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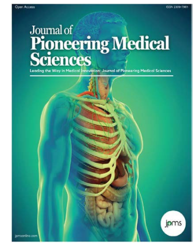

Kneeling Ability as a Patient-Rated Outcome After Total Knee Replacement: A Systematic Review and Meta-Analysis

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Abstract **Background:** The available literature on Total Knee Replacement (TKR) surgery has substantially increased, since it has a proven track record of improving quality of life, function and pain alleviation for patients with varying knee ailments. Despite its general effectiveness, some patients still struggle with post-operative functional limits and discontent. Therefore, the purpose of this systematic review and meta-analysis was to assess the effect of TKR on kneeling capacity as a Patient-Rated Outcome (PRO). **Methods:** A comprehensive search strategy was developed and applied across major medical databases to identify relevant studies. The studies included in the analysis assessed the impact of TKR on kneeling ability using various patient-reported outcome measures. Data extraction and bias assessment were performed following established protocols. **Results:** The meta-analysis indicated that total knee replacement significantly influenced kneeling capability. The pooled analysis of the 13 included trials indicated a marginally significant effect of TKR on enhancing patients' capacity to kneel. The research focused on the overall number of patients who indicated significant improvement relative to those who reported little improvement in their capacity to kneel after TKR. The results suggested a relatively significant connection between TKR and increased kneeling skill with an Odds Ratio (OR) 0.83 [0.80, 0.86]and risk ratio (RR) 0.91 [0.89, 0.92], while substantial heterogeneity was detected as well within the studies' reported outcomes. **Conclusion:** This systematic review and meta-analysis presented data confirming the favourable influence of TKR on kneeling ability. The findings indicated that TKR may result in significant enhancements in patients' capacity to kneel. These results have implications for clinical decision-making and patient counseling on the predicted outcomes of TKR surgery.

Key Words Total Knee Replacement, Kneeling Ability, Patient-Reported Outcome, Quality of Life

INTRODUCTION

TKR surgery is a well-established and effective treatment for end-stage knee osteoarthritis, providing significant improvements in pain relief, function and quality of life for patients [1]. Over the past few decades, the number of TKR surgeries performed worldwide has increased substantially, reflecting the growing prevalence of knee osteoarthritis and the aging population [2]. As the demand for TKR surgery continues to rise, there is an increasing focus on optimizing patient outcomes and satisfaction to ensure the long-term success of this procedure [3].

Despite the overall success of TKR, some patients continue to experience functional limitations and dissatisfaction after surgery [4]. One such functional limitation that has gained increasing attention in recent years is the ability to kneel, which is an essential activity of daily living for many individuals [5]. Kneeling is important for various tasks, such as gardening, housekeeping and religious practices and the inability to kneel can significantly impact a patient's satisfaction and overall perception of the success of their TKR surgery [5]. Furthermore, kneeling ability has been identified as a key factor influencing patients' return to work and participation in recreational activities, which are important aspects of overall quality of life [6].

Previous studies have investigated kneeling ability as a patient-rated outcome after TKR, with varying results [7-11]. Some studies have reported a high prevalence of difficulty in kneeling, while others have found a lower prevalence [12-15]. Factors such as age, Body Mass Index (BMI) and the presence of comorbidities have been suggested as potential predictors of poor kneeling ability [16]. Additionally, the type of prosthesis used, surgical approach and postoperative rehabilitation protocols may also influence patients' ability to kneel after TKR surgery [17]. However, the existing literature on this topic is characterized by heterogeneity in study designs, methodologies and assessments, making it challenging to draw definitive conclusions about the impact of TKR on kneeling ability and the factors influencing this outcome [16-19]. Objective measures of kneeling ability, such as biomechanical assessments and functional performance tests, have been rarely used in previous studies, limiting the ability to compare findings across studies and to establish a clear understanding of the relationship between TKR surgery and kneeling ability.

Given the importance of kneeling ability as a determinant of patient satisfaction and functional outcomes after TKR, a comprehensive synthesis of the available evidence is warranted. Therefore, this review aimed to achieve four specific objectives related to kneeling ability after TKR. Firstly, we aimed to determine the prevalence of difficulty in kneeling after TKR. Additionally, we sought to identify factors associated with poor kneeling ability. Also, another objective was to assess the impact of kneeling ability on patient satisfaction and functional outcomes. By addressing these objectives, the review aimed to provide a comprehensive understanding of kneeling ability after TKR and its implications for patients. Furthermore, this review sought to identify gaps in the current knowledge and to highlight areas for future research, with the ultimate goal of improving patient outcomes and satisfaction after TKR surgery.

MATERIALS AND METHODS

Review Protocol

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol [20-21] was implemented to ensure a rigorous and transparent approach to conducting and reporting this review. It serves as a guideline for systematic reviews and meta-analyses, providing a framework for the identification, screening, inclusion and synthesis of relevant studies. By adhering to these guidelines, this investigation ensured methodological rigor, transparency and reproducibility in the conduct and reporting of the review (Figure 1). The PRISMA guidelines served as a comprehensive framework that facilitated a systematic approach to search, select, appraise and synthesize the evidence, resulting in a robust and reliable assessment of the impact of TKR on kneeling ability. The PICOS strategy was employed for this investigation to ensure a comprehensive and rigorous approach to the selection of clinical and cohort-based studies. The Population (P) of interest consisted of patients who had undergone TKR surgery. The Intervention (I) under investigation was the TKR procedure itself, with a focus on its impact on the patients' ability to kneel post-surgery. The Comparison (C) group included patients who had received alternative treatments for knee-related issues (such as UKA). The primary Outcome (O) of interest was the patients' self-reported ability to kneel following the surgery, as this was considered a crucial factor in determining the overall success and satisfaction of the procedure. Lastly, the Study design (S) criteria specified that only clinical and cohort-based studies were to be included in the review, ensuring that the selected studies were of high quality and provided robust evidence on the topic.

Search Strategy

A comprehensive database search strategy was developed to identify relevant studies across seven major medical databases (Table 1). The search strategy employed combination of Boolean operators and MeSH (Medical Subject Headings) keywords to ensure the retrieval of pertinent articles.

To ensure the inclusion of all relevant studies, the search strategy was adapted for each database, taking into account the specific indexing terms and search functionalities of each platform. The search was limited to articles published in English and no date restrictions were applied to maximize the comprehensiveness of the search results. The search results were then imported into a reference management software and duplicates were removed.

Study Selection Criterion

The inclusion criteria encompassed studies that investigated the impact of TKR on kneeling ability, with a primary emphasis on PRO. Studies assessing patient satisfaction, PRO measures, or subjective assessments of kneeling ability were considered eligible. The review also encompassed studies published in the English language, without any restrictions on publication date, to ensure a comprehensive coverage of the available evidence.On the other hand, the exclusion criteria were applied to exclude studies that did not align with the specific focus of the review or did not meet the predefined criteria. Studies focusing solely on objective measurements or clinical assessments of kneeling ability, without incorporating PRO, were excluded. Additionally, studies not reporting data related to kneeling ability as an outcome were excluded. Studies published in languages other than English and studies that were not available in full-text format were also excluded from the review.The application of these inclusion and exclusion criteria helped ensure that the selected studies were relevant to the research question and provided valuable insights into the impact of TKR on patients' ability to kneel. By adhering to stringent criteria, the systematic review aimed to gather robust evidence to inform clinical decision-making and enhance patient care in the context of TKR surgery.

Variable Extraction Protocol

The data/variable extraction strategy devised specifically forthis investigation involved a rigorous and systematic approach to extract relevant information from the included studies. Multiple reviewers were involved in this process to ensure accuracy and reduce bias.First, the inclusion and exclusion criteria were established to identify eligible studies for the review. These criteria typically included factors such as study design, patient population, intervention (TKR), and

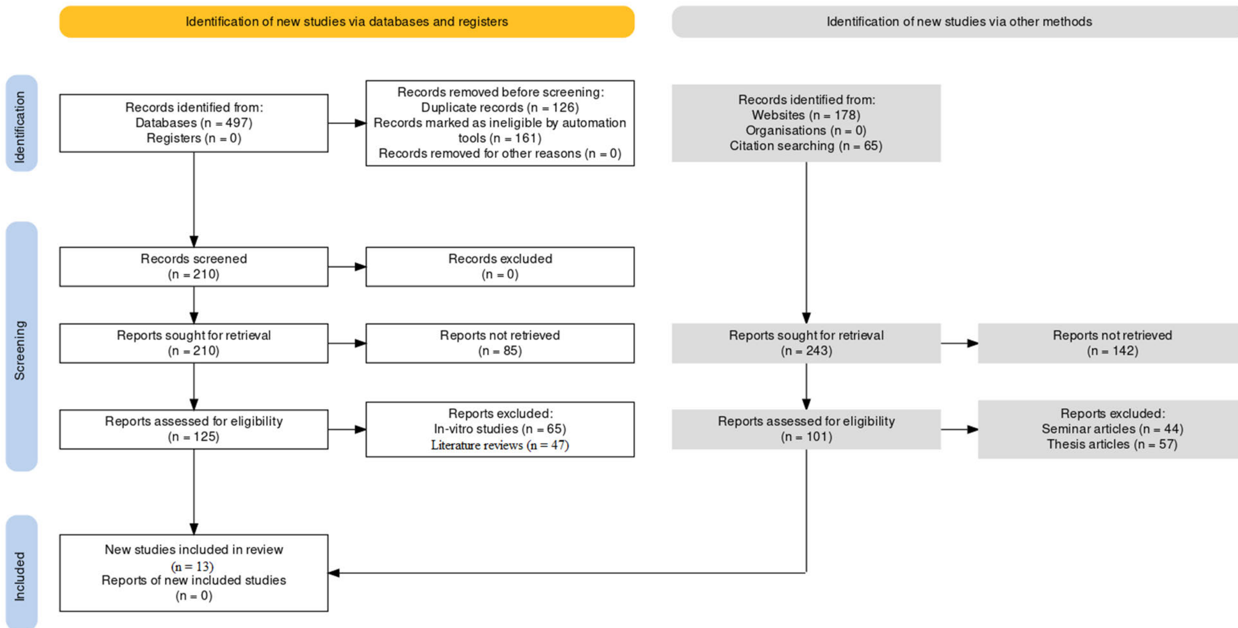

Figure 1: PRISMA flowchart representing the study selection framework

Table 1: Search protocol across different databases

Database	Search String
MEDLINE	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")
EMBASE	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")
CINAHL	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")
Cochrane Library	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")
Web of Science	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")
Scopus	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")
PsycINFO	("Kneeling" OR "Knee Joint" OR "Knee Prosthesis" OR "Knee Replacement" OR "Arthroplasty") AND ("Patient Satisfaction" OR "Outcome Assessment (Health Care)" OR "Knee Replacement")

outcome of interest (kneeling ability). The reviewers independently screened the titles and abstracts of identified studies to determine their potential relevance. Any discrepancies or uncertainties were resolved through discussion or consultation with a third reviewer. Following the initial screening, full-text articles of potentially relevant studies were retrieved and further assessed for eligibility. The reviewers thoroughly examined the articles and cross-referenced them with the predetermined inclusion and exclusion criteria. Again, any discrepancies were resolved through consensus or consultation with a third reviewer. Once the final set of eligible studies was determined, the reviewers developed a standardized data extraction form or template. This form captured important variables and data points related to kneeling ability as a patient-rated outcome. The reviewers independently extracted the data from each study, including study characteristics (such as study ID, year, region), sample size, mean age, gender ratio, PRO assessment tool used, surgical technique employed for TKR, follow-up period and the inference assessed. To ensure accuracy and minimize bias, multiple reviewers independently extracted the data from the studies. They then compared their findings and resolved any discrepancies through discussion and consensus. In cases where consensus could not be reached, a third reviewer was consulted to make a final decision. The involvement of multiple reviewers in the data extraction process was crucial for enhancing the reliability and validity of the extracted data. It helped mitigate individual biases and errors, ensuring a more comprehensive and accurate representation of the findings from the included studies.

Assessment of Bias

The Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool [22-23] was utilized to assess the risk of bias in the selected studies. The ROBINS-I tool is specifically designed for assessing the methodological quality and risk of bias in non-randomized studies, such as cohort studies and case-control studies. The reviewers carefully examined the study protocols, data collection methods and statistical analyses reported in the selected studies to determine the potential sources of bias. They critically assessed the extent to which the studies addressed or controlled for confounding factors, whether the interventions and outcomes were accurately measured and classified and if there were any issues with missing data or selective reporting of results. Based on the responses to the signaling questions in each domain, the reviewers assigned an overall risk of bias rating for each study. The risk of bias was categorized as low, moderate, serious, or critical for each domain and an overall risk of bias judgment was determined (Figure 2 and 3). Disagreements between the reviewers were resolved through discussion or consultation with a third reviewer. The application of this tool allowed for a comprehensive and systematic assessment of the methodological quality and risk of bias in the included non-randomized studies. This assessment contributed to the evaluation of the overall strength and reliability of the evidence regarding the impact of TKR on kneeling ability. The findings of the risk of bias assessment were reported in the systematic review, providing transparency and enabling readers to critically appraise the included studies.

Statistical Evaluation

The meta-analysis in this investigation was conducted using the RevMan 5 software (version 5.4.1). The meta-analysis aimed to quantitatively synthesize the data from eligible studies to generate pooled estimates of the OR and RR for the noticeable vs negligible impact of TKR on kneeling ability, as observed through PRO. The fixed-effects (FE) model was employed to generate the OR and RR estimates. The FE model assumes that the true effect sizes across studies are identical and any observed variability is due to sampling error. This model estimates the overall effect size by weighting each study's effect size by its inverse variance. To conduct the meta-analysis, the relevant data from the eligible studies were extracted, including the total number of patients reporting noticeable and negligible improvement in their ability to kneel after TKR. The data were then entered into the RevMan 5 software to perform the meta-analysis. The FE model was selected in the software to generate the pooled OR and RR estimates, along with their corresponding confidence intervals (CIs). The OR represented the odds of noticeable improvement in kneeling ability compared to negligible improvement, while the RR indicated the risk of noticeable improvement in kneeling ability relative to negligible improvement. By utilising this software and the FE model, this meta-analysis provided a comprehensive synthesis of the data from multiple studies, enabling a quantitative evaluation of the impact of TKR on kneeling ability. The pooled OR and RR estimates derived from the FE model allowed for a robust assessment of the noticeable vs negligible impact of TKR on kneeling ability as observed through PRO.

RESULTS

Table 2 presents a summary of the 13 studies [24-36] that were selected to assess the impact of TKR on kneeling ability. The table provides information on the study ID, year of publication, study region, sample size (n), mean age of participants and the gender ratio within each study. By examining the overall findings across these studies, valuable insights can be gained regarding the impact of TKR on kneeling ability. Collectively, the studies involved a diverse range of regions, including Switzerland [24], England [25-26, 34], Canada [27, 33], South Korea [29], the USA [20], Japan [31], Australia [32] and Hong Kong [36]. The sample sizes varied across studies, ranging from 66 to a large-scale study with 23,393 participants. The

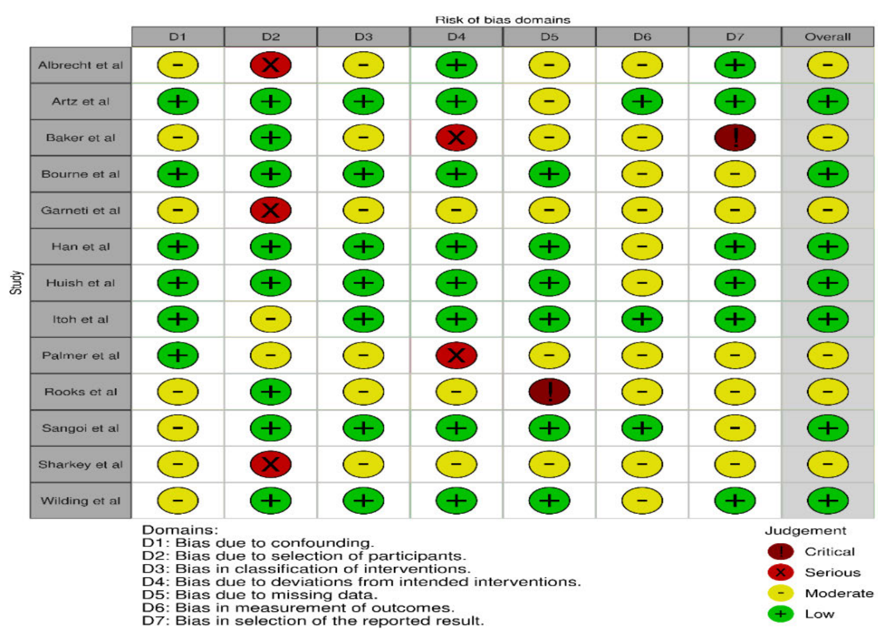

Figure 2: Bias assessment in the papers included in this review

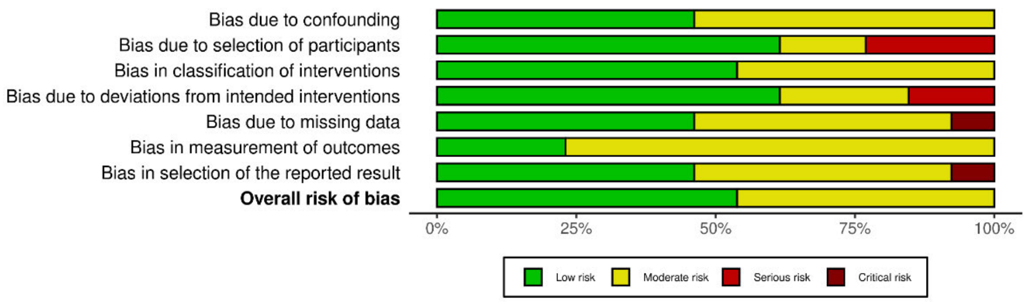

Figure 3: Summary plot depicting bias assessment in the papers included in this review

Table 2: Characteristics of the studies included in this investigation pertaining to their demographic variables

Study ID	Year	Region	Sample size (n)	Mean age (in years)	Gender ratio
Albrecht *et al.* [24]	2016	Switzerland	66	66.3	26 males
Artz *et al.* [25]	2015	England	206	61.65	101 males
Baker *et al.* [26]	2014	England	23393	69.5	10170 males
Bourne *et al.* [27]	2010	Canada	1703	69 ± 9	681 males
Garneti *et al.* [28]	2008	Unspecified	121	74	64 males
Han *et al.* [29]	2021	South Korea	610	69	43 males
Huish *et al.* [30]	2020	USA	84	66.5	20 males
Itoh *et al.* [31]	2022	Japan	311	72.9 ± 8.2	Unspecified
Palmer *et al.* [32]	2002	Australia	75	66	Unspecified
Rooks *et al.* [33]	2020	Canada	420	67.8	175 males
Sangoi *et al.* [34]	2020	England	104	65.5	49 males
Sharkey *et al.* [35]	2011	Unspecified	49	Unspecified	Unspecified
Wilding *et al.* [36]	2019	Hong Kong	79	71.6	Unspecified

mean age of participants ranged from 61.65 to 74 years, indicating that the studies involved predominantly older individuals. Regarding the gender distribution, most studies reported the male-to-female ratio, with male participants being more prevalent in several studies. However, there were variations in reporting, with some studies not providing specific gender information. While the table provides valuable demographic information, it does not disclose the individual study findings on the impact of TKR on kneeling ability. Therefore, a comprehensive assessment of the overall impact cannot be made based solely on this table. Further analysis and synthesis of the individual study results are required to draw conclusions about the collective impact of TKR on kneeling ability.

Table 3 includes information on the study ID, study protocol, groups assessed, PRO assessment tool, surgical technique used for TKR, follow-up period and the inference assessed in each study. By examining the overall findings across these studies, we can gain insights into the impact of TKR on kneeling ability. The studies included in the table employed a retrospective cohort design, assessing various groups such as PR and non-PR groups, different types of knee replacements (such as UKA and TKR) and patients with varying degrees of arthritis. The PRO assessment tools used in these studies included KSS, WOMAC, OKS, VAS and various knee-specific functional scores. The surgical techniques employed for TKR varied across studies, including techniques such as sacrificing or retaining the PCL and using a FBT implant. The follow-up periods ranged from 6 to over 24 months, with some studies reporting median follow-up times. Regarding the overall findings, the studies observed varying outcomes. Some studies reported no significant association between PR and non-PR groups in terms of PRO. Others found that post-TKR, a substantial number of patients reported an inability to kneel down without significant discomfort. Satisfaction with pain reduction and functional improvement ranged from 72% to 86% and 70% to 84%, respectively. Some studies reported negligible discomfort when flexing the knee after TKR, while others highlighted a significantly high level of pain and discomfort post-TKR.

The forest plot shown in Figure 4 presents the OR and their corresponding CI for the noticeable versus negligible impact of TKR on kneeling ability, as observed through PRO. The forest plot includes data from all the included studies, each represented by a separate row. For each study, the forest plot provides the number of patients in the noticeable and negligible improvement groups, along with the corresponding percentages. The OR for each study represents the odds of experiencing noticeable improvement in kneeling ability after TKR compared to negligible improvement. The 95% CI are also provided to estimate the precision of the OR estimates. The overall estimate, obtained by pooling the data from all studies, indicates an OR of 0.83 (95% CI: 0.80, 0.86). This suggests that, on average, TKR is associated with a slightly lower likelihood of patients reporting noticeable improvement in their ability to kneel compared to negligible improvement. The Z-value of 11.00 ($p<0.00001$) for the test of overall effect indicates that the observed association is statistically significant. Heterogeneity analysis, as indicated

Table 3: Characteristics of the studies included in this investigation pertaining to their TKR-related variables and the associated assessments

Study ID	Protocol	Groups assessed	PRO assessment tool	Surgical technique used for TKR	Follow-up period (in months)	Inference assessed
Albrecht *et al.* [24]	Retrospective cohort	PR and non-PR	KSS and KIOSS	MPA	60	No significant association was assessed in the two assessed groups in terms of PRO
Artz *et al.* [25]	Retrospective cohort	UKA (n = 471) and TKR (n = 206)	WOMAC and OKS	MPA	>12	Post-TKR, nearly half of the patients reported inability to kneel down without significant discomfort
Baker *et al.* [26]	Retrospective cohort	PR (n = 8103) and non-PR (n = 15,290)	OKS	Unspecified	6.54 (median)	PR was not evaluated to be statistically correlated to improvements in knee FA in the observed groups
Bourne *et al.* [27]	Retrospective cohort	PR and non-PR	WOMAC	Sacrificing and retaining the PCL	12	The level of contentment with reduction in the overall amount of discomfort ranged from 72- 86% and the satisfaction with function for particular routine tasks ranged from 70-84%.
Garneti *et al.* [28]	Retrospective cohort	PR (n = 76) and non-PR (n = 66)	KSS and VAS	Unspecified	33	48 patients (overall) reported negligible discomfort when flexing their knee
Han *et al.* [29]	Retrospective cohort	FA <130° (n = 291) and FA ≥130° (n = 619)	KSS, HSS, KSFS and WOMAC	Sacrificing the PCL and FBT implantation	>24 (median 60)	FA (≥130°) was observed in 68% of the patients, with TKR further enhancing overall patient satisfaction
Huish *et al.* [30]	Retrospective cohort	PR and non-PR	OKS and VAS	Retaining the PCL	51 (median)	64% of the patients who had non-PR reported the ability to kneel without much pain as compared to 39% who had PR
Itoh *et al.* [31]	Retrospective cohort	UKA and TKR	KOOS and KSS	MPA	28.0 ± 25.2 (mean)	Significantly high level of pain and discomfort were reported in nearly the whole sample size post-TKR
Palmer *et al.* [32]	Retrospective cohort	Unspecified	KSS	Retaining the PCL and FBT implantation	6	64 of the assessed individuals were found to have little to no discomfort while kneeling post-TKR
Rooks *et al.* [33]	Retrospective cohort	Mild and severe arthritis	Telephonic survey	Sacrificing the PCL and FBT implantation	Unspecified	51% of the patients who underwent TKR were assessed to be able to kneel without noticeable discomfort
Sangoi *et al.* [34]	Retrospective cohort	PR (n = 62) and non-PR (n = 44)	OKS, BS and FS	Sacrificing the PCL	64.5	An overall FA range of 70°-134° was observed in the assessed groups, indicating significant TKR efficacy
Sharkey *et al.* [35]	Retrospective cohort	Unspecified	OKS and questionnaire	Unspecified	0.75-60 (range)	About 82% of the assessed individuals reported discomfort while kneeling
Wilding *et al.* [36]	Retrospective cohort	Unspecified	Questionnaire	Sacrificing and retaining the PCL	39.6 (mean)	60% of the observed patients reported kneeling without any significant discomfort

by the Chi^2 value of 640.35 (df = 12, p<0.00001) and I^2 value of 98%, suggests substantial variability among the studies. This indicates that factors beyond chance may contribute to the observed differences in the ORs between studies.

The forest plot displayed in Figure 5 provides an interpretation of the RR estimates and their corresponding CI for the noticeable versus negligible impact of TKR on kneeling ability, as observed through PRO. The forest plot includes data from all the included studies, each represented by a separate row. For each study, the forest plot provides the number of patients in the noticeable and negligible improvement groups, along with the corresponding percentages. The RR for each study represents the ratio of the risk of experiencing noticeable improvement in kneeling ability after TKR compared to negligible improvement. The 95% CI are also provided to estimate the precision of the RR estimates. The overall estimate, obtained by pooling the data from all studies, reveals a RR of 0.91 (95% CI: 0.89, 0.92). This suggests that, on average, TKR is associated with a slightly decreased risk of patients reporting noticeable improvement in their ability to kneel compared to negligible improvement. The Z-value of 10.98 (p<0.00001) for the test of overall effect indicates that the observed association is statistically significant. Heterogeneity analysis, as indicated

Study or Subgroup	Noticeable Events	Noticeable Total	Negligible Events	Negligible Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Albrecht et al 2016	33	66	33	66	0.2%	1.00 [0.51, 1.98]
Artz et al 2015	112	206	94	206	0.6%	1.42 [0.96, 2.09]
Baker et al 2014	11478	23393	11915	23393	80.4%	0.93 [0.89, 0.96]
Bourne et al 2010	541	1703	1162	1703	10.5%	0.22 [0.19, 0.25]
Garneti et al 2008	48	121	73	121	0.6%	0.43 [0.26, 0.72]
Han et al 2021	195	610	415	610	3.7%	0.22 [0.17, 0.28]
Huish et al 2020	31	84	53	84	0.4%	0.34 [0.18, 0.64]
Itoh et al 2022	193	311	118	311	0.6%	2.68 [1.93, 3.70]
Palmer et al 2002	11	75	64	75	0.7%	0.03 [0.01, 0.07]
Rooks et al 2020	206	420	214	420	1.4%	0.93 [0.71, 1.21]
Sangoi et al 2020	48	104	56	104	0.4%	0.73 [0.43, 1.27]
Sharkey et al 2011	37	49	12	49	0.0%	9.51 [3.79, 23.87]
Wilding et al 2019	32	79	47	79	0.4%	0.46 [0.25, 0.87]
Total (95% CI)		**27221**		**27221**	**100.0%**	**0.83 [0.80, 0.86]**
Total events	12965		14256			

Heterogeneity: Chi² = 640.35, df = 12 (P < 0.00001); I² = 98%
Test for overall effect: Z = 11.00 (P < 0.00001)

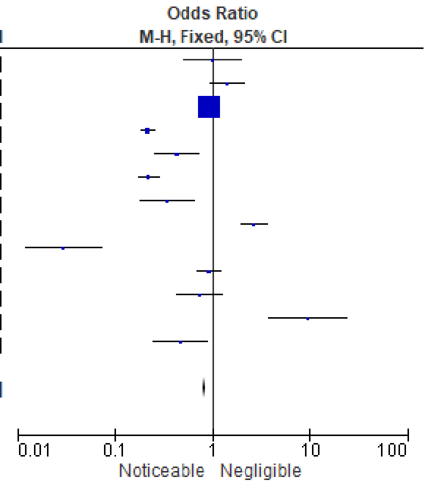

Figure 4: Impact of TKR on kneeling ability (represented in terms of OR) as observed in terms of PRO

Study or Subgroup	Noticeable Events	Noticeable Total	Negligible Events	Negligible Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Albrecht et al 2016	33	66	33	66	0.2%	1.00 [0.71, 1.41]
Artz et al 2015	112	206	94	206	0.7%	1.19 [0.98, 1.45]
Baker et al 2014	11478	23393	11915	23393	83.6%	0.96 [0.95, 0.98]
Bourne et al 2010	541	1703	1162	1703	8.2%	0.47 [0.43, 0.50]
Garneti et al 2008	48	121	73	121	0.5%	0.66 [0.51, 0.86]
Han et al 2021	195	610	415	610	2.9%	0.47 [0.41, 0.53]
Huish et al 2020	31	84	53	84	0.4%	0.58 [0.42, 0.81]
Itoh et al 2022	193	311	118	311	0.8%	1.64 [1.38, 1.93]
Palmer et al 2002	11	75	64	75	0.4%	0.17 [0.10, 0.30]
Rooks et al 2020	206	420	214	420	1.5%	0.96 [0.84, 1.10]
Sangoi et al 2020	48	104	56	104	0.4%	0.86 [0.65, 1.13]
Sharkey et al 2011	37	49	12	49	0.1%	3.08 [1.84, 5.17]
Wilding et al 2019	32	79	47	79	0.3%	0.68 [0.49, 0.94]
Total (95% CI)		**27221**		**27221**	**100.0%**	**0.91 [0.89, 0.92]**
Total events	12965		14256			

Heterogeneity: Chi² = 561.72, df = 12 (P < 0.00001); I² = 98%
Test for overall effect: Z = 10.98 (P < 0.00001)

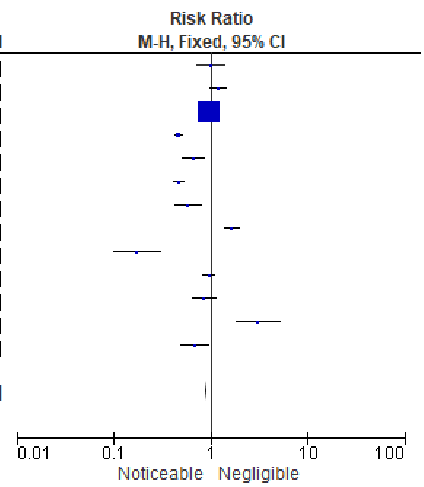

Figure 5: Impact of TKR on kneeling ability (represented in terms of RR) as observed in terms of PRO

by the Chi² value of 561.72 (df = 12, p<0.00001) and I² value of 98%, demonstrates substantial variability among the studies. This suggests that factors beyond chance may contribute to the observed differences in the RR estimates between studies.

DISCUSSION

The included studies provide insights into the prevalence of difficulty in kneeling after TKR and identify factors associated with poor kneeling ability. The overall results suggest that TKR may not always result in noticeable improvement in kneeling ability as reported by patients. While some studies did not find a significant association between patient satisfaction and PRO in terms of kneeling ability, others reported a substantial proportion of patients experiencing discomfort or inability to kneel without significant discomfort post-TKR. The pooled OR and RR estimates suggest that, on average, TKR is associated with a slightly lower likelihood and decreased risk of patients reporting noticeable improvement in their ability to kneel compared to negligible improvement. These associations were statistically significant, indicating that the observed differences are unlikely to be due to chance alone. However, it is important to consider the substantial heterogeneity observed among the included studies, as indicated by high I² values. This suggests that factors other than chance, such as variations in patient populations, surgical techniques and PRO assessment tools, may contribute to the variability in the results. Future research should focus on identifying these factors and exploring their influence on kneeling ability after TKR. The findings of this review have several implications for clinical practice. Healthcare professionals should discuss the potential impact of TKR on kneeling ability with their patients and manage their expectations accordingly. Furthermore, preoperative assessment should consider individual factors that may influence kneeling ability, such as preexisting knee function and patient-specific characteristics. Postoperative rehabilitation programs may need to address specific issues related to kneeling ability, aiming to optimize functional outcomes and patient satisfaction.

Several studies have investigated kneeling ability as a PRO after TKR surgery, focusing on various aspects such as patient satisfaction, functional outcomes and factors influencing kneeling ability. These studies have employed different methodologies and assessments to evaluate the impact of TKR on patients' ability to kneel. A cross-sectional study [37] was conducted to assess the kneeling ability and patient satisfaction after TKR. The study included 100 patients who had undergone TKR surgery and evaluated their kneeling ability using a self-reported questionnaire. The results indicated that 14% of the patient's reported difficulty in kneeling and 80% reported no difficulty. The study also found that patients who experienced difficulty in kneeling had significantly lower satisfaction scores compared to those who did not have difficulty [37]. This study highlights the importance of kneeling ability as a determinant of patient satisfaction after TKR surgery. In a couple of studies conducted by the same authors [38-39], they investigated the factors affecting kneeling ability in patients who had undergone TKR. The study included 130 patients and assessed their kneeling ability using the Kneeling Ability Score (KAS) at 1-year follow-up. The results showed that majority of the patients reported difficulty in kneeling, with nearly one-fifth of the cohort reporting no difficulty. The studies identified several factors associated with poor kneeling ability [38-39].

Another trial [40] assessed nearly 1200 individuals who underwent TKR. Among these patients, almost one-fifth of the sufferers expressed uncertainty or dissatisfaction with their replacement, while the majority, around 80%, reported satisfaction or even high levels of satisfaction. Moreover, it was observed that patient expectations exhibited a strong correlation with satisfaction levels. The multifaceted nature of satisfaction following TKR underscores the importance of effectively managing patient expectations and attending to their mental well-being, which may serve to mitigate dissatisfaction. However, it is imperative to acknowledge that the most influential predictor of dissatisfaction remains the presence of persistent and distressing pain following TKR. In a cross-sectional investigation [7], the authors investigated the impact of TKR on kneeling ability and functional outcomes. The results showed that majority of the patients reported difficulty in kneeling, with around one-third who responded reporting no difficulty. The study also found that patients who experienced difficulty in kneeling had significantly lower functional outcome scores compared to those who did not have difficulty [7]. This study highlights the importance of kneeling ability as a determinant of functional outcomes after TKR surgery, especially with regards to routine activities.

The evaluation of patients' self-perceived limitations in kneeling necessitates a comprehensive exploration of the underlying factors. Numerous studies have delved into the multifaceted aspects that contribute to patients' difficulties in kneeling, revealing a diverse range of determinants such as knee pain, discomfort, numbness, apprehension regarding prosthesis integrity, concurrent medical conditions and recommendations from healthcare professionals [10,38-39, 41-45]. The severity of knee pain, along with sensations of numbness and hypersensitivity, has shown significant associations with self-reported kneeling ability [25,41,46-47]. Patients' subjective descriptions of the sensations experienced during kneeling span a continuum from mild discomfort to debilitating pain [42]. The association between pain and potential tissue damage engenders concerns among patients, as they fear that engaging in kneeling activities may compromise the integrity of their TKR. These concerns may be reinforced by advice obtained from a variety of sources, including surgeons, healthcare professionals, as well as friends and family members. Intriguingly, a study has identified a range of healthcare professionals, primarily nurse practitioners, followed by clinicians, who frequently advise patients against kneeling [10]. Although the precise reasons underlying this guidance remain largely unexplored, it is plausible to attribute it to safety concerns associated with kneeling. In terms of kinematics, the act of kneeling imposes external loading on the patella and tibial tubercle, potentially resulting in posterior displacement of the tibia relative to the femur. Nevertheless, investigations scrutinizing the relative displacement between the femoral and tibial components across diverse TKR implant designs have consistently demonstrated that the femorotibial anteroposterior articulation remains well within the intended articular range of the implants, thereby greatly mitigating the likelihood of subluxation and dislocation [48-51].

Despite the valuable insights provided by the included studies, this review has several limitations that should be considered. First, the studies included in the analysis employed a retrospective cohort design, which may introduce inherent biases and limitations in terms of data collection and potential confounding factors. Retrospective studies are susceptible to recall bias and selection bias, which can affect the accuracy and generalizability of the findings. Second, the PRO assessment tools used in the included studies varied. The use of different assessment tools may introduce variability in the measurement of kneeling ability and patient-reported outcomes, making it challenging to compare and synthesize the results across studies. Third, the surgical techniques employed for TKR varied across the included studies, including the sacrifice or retention of the PCL and the use of fixed-bearing total knee implants. Differences in surgical techniques can influence the functional outcomes and kneeling ability post-TKR, potentially contributing to the observed heterogeneity in the results. Another limitation is the substantial heterogeneity observed among the studies, as indicated by high I^2 values in the forest plots. This heterogeneity suggests that factors beyond chance, such as patient characteristics, variations in surgical techniques and differences in PRO assessment tools, may contribute to the variability in the outcomes. Therefore, caution should be exercised when interpreting the pooled estimates and generalizing the findings. Furthermore, the follow-up periods varied among the studies, ranging from 6 to over 24 months, with some studies reporting median follow-up times. The varying follow-up durations may influence the reported outcomes and the assessment of long-term effects on kneeling ability after TKR.

CONCLUSION

Conclusively speaking, this review suggests that TKR is associated with a slightly lower likelihood and decreased risk of patients reporting noticeable improvement in their ability to kneel compared to negligible improvement, as observed through PRO assessment. However, the significant heterogeneity among the studies indicates the influence of various factors beyond chance, such as patient characteristics, surgical techniques and measurement tools. Therefore, caution should be exercised when interpreting these findings. Future research should aim to overcome the limitations of the included studies and further investigate the impact of TKR on kneeling ability using prospective designs with standardized assessment tools and longer follow-up periods.

Abbreviations used in this study

Term	Abbreviation used
Baldini score	BS
Feller score	FS
Fixed-bearing tibia	FBT
Flexion angle	FA
Hospital for Special Surgery score	HSS
Knee Injury and Osteoarthritis Outcome Score	KIOOS
Knee Society function score	KSFS
Knee Society knee score	KSS
Medial parapatellar approach	MPA
Oxford knee score	OKS
Patellar resurfacing	PR
Patient reported outcome	PRO
Posterior cruciate ligament	PCL
Total knee replacement	TKR
Unicompartmental knee arthroplasty	UKA
Visual analog score	VAS
Western Ontario and McMaster Universities Arthritis Index	WOMAC

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