitivity to change. These tools are particularly valuable in assessing pain, stiffness, and physical performance over time. In parallel, the emergence of Single Assessment Numeric Evaluation (SANE) as a simplified, single-item measure has demonstrated strong psychometric properties and excellent correlation with more complex scales such as KOOS, IKDC, and SF-36 [22–27]. The Brazilian version of the SANE, recently validated by Silva Filho *et al.* [31], further enhances its cultural and clinical applicability.

The forest plot (Figure 1) reinforces the qualitative findings, presenting a consistent pattern of functional improvement following TKA. All 15 studies included in the quantitative synthesis demonstrated risk ratios (RR) ≤ 1.0 , with most ranging from 0.66 to 0.85—indicating a 15% to 35% reduction in the relative risk of poor postoperative function. High-quality studies, such as those by Christensen *et al.* [5], Brinkmann & Fitz [6], and Goh *et al.* [2], presented narrow confidence intervals and methodological clarity, supporting the reliability and external validity of their findings. Even moderate- and low-quality studies aligned in directionality, suggesting a robust and reproducible effect across different study designs and patient cohorts.

Importantly, the findings demonstrate that functional improvement is not restricted to low-risk populations or routine procedures. Patients undergoing complex TKA—such as bilateral operations [4], revision surgeries [14–16], or procedures involving customized or bicruciate-retaining implants [6,11,13]—also showed significant gains in function, provided that recovery was assessed using valid, responsive instruments. These findings affirm that the success of TKA is not solely dependent on surgical technique or implant type, but also on postoperative monitoring and rehabilitation guided by reliable functional metrics.

From a clinical perspective, the results emphasize the value of incorporating PROMs into routine TKA follow-up protocols. The use of validated tools enhances the ability of clinicians to monitor patient progress, detect deviations from expected recovery trajectories, and support individualized rehabilitation planning. The SANE scale, due to its brevity and validity, emerges as a particularly useful tool in high-volume clinics or when electronic health integration is required [22,23,25].

Nevertheless, this review presents some methodological limitations. The selection of studies was based on a curated and manual process, rather than an automated database search, which may introduce selection bias. Additionally, although methodological quality was inferred based on study design, reporting clarity, and use of validated instruments, no formal risk-of-bias instrument (e.g., RoB 2.0 or NOS) was applied. A meta-analytic effect estimate was also not calculated, given the heterogeneity in statistical reporting, populations, and outcome measures. However, the forest plot successfully visualized the magnitude and direction of benefit across studies, providing a meaningful and interpretable synthesis of functional outcomes.

Future studies should aim to standardize functional outcome reporting by promoting the use of cross-culturally validated PROMs. The continued evaluation of single-item

tools like the SANE in diverse populations and clinical scenarios will be essential. Moreover, longitudinal studies with longer follow-up durations and robust statistical modeling are needed to evaluate the durability of functional gains and identify predictors of suboptimal outcomes, particularly in older adults and revision cases.

The evidence presented in this review affirms that total knee arthroplasty consistently improves postoperative function when evaluated with validated outcome measures. These benefits are observed across a range of surgical techniques, implant types, and patient profiles. The systematic application of PROMs—particularly those that are psychometrically sound and clinically feasible—should be considered a central element of postoperative care, enabling better clinical decision-making and higher standards of patient-centered outcomes research.

5. Conclusion

This systematic review aimed to identify and analyze the main functional assessment tools applied in the postoperative evaluation of patients undergoing total knee arthroplasty (TKA). Based on the synthesis of 31 studies and the graphical analysis of 15 with quantitative data, the evidence clearly demonstrates that the use of validated functional outcome measures is essential for accurately monitoring recovery and guiding clinical decision-making after TKA.

Validated instruments such as the WOMAC, KSS, SF-36, KOOS, and IKDC remain well-established in the literature for multidimensional assessment of function. More recently, the SANE scale has emerged as a promising alternative, combining simplicity, clinical feasibility, and high psychometric validity, including in culturally adapted versions such as the Brazilian validation. These tools consistently detect meaningful improvements in postoperative function across various patient groups and surgical contexts, including elderly patients, bilateral procedures, and revision arthroplasties.

The evidence compiled reinforces that TKA is associated with substantial functional recovery when evaluated using reliable and responsive instruments. Therefore, the systematic use of functional assessment tools—particularly those that are standardized and validated—should be incorporated as an essential component of postoperative follow-up in clinical practice and research involving TKA patients.

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