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# Functional Outcomes in Smokers Following Total Hip and Knee Arthroplasty: A Narrative Review

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## Abstract

Smoking is associated with perioperative complications after total hip arthroplasty (THA) and total knee arthroplasty (TKA), and in 2021, most English commissioners had smoking-related access policies for these operations. Its association with functional recovery is less certain. This narrative review, guided by the Scale for the Assessment of Narrative Review Articles (SANRA), synthesizes evidence on smoking status and function after primary THA and TKA. PubMed was searched from inception to November 2, 2026, and 26 primary studies reporting function, baseline status, or related outcomes by smoking status were appraised. All functional evidence identified was observational. In the largest baseline-adjusted analysis (10,009 patients across both joints, representing 8.6% of the source cohort), smokers improved substantially. However, their six-month Oxford Hip and Knee Scores were 2.5 and 3.2 points lower than those of nonsmokers. The upper limits of the 95% confidence intervals (3.5 and 4.5 points) fell below the between-group minimal important difference of approximately 5 points, although the TKA limit exceeded the original authors' 4-point threshold. Smaller cohorts generally reported lower scores or smaller gains, whereas responder analyses were mixed, and two TKA recovery-modeling studies with few current smokers were inconclusive. Registry analyses linked smoking with slower or less sustained recovery after THA, and current smokers reported more pain after TKA. Smokers had worse preoperative scores, and confounding was rarely fully addressed. No trial identified has measured functional outcomes after cessation, and observational cessation data are limited and affected by early relapse. Smokers gain substantial function but achieve modestly lower average scores than nonsmokers. The gap appears to be below the usual threshold for a clinically important group difference, but this conclusion rests largely on one dataset with incomplete outcome data, and its causal basis remains uncertain. The evidence supports cessation support for perioperative safety but does not show that quitting improves function or justify withholding surgery.

**Categories:** Osteopathic Medicine, Trauma, Sports Medicine
**Keywords:** functional recovery, patient-reported outcome measures, smoking, smoking cessation, tobacco, total hip arthroplasty, total knee arthroplasty

## Introduction And Background

Primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) are performed mainly for end-stage osteoarthritis, with the aim of relieving pain and restoring function. Systematic reviews have associated smoking with higher rates of postoperative complications and mortality, prosthesis-related complications after THA, and surgical complications and revision after TKA [1-3]. The most recent meta-analysis, covering studies published from 2000 to August 2022, pooled 40 studies and reported higher odds of wound complications, prosthetic joint infection, revision, and systemic complications in smokers, rating the certainty of evidence as low or very low for every pooled outcome [4].

Smoking has also become a criterion in access policies. In June 2021, 80 of 106 (75.5%) clinical commissioning groups in England had a smoking-related policy for hip or knee arthroplasty; most offered advice or optional cessation support, whereas 12 of 80 (15%) imposed additional waiting times or mandatory cessation [5]. NICE's osteoarthritis quality standard notes that smoking should not be a barrier to referral for consideration of joint surgery [6]. Debate about such policies turns partly on whether smokers benefit less from surgery, a question about function rather than complications that framed the largest cohort study in this field [7]. In that cohort, 11% of patients were current smokers and 33% were former smokers [7].

The functional evidence has received less scrutiny than the complication evidence. Yue et al. synthesized patient-reported outcomes narratively from five studies and concluded that smoking was associated with worse outcomes within one year [4]. Narrative summaries of this kind can conflate different questions: whether smokers start with worse baseline function, achieve lower postoperative scores, improve less, recover more slowly, or are less likely to achieve a clinically meaningful response. These distinctions matter because a group can improve substantially yet still finish below a comparator.

This review addresses the following question: In adults undergoing primary elective THA or TKA, how is smoking status associated with postoperative function and functional recovery compared with never

smoking, former smoking, or sustained cessation? THA and TKA are considered separately where possible because deficits in the largest cohort were slightly larger after TKA, although the confidence intervals overlapped [7]. The review also distinguishes function from pain and satisfaction, examines smoking intensity, cessation, and relapse, and considers why findings conflict.

# Review

## Methods

*Design*

This is a narrative review. Its planning and reporting were guided by the Scale for the Assessment of Narrative Review Articles (SANRA) [8]. SANRA was used as a reporting guide, not as a measure of the quality of the included studies.

*Search*

PubMed was searched from inception to November 2, 2026, without language restrictions. Smoking terms (smoking, smoker, tobacco, cigarette, nicotine, and the corresponding MeSH headings) were combined with procedure terms (total hip or knee arthroplasty or replacement) and, in separate subqueries, with outcome terms (patient-reported outcomes and named instruments), range of motion and stiffness, cessation and abstinence, other nicotine products, smoking intensity and biochemical verification, and review designs. Related-article links from four seed studies and the included-study table of a 2022 review were also checked. Embase, Scopus, Web of Science, and the Cochrane Library were not searched [4]. The full search strings, along with the number of records returned by each, are listed in Appendix 1. A broad exposure-plus-procedure query returned 1,056 records, which were not screened individually. Ten narrower queries returned 469 unique records, of which 381 were screened by title and abstract; the remaining 88 lacked arthroplasty or joint-replacement terms in the title. Including studies identified through related-article links and the review's included-study table, 26 primary studies reporting function, baseline status, or related outcomes by smoking status were included. Additional studies on cessation, other nicotine products, stiffness, and mechanisms were used as related evidence.

*Eligibility*

Eligible studies were primary investigations in adults undergoing primary THA or TKA that reported a measure of function or recovery (joint-specific or generic physical function scores, objective performance, range of motion or stiffness, activity level, or return to work) by smoking status, or that reported smoking as a predictor of such outcomes in a multivariable analysis. Pain, satisfaction, and quality-of-life outcomes were retained as related outcomes and are reported separately. Studies of revision arthroplasty, hemiarthroplasty, unicompartmental arthroplasty, or other joints were excluded from the main synthesis unless results for primary THA or TKA were reported separately; a few mixed-population studies were retained as related evidence and are identified as such. Complication-only studies and reviews were used for context.

*Extraction and Appraisal*

One author (AK) screened records and extracted data on study design, setting, sample, smoking definition and comparator, instrument and scoring direction, timing, estimates, and adjustment, along with source locations. A second author (BE) independently checked all extracted data against the full texts, and discrepancies were resolved through discussion. Studies were critically appraised narratively, with attention to confounding and adjustment, exposure misclassification, selection, missing outcome data, outcome thresholds, and overlap between datasets, rather than using a formal risk-of-bias instrument. Certainty ratings were not assigned.

## Outcome measurement and smoking definitions

*Outcome Instruments*

The included studies used instruments that measure different constructs. The Oxford Hip Score (OHS) [9] and Oxford Knee Score (OKS) [10] are patient-reported composites of pain and function, scored from 0 to 48, with higher scores indicating better status. The OKS can also be divided into pain and function subscales [11]. The Harris Hip Score [12], the Knee Society Score (KSS) [13,14], and the Hospital for Special Surgery (HSS) knee score [15] include clinician-assessed components, and the content of the KSS differs between its original and 2011 versions. The Hip Disability and Osteoarthritis Outcome Score (HOOS) [16] and the Knee Injury and Osteoarthritis Outcome Score (KOOS) [17] report separate subscales, so adjusted estimates for one subscale cannot be generalized to overall function [18]. Their shorter versions include the physical function short forms (HOOS-PS and KOOS-PS) [19,20] and the joint replacement versions: HOOS JR retains six items from the HOOS pain and daily activity domains, whereas KOOS JR retains seven items covering pain, stiffness, and daily activities [21,22]. Raw and converted JR scores run in opposite directions: in one

study, nonsmokers had lower raw totals and higher converted scores, both favoring nonsmokers [23]. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [24] measures pain, stiffness, and physical function; its direction depends on the scoring convention, and higher values indicated worse status in one cohort [25]. Generic measures included PROMIS Physical Function [26], the Patient-Reported Outcomes Measurement Information System (PROMIS)-10 Global Health items [27], the 36-item and 12-item Short Form Health Surveys (SF-36 and SF-12) [28,29], and the EQ-5D-5L with its visual analog scale (EQ-VAS) [30]. Pain intensity was also rated on visual analog scales, and one study measured activity using the Lower Extremity Activity Scale (LEAS) [31,32].

*Responder, Trajectory, and Threshold Definitions*

Several studies dichotomized outcomes [33-35] using the minimal clinically important difference (MCID) [36], the patient acceptable symptom state (PASS) [37], or substantial clinical benefit (SCB) [38], or used latent class models to identify recovery trajectories [39,40]. These thresholds describe meaningful change or an acceptable state for an individual patient, and attainment depends on baseline status: worse preoperative scores were associated with achieving the MCID, whereas better preoperative scores were associated with achieving the PASS [33,34]. Differences in mean scores between groups require a different benchmark. For the Oxford scores, Beard et al. distinguished the minimal important change for an individual (approximately 8 OHS and 7 OKS points), the minimal important difference (MID) between groups (approximately 5 points for both), and measurement error (minimal detectable change of approximately 5 OHS and 4 OKS points) [41]. A later analysis of NHS data again estimated between-group MIDs of approximately 5 points (Table *1*)[42].

| Included studies (reference) | Instrument (development reference) | Construct measured | Score range and direction | Completed by |
|---|---|---|---|---|
| Matharu et al. (2019) [7]; Hesseling et al. (2019) [39] | OHS [9] | Hip-specific pain and function (12 items) | 0 to 48; higher is better | Patient |
| Matharu et al. (2019) [7]; Mohammad et al. (2021), pain subscale [43] | OKS [10]; OKS pain subscale [11] | Knee-specific pain and function (12 items); the pain subscale uses the pain items only | Total 0 to 48; higher is better (subscales scored in the same direction) | Patient |
| Khan et al. (2009) [44] | HHS [12] | Pain, function, deformity, and range of motion | 0 to 100; higher is better | Clinician |
| Ergin et al. (2026) [18]; Yousef et al. (2024) [45]; Emara et al. (2022) [46]; Pasqualini et al. (2026) [35]; Khan et al. (2025) [47] | HOOS [16] | Five subscales: pain, symptoms, ADL, sport and recreation, and hip-related QoL | 0 to 100 per subscale; higher is better | Patient |
| Vega et al. (2023) [48] | KOOS [17] | Five subscales: pain, symptoms, ADL, sport and recreation, and knee-related QoL | 0 to 100 per subscale; higher is better | Patient |
| Kuijpers et al. (2022) [40]; Emara et al. (2022) [46]; Pasqualini et al. (2026) [35]; Khan et al. (2025) [47] | HOOS-PS [19] | Physical function (5 items from the HOOS daily-activity and sport domains) | 0 to 100; direction depends on scoring convention (originally, higher indicates more difficulty); lower was better in Kuijpers et al. [40] | Patient |
| Vega et al. (2023) [48] | KOOS-PS [20] | Physical function (7 items from the KOOS daily-activity and sport domains) | 0 to 100; direction depends on scoring convention (originally, higher indicates more difficulty) | Patient |
| Sato et al. (2024) [49]; Goh et al. (2023) [33]; Pasqualini et al. (2026) [35]; Khan et al. (2025) [47]; Kim et al. (2024) [50] | HOOS JR [21] | Hip pain and daily function (6 items) | Raw total 0 to 24, higher is worse; converted interval score 0 to 100, higher is better | Patient |
| Couture et al. (2025) [23]; Goh et al. (2022) [34]; Rainey et al. (2026) [51]; Omran et al. (2025) [52]; Kim et al. (2024) [50] | KOOS JR [22] | Knee pain, stiffness, and daily function (7 items) | Raw total 0 to 28, higher is worse; converted interval score 0 to 100, higher is better | Patient |

| | | | | |
|---|---|---|---|---|
| Halawi et al. (2019) [25]; Baum et al. (2022) [53] | WOMAC [24] | Pain, stiffness, and physical function (24 items) | Direction depends on scoring convention; higher was worse in Halawi et al. [25] | Patient |
| Parry et al. (2025) [54] | KCC [13]; 2011 version [14] | Original version: knee score (pain, stability, range of motion, and alignment) and function score (walking and stairs); the 2011 version adds patient-reported satisfaction, expectations, and activities | Original version: 0 to 100 for each score; higher is better | Clinician (original version); clinician and patient (2011 version) |
| An et al. (2021) [55] | HSS knee score [15] | Pain, function, range of motion, muscle strength, deformity, and instability | 0 to 100; higher is better | Clinician |
| Penrose et al. (2023) [56] | PROMIS Physical Function [26] | Generic physical function | T-score with general-population mean 50 (SD 10); higher is better | Patient |
| Kim et al. (2024) [50] | PROMIS-10 Global Health [27] | Global physical and mental health | T-scores with general-population mean 50 (SD 10); higher is better | Patient |
| Khan et al. (2009) [44]; An et al. (2021) [55] | SF-36 [28] | Generic health status in eight domains, with physical and mental component summaries | 0 to 100 per domain; higher is better | Patient |
| Halawi et al. (2019) [25] | SF-12 [29] | Physical and mental component summaries | Norm-based summary scores, mean 50 (SD 10); higher is better | Patient |
| Ergin et al. (2026) [18] | EQ-5D-5L and EQ-VAS [30] | Health-related QoL in five dimensions; self-rated overall health | Index from a national value set (1=full health); EQ-VAS 0 to 100; higher is better | Patient |
| Major et al. (2026) [57]; An et al. (2021) [55] | Pain VAS [31] | Pain intensity | 0 to 10 (or 0 to 100 mm); higher is worse | Patient |
| Issa et al. (2015) [58] | LEAS [32] | Daily physical activity level | 1 to 18; higher indicates greater activity | Patient |
| Goh et al. (2023) [33]; Goh et al. (2022) [34]; Pasqualini et al. (2026) [35]; Khan et al. (2025) [47]; Major et al. (2026) [57] | Responder thresholds: MCID [36], PASS [37], SCB [38] | Meaningful individual improvement (MCID, SCB) or an acceptable symptom state (PASS) | Achieved or not achieved; threshold values are specific to the instrument and population | Derived from patient-reported scores |

**TABLE 1: Outcome instruments used by the included studies, with their original development references and scoring conventions**

Original table created by the authors from the included studies and the original instrument development publications; no material has been reproduced or adapted from another source. Each row describes one instrument. The first column lists the included studies that used it, with their reference numbers in square brackets. The reference numbers in the Instrument column refer to the original development publications for each instrument. The construct measured, score range and direction, and completed by columns describe the instrument itself, not the results of the included studies. Where a reference number appears in the score range and direction column, it identifies the included study whose scoring direction is described. Individual studies may transform scores, so the source of each estimate should be checked before comparison.

ADL, activities of daily living; EQ-5D-5L, EuroQol five-dimension five-level questionnaire; EQ-VAS, EuroQoL Visual Analogue Scale; HOOS, Hip Disability and Osteoarthritis Outcome Score; HOOS JR, HOOS for Joint Replacement; HOOS-PS, HOOS Physical Function Short Form; HHS, Harris Hip Score; HSS, Hospital for Special Surgery; KOOS, Knee Injury and Osteoarthritis Outcome Score; KOOS JR, KOOS for Joint Replacement; KOOS-PS, KOOS Physical Function Short Form; LEAS, Lower Extremity Activity Scale; MCID, minimal clinically important difference; OHS, Oxford Hip Score; OKS, Oxford Knee Score; PASS, patient acceptable symptom state; PROMIS, Patient-Reported Outcomes Measurement Information System; PROMIS-10, PROMIS Global Health 10-item scale; QoL, quality of life; SCB, substantial clinical benefit; SD, standard deviation; SF-12, 12-item Short Form Health Survey; SF-36, 36-item Short Form Health Survey; VAS, visual analogue scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; KSS, Knee Society Score

*Smoking Definitions and Ascertainment*

The national cohort used primary care records of current, former, and nonsmoking status at the time of surgery, in which former smoking may have been under-recorded [7]. Halawi et al. compared current smokers with previous and never smokers combined, which does not provide a never-smoking comparator

[25]. Major et al. defined current smoking as self-reported smoking within 30 days before surgery, without cotinine testing, and Ergin et al. did not describe the former-smoking status of their nonsmoking group [57,18]. Most studies relied on self-report or routine records. Biochemical verification appeared mainly in cessation studies, using urine anabasine or nicotine and cotinine testing, for which 31.1% of counseled patients reported abstinence, but only 28.2% had laboratory confirmation [59,60]. In a younger hip-surgery population that included nonarthroplasty procedures, 97.6% of self-reported nonsmokers had cotinine levels consistent with nonsmoking [61].

## Functional outcomes following total hip arthroplasty

*Population Cohort*

Matharu et al. linked UK primary care, hospital, and national PROMs data for 60,812 THAs and 56,212 TKAs, but Oxford scores before and six months after surgery were available for only 10,009 patients (8.6%) across both joints; joint-specific denominators were reported only in a supplement [7]. After THA, smokers improved from a lower preoperative median OHS (16, compared with 18 in nonsmokers and ex-smokers) and finished 2.5 points (95% CI, 1.5-3.5) below nonsmokers and 1.8 points (95% CI, 0.79-2.9) below ex-smokers in models adjusted for baseline scores. The authors judged these differences not clinically meaningful against a 5-point threshold. The upper confidence limits (3.5 and 2.9) lie below the approximately 5-point between-group MID [41,42] (Figure *1*), so the data do not support a group-level difference of that magnitude. Smokers were younger and more deprived (11% compared with 3.7% of nonsmokers were in the most deprived decile), and it is unclear whether the PROM models adjusted for these factors [7].

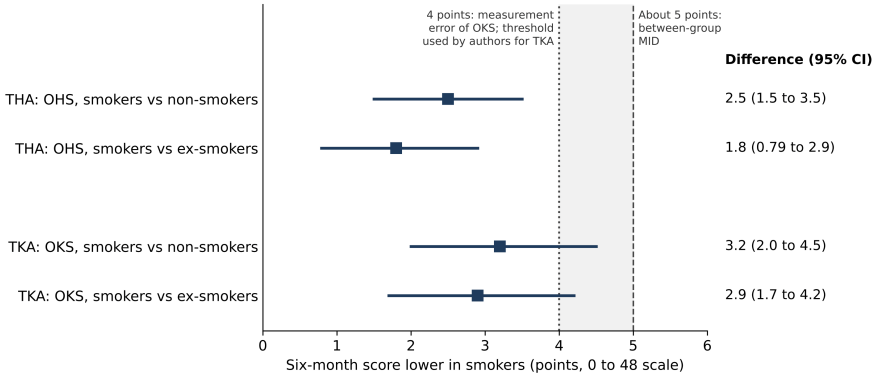


**FIGURE 1: Six-month Oxford score differences between smokers and comparators in the national UK cohort, against interpretation thresholds**

Original figure created by the authors from estimates reported by Matharu et al. [7]. No material has been reproduced or adapted from another source. Squares show the adjusted mean difference by which smokers' six-month OHS (after THA) or OKS (after TKA) was lower than that of nonsmokers or ex-smokers, and horizontal lines show 95% confidence intervals. Differences were adjusted for baseline scores. The dashed line marks the between-group MID of about 5 points [41,42]. The dotted line marks 4 points, the measurement error of the OKS, and the threshold used by the original authors for TKA [7,41]. The shaded band lies between the two thresholds.

CI, confidence interval; MID, minimal important difference; OHS, Oxford Hip Score; OKS, Oxford Knee Score; THA, total hip arthroplasty; TKA, total knee arthroplasty; UK, United Kingdom

*Single-Center Cohorts*

Khan et al. followed 1,767 patients for five years after cemented THA at one Scottish hospital [44]. Smokers had a lower Harris Hip Score than never smokers at six months, but not at 18, 36, or 60 months; nonsignificant differences at later time points do not establish equivalence. Ergin et al. compared 115 active smokers with 835 nonsmokers who underwent THA between 2020 and 2023 and had similar age, sex, body mass index, and preoperative PROMs [18]. At 12 months, nonsmokers had higher scores on every HOOS subscale, the EQ-5D-5L, and the EQ-VAS, as well as larger gains. Adjusted associations were reported for the EQ-5D-5L, EQ-VAS, and HOOS quality-of-life subscale, but not for the functional subscales; therefore, the adjusted association with function cannot be quantified [18].

*Recovery Trajectories*

Two Dutch Arthroplasty Register analyses modeled patterns of recovery. Using latent class growth modeling of OHS over one year in 6,030 patients, Hesseling et al. identified fast starters (87.7%), slow starters (4.6%), and late dippers (7.7%) [39]. Smoking was associated with membership in the slow-starter (OR 1.95, 95% CI,

1.26-3.03) and late-dipper (OR 1.68, 95% CI, 1.17-2.42) classes, although all classes improved after surgery. In 3,207 patients younger than 55 years, Kuijpers et al. reported that smoking was associated with membership in the good-responder (RR 1.1, 95% CI, 1.0-1.1) and poor-responder (RR 1.2, 95% CI, 1.1-1.2) classes on the HOOS physical function short form, rather than the optimal-responder class [40]. These relative risks were converted from odds ratios and appear smaller than the study's class counts would suggest: smokers made up 34% of the poor-responder class (52 of 152) and 17% of the optimal-responder class (414 of 2,391). These figures correspond to an unadjusted odds ratio of approximately 2.5 (95% CI, 1.7-3.5), calculated by the review authors from the published counts using the Woolf method, for poor vs. optimal response. The poor-responder class (4.7%) showed little improvement. In addition, the smoking estimate was adjusted for age only; patients who underwent revision within one year were excluded, and the 28% of eligible patients with complete PROMs were more often nonsmokers than those who were excluded.

*Multivariable Predictor Studies*

In a multicenter cohort of 1,724 THAs, smokers had lower HOOS JR scores at every time point [49]. In the FORCE-TJR cohort of 7,934 enrolled patients, smoking was among the predictors of five-year HOOS pain and activities-of-daily-living scores [45]. At one tertiary center, smoking was associated with failure to achieve SCB on HOOS measures among 9,229 patients with one-year data and ranked third in importance for failure to achieve the HOOS JR MCID in an overlapping cohort [35,47]. In a cross-sectional survey with a 19.5% response rate and no preoperative scores, any history of tobacco use predicted lower PROMIS Physical Function scores after THA [56]. By contrast, among 3,581 THAs at one practice, smoking did not predict MCID or PASS attainment for HOOS JR, whereas preoperative scores did [33].

*Baseline Status*

Among 6,902 THAs, smokers were more likely to have low preoperative HOOS pain (OR 1.56, 95% CI, 1.29-1.89) and physical function (OR 1.52, 95% CI, 1.25-1.85) scores [46]. Unadjusted postoperative comparisons therefore partly reflect baseline differences, whereas responder analyses may be biased in the opposite direction because worse preoperative scores favored MCID attainment [33].

## Functional outcomes following total knee arthroplasty

*Population Cohort*

In the same national cohort, smokers undergoing TKA had six-month OKS scores that were 3.2 points (95% CI, 2.0-4.5) lower than those of nonsmokers and 2.9 points (95% CI, 1.7-4.2) lower than those of ex-smokers, having started from a lower preoperative median score (17, compared with 19 in nonsmokers and 20 in ex-smokers) [7]. The authors judged the differences not clinically meaningful against a 4-point threshold, which corresponds to the measurement error of the OKS rather than to a between-group difference [41]. Against the approximately 5-point between-group MID, both upper confidence limits (4.5 and 4.2) fall below the threshold, with the first only narrowly below it. Against the 4-point threshold used by the authors, both upper limits exceed it, so the conclusion for TKA depends on the threshold chosen (Figure *1*).

*Single-Center Cohorts*

In 203 primary TKAs, current smokers had lower KSSs than nonsmokers and former smokers at six weeks and one year, based on a one-way analysis of variance without reported adjustment; among former smokers, each additional 20 months of smoking was associated with a score approximately 1 point lower [54]. Couture et al. compared 100 preoperative smokers (mean age, 62.8 years) with 100 nonsmokers (mean age, 67.6 years) undergoing TKA between 2018 and 2021; nonsmokers had better KOOS JR scores, with lower raw totals (P=0.016) and higher converted scores [23].

*Responder and Activity Outcomes*

Among 1,239 TKAs, smoking status did not predict attainment of the MCID or PASS for KOOS JR at one year, and in the PROMIS survey described above, tobacco history did not predict physical function after TKA [34,56]. In 281 patients followed for two to five years after TKA, tobacco use was associated with lower activity scores [58].

*Longitudinal and Trajectory Analyses*

Two TKA studies modeling recovery over the first year found no association with smoking. In 2,196 patients from a multicenter trial of a remote-care application, generalized estimating equations showed no difference between ever and never smokers in KOOS JR scores or rates of improvement from before surgery to 12 months [51]. Current and former smokers were not analyzed separately, iPhone ownership was required, and socioeconomic status, mental health, and comorbidities were not measured. In a growth mixture analysis of 700 patients at one center, smoking status did not differ between the two improving trajectories [52]. However, only 22 current smokers were analyzed; the cohort represented 10.9% of the

source population, and current smokers were more common among nonparticipants (5.2%) and incomplete responders (3.9%) than among the patients analyzed (3.2%). These studies argue against a large difference in recovery patterns after TKA but, given the small number of current smokers, are inconclusive and cannot exclude a modest association with current smoking.

*Related Outcomes: Pain and Satisfaction*

Associations with pain were more consistent. In 1,124 TKAs performed by one surgeon, with pain scores recorded before surgery and at two and six weeks, patients who had smoked within 30 days before surgery reported more pain than never smokers (adjusted mean difference, 0.83 on a 0-10 scale), and former and never smokers were more likely than current smokers to achieve an acceptable pain state (ORs, 1.62 and 1.78, respectively) [57]. At six weeks, 50.7% of current smokers, 72.4% of former smokers, and 72.7% of never smokers achieved that state. The authors judged these differences to be below the MCID. The article attributes a further 0.63-point difference to current vs. former smokers in its abstract but to former vs. never smokers in its results; the mean pain scores before surgery and at two and six weeks (former smokers: 5.4, 4.1, and 2.5; never smokers: 5.2, 4.0, and 2.3) support the abstract. No correction had been published at the time of writing. In linked UK primary care and English PROMs data on 4,750 knee replacements, 24.1% of current smokers had a poor six-month response on the OKS pain subscale, compared with 8.9% of nonsmokers (adjusted risk difference for current smoking, 12.0 percentage points; 95% CI, 7.3-16.6) [43]. In a prospective cohort of 241 patients (25 current smokers) undergoing primary or revision TKA, those who were not current smokers were more likely to be satisfied at eight weeks (OR 3.56, 95% CI, 1.21-10.45), although smoking was not associated with WOMAC improvement (P=0.096) [53].

*Stiffness and Range of Motion*

Most evidence uses manipulation under anesthesia (MUA) as a proxy for stiffness. Smoking was associated with MUA in a case-control analysis drawn from 3,182 TKAs (OR 1.59, 95% CI, 1.03-2.47) and in a 2025 meta-analysis of 53 studies (OR 1.43, 95% CI, 1.02-2.02) [62,63]. Conversely, current or former smokers were more likely not to undergo MUA in a prospective cohort of 3,556 TKAs [64]. MUA rates did not differ by smoking status in the single-surgeon cohort described above (2.3% for current smokers, 1.6% for former smokers, and 3.2% for never smokers) [57]. In Dutch registry revisions, which included unicompartmental replacements, nonsmoking was associated with arthrofibrosis rather than other causes as the reason for revision (OR 1.7, 95% CI, 1.2-2.3) [65]. MUA reflects a treatment decision, and revision-reason analyses compare causes among failures; therefore, neither directly measures range of motion.

*Baseline Status*

As with THA, current smoking was associated with poor preoperative KOOS pain and physical function scores in 14,079 TKAs, so unadjusted postoperative comparisons partly reflect baseline status [48].

## Mixed total hip arthroplasty and total knee arthroplasty evidence and recovery trajectories

Halawi et al. analyzed 713 primary THAs and TKAs, with WOMAC and SF-12 scores assessed before surgery and at six and 12 months [25]. Current smokers were compared with previous and never smokers combined. Smokers had more demographic and preoperative health disadvantages. In linear mixed-effects models adjusting for baseline differences, smokers had smaller improvements in WOMAC (P=0.002) and SF-12 physical component scores (P=0.03), and nonsmokers had better absolute scores at final follow-up for all outcomes except mental health.

Table *2* summarizes the primary studies by joint. Across designs, smokers present with worse preoperative pain and function, improve substantially, and reach somewhat lower postoperative scores on average [7,18,25,39,46,48]. Whether the gap narrows over time remains unresolved: one THA cohort found no significant difference after six months, whereas THA trajectory analyses associated smoking with slower or less sustained recovery, two TKA analyses found no difference in recovery over one year, and a five-year cohort retained smoking as a predictor [39,40,44,45,51,52]. No study tested whether the association differed between joints; in the national cohort, the TKA estimate was slightly larger, but the confidence intervals overlapped [7].

| Study (reference) | Joint | Design, setting, and period | Number analyzed (PROM completeness where reported) | Smoking exposure (comparator) | Outcome measure; timing | Main smoking-related finding | Variables adjusted for (model) |
|---|---|---|---|---|---|---|---|
| | | | Cohort: 60,812 | | | THA: OHS 2.5 (95% confidence interval | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Matharu et al. (2019) [7] | THA and TKA (analyzed separately) | Population cohort; linked UK primary-care, hospital and PROMs data; surgery 1995 to 2017, PROMs from 2009 | THA and 56,212 TKA; PROM analysis: 10,009 across both joints (8.6%; joint split in supplement) | Current vs. ex- vs. nonsmoker (records at surgery) | THA: OHS; TKA: OKS (both 0 to 48); 6 months | 1.5 to 3.5) lower vs. nonsmokers and 1.8 (0.79 to 2.9) lower vs. ex-smokers. TKA: OKS 3.2 (2.0 to 4.5) lower vs. nonsmokers and 2.9 (1.7 to 4.2) lower vs. ex-smokers. Smokers improved from baseline after both | Preoperative score and other covariates included in the PROM model are unclear |
| Penrose et al. (2023) [56] | THA and TKA (separate models) | Cross-sectional survey in one health system; surgery 2014 to 2020 | 2,411 respondents (19.5% response rate) | Any tobacco history vs. none | PROMIS Physical Function; postoperative, timing varied | THA: tobacco history predicted lower function. TKA: not a predictor | Sex, age, race, BMI, comorbidity, preoperative pain, number of surgeries and time to survey (multivariable linear regression) |
| Halawi et al. (2019) [25] | THA and TKA combined (not reported separately) | Retrospective; one center | 713 procedures | Current vs. previous and never-smokers combined | WOMAC, SF-12; baseline, 6 and 12 months | Smaller WOMAC (P=0.002) and SF-12 physical component summary (P=0.03) gains; WOMAC 7.7 points worse per pack/day; satisfaction 82% vs. 89% (P=0.052) | Baseline differences between groups (linear mixed model) |
| Kim et al. (2024) [50] | THA and TKA (abstinence after preoperative cessation) | Retrospective record review with telephone survey; one tertiary center; surgery 2014 to 2022 | 37 of 88 eligible (42% response); 20 THA, 17 TKA | Sustained abstinence (16) vs. relapse (21) | THA: HOOS JR; TKA: KOOS JR; both: PROMIS-10; mean 2.85 years | THA: HOOS JR 82.05 vs. 63.12 (P=0.02). TKA: KOOS JR not significantly different (P=0.40). Both: higher PROMIS-10 mental health scores in abstinent patients (57.79 vs. 48.58, P<0.01) | None (unadjusted comparisons) |
| Khan et al. (2009) [44] | THA | Prospective cohort; one hospital, Scotland; period not reported | 1,767 cemented THA; number of smokers not reported | Smokers vs. never-smokers | HHS, SF-36; 6, 18, 36, and 60 months | Lower HHS at 6 months only; no significant difference from 18 to 60 months | Not reported |
| Ergin et al. (2026) [18] | THA | Retrospective cohort; January 2020 to January 2023 | 950 (115 smokers and 835 nonsmokers) | Active smokers vs. nonsmokers (former status not described) | HOOS subscales, EQ-5D-5L, and EQ-VAS; 12 months | Lower scores on all HOOS subscales and smaller gains; adjusted association with lower EQ-5D-5L, EQ-VAS, and HOOS QoL | Covariates not reported (multivariable) |
| Hesseling et al. (2019) [39] | THA | National register, Netherlands | 6,030 | Registry smoking status | OHS trajectory to 12 months | Slow starter OR 1.95 (1.26 to 3.03); late dipper OR 1.68 (1.17 to 2.42); all classes improved | Multivariable (multinomial regression) |
| Kuijpers et al. (2022) [40] | THA | National register, Netherlands; 2014 to 2018; age under 55 years | 3,207 (28% of eligible; revisions within 1 year excluded) | Registry smoking status; included patients more often nonsmokers | HOOS-PS (lower is better) trajectory to 12 months | Reported relative risk 1.1 (1.0 to 1.1) for good and 1.2 (1.1 to 1.2) for poor responders; class counts imply unadjusted OR about 2.5 (1.7 to 3.5) for poor responders (review authors' calculation, Woolf method); smokers 34% of poor vs. 17% of optimal responders; poor class barely improved | Age only (selected with a directed acyclic graph) |
| Sato et al. (2024) [49] | THA | Multicenter cohort | 1,724 | Tobacco use (definition not reported) | HOOS JR at multiple time points | Lower HOOS JR at all time points | Not reported (longitudinal estimating equations) |
| Yousef et al. (2024) [45] | THA | Prospective multicenter cohort (Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement) | 7,934 enrolled; number at 5 years not reported | Smoking (definition not reported) | HOOS pain and ADL; 5 years | Smoking among predictors of both | Multivariable |
| Pasqualini et al. | THA | Prospective, one institution; 2016 to 2022 | 9,229 with 1-year data | Smoking (definition not | SCB on HOOS pain, HOOS-PS | Associated with not achieving SCB | Multivariable (logistic regression) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (2026) [35] | | | (78.4%) | reported) | and HOOS JR; 1 year | | |
| Khan et al. (2025) [47] | THA | Same institution as Pasqualini et al. [35]; 2016 to 2020 (overlapping) | 8,893 in cohort; 2,476 without 1-year PROMs | Smoking (definition not reported) | MCID and PASS on HOOS measures; 1 year | Ranked third in importance for not achieving HOOS JR MCID | Multivariable (logistic regression) |
| Goh et al. (2023) [33] | THA | One practice; 2015 to 2019 | 3,581 | Smoking status (definition not reported) | MCID and PASS for HOOS JR; 1 year | Not a significant predictor | Multivariable |
| Emara et al. (2022) [46] | THA (baseline status only) | Prospective cohort; one institution; 2016 to 2020 | 6,902 | Smokers vs. nonsmokers | Preoperative HOOS pain and HOOS-PS | Higher odds of low preoperative HOOS pain (OR 1.56, 95% confidence interval 1.29 to 1.89) and HOOS-PS (OR 1.52, 1.25 to 1.85) | Multivariable |
| Parry et al. (2025) [54] | TKA | Retrospective; one university hospital | 203 | Current vs. former vs. nonsmokers | KSS; 6 weeks, 1 year | Lower in current smokers at both times; in former smokers about 1 point lower per 20 months of use | None reported (one-way analysis of variance) |
| Couture et al. (2025) [23] | TKA | Record review and survey; one institution; 2018 to 2021 | 200 (100 smokers and 100 nonsmokers) | Preoperative smokers vs. nonsmokers | KOOS JR raw and converted | Better scores in nonsmokers (raw total P=0.016) | Not reported |
| Goh et al. (2022) [34] | TKA | One institution; 2015 to 2019 | 1,239 | Smoking status (definition not reported) | MCID and PASS for KOOS JR; 1 year | Not a significant predictor | Multivariable |
| Issa et al. (2015) [58] | TKA | Prospective cohort | 281 | Tobacco use | LEAS; 2 to 5 years | Negative association with activity level | Multivariable (regression) |
| Rainey et al. (2026) [51] | TKA | Secondary analysis of multicenter trial of a remote-care app; more than 20 sites in the United States, Australia and the Netherlands; iPhone ownership required | 2,196 | Ever vs. never-smokers (66.4% never) | KOOS JR (converted, higher is better); preoperative, 1, 3, 6, and 12 months | No significant difference in overall scores or rate of improvement at any interval | All measured demographic and modifiable factors (generalized estimating equations with time interactions); socioeconomic status, mental health, and comorbidity not measured |
| Omran et al. (2025) [52] | TKA | Retrospective; one center, New York; January 2020 to March 2023 | 700 (10.9% of 6,433); 22 current, 241 former, 437 never | Current vs. former vs. never | KOOS JR trajectories (growth mixture model) to 12 months | Smoking distribution did not differ between two improving classes (P=0.159); not retained in model; current smokers over-represented among non-participants and incomplete responders | Variables selected by Akaike information criterion (stepwise logistic regression) |
| Issa et al. (2015) [62] | TKA (stiffness) | Case-control within 3,182 TKAs at two centers; 2005 to 2011 | 156 knees with MUA and 1:4 controls | Tobacco smoking | MUA as stiffness proxy | OR 1.59 (1.03 to 2.47) | Multivariable (logistic regression) |
| Major et al. (2026) [57] | TKA (related outcome: pain) | Retrospective; one surgeon; 2019 to 2023 | 1,124 (87 current, 320 former, and 717 never) | Current (self-reported, within 30 days) vs. former vs. never | VAS pain; acceptable pain state (VAS 3 or less); preoperative, 2, and 6 weeks | Higher pain in current vs. never-smokers (mean difference 0.83); 0.63 difference attributed inconsistently by the authors (see text); lower odds of acceptable pain state in current smokers; differences below MCID per authors; MUA rates similar | Age, sex, race, BMI, deformity, technique, and insurance |
| Mohammad et al. | Knee replacement, 11.3% | Linked UK primary-care and English hospital and PROMs data; 2009 | 4,750 knee replacements (60.4% of six- | Current vs. ex- vs. | Poor response on OKS pain | Poor response 24.1% in current smokers vs. 8.9% in nonsmokers; adjusted risk | Multivariable (with |

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| (2021) [43] | unicompartmental (related outcome: pain) | to 2016 (overlaps Matharu et al. [7]) | month PROMs missing) | nonsmoker (records) | subscale; 6 months | difference 12.0 percentage points (7.3 to 16.6) | multiple imputation) |
| Vega et al. (2023) [48] | TKA (baseline status only) | Prospective cohort; one institution | 14,079 | Current smoking vs. not | Preoperative KOOS pain and KOOS-PS | Current smoking independently associated with scores at or below the 25$^{th}$ percentile; current smokers less likely to have good rather than poor pain and function scores (OR 0.62) | Multivariable |
| Baum et al. (2022) [53] | TKA, primary or revision (related outcome: satisfaction) | Prospective single-center cohort; December 2019 to May 2021 | 241 (85.2% response; 25 current smokers) | Current smokers vs. others | Satisfaction and WOMAC; 8 weeks | Patients who were not current smokers more likely to be satisfied (OR 3.56, 95% confidence interval 1.21 to 10.45); smoking not associated with WOMAC change (P=0.096) | Multivariable (logistic and linear regression) |
| An et al. (2021) [55] | TKA (related exposure: passive smoking in nonsmoking women) | Prospective cohort | 216 | Heavy vs. mild vs. no passive smoke exposure | VAS pain, range of motion, HSS knee score, SF-36; 3 months | Heavy exposure: higher pain and lower range of motion, HSS knee score and SF-36 summary score at 3 months (P<0.01) | None reported (baseline characteristics similar between groups) |

**TABLE 2: Primary studies reporting function, baseline status, or related outcomes by smoking status in total hip or knee arthroplasty**

Original table created by the authors from data reported in the cited studies; no material has been reproduced or adapted from another source. Each study is listed once; where a study reported both joints, findings are labeled THA or TKA. Number analyzed includes PROM completeness or response rates, where reported. Variables adjusted for: the covariates, with the model type in brackets, used to estimate the association between smoking and the outcome, as reported. 'Not reported' means no adjusted analysis was reported, and 'multivariable' alone means no covariate list could be extracted.

BMI, body mass index; EQ-5D-5L, EuroQol five-dimension five-level questionnaire; EQ-VAS, EuroQoL Visual Analogue Scale; HHS, Harris Hip Score; HOOS, Hip Disability and Osteoarthritis Outcome Score; HOOS JR, HOOS for Joint Replacement; HOOS-PS, HOOS Physical Function Short Form; HSS, Hospital for Special Surgery; KOOS, Knee Injury and Osteoarthritis Outcome Score; KOOS JR, KOOS for Joint Replacement; KOOS-PS, KOOS Physical Function Short Form; MCID, minimal clinically important difference; MUA, manipulation under anesthesia; OHS, Oxford Hip Score; OKS, Oxford Knee Score; OR, odds ratio; PASS, patient acceptable symptom state; PROMIS, Patient-Reported Outcomes Measurement Information System; PROMIS-10, PROMIS Global Health 10-item scale; PROMs, patient-reported outcome measures; SCB, substantial clinical benefit; SF-12, 12-item Short Form Health Survey; SF-36, 36-item Short Form Health Survey; THA, total hip arthroplasty; TKA, total knee arthroplasty; UK, United Kingdom; VAS, visual analogue scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; LEAS, Lower Extremity Activity Scale; ADL, activities of daily living; QoL, quality of life; KSS, Knee Society Score

## Smoking intensity, cessation, and relapse

*Intensity*

Evidence on intensity is sparse. Halawi et al. reported that each additional pack smoked per day was associated with WOMAC scores that were 7.7 points worse and SF-12 physical component scores that were 4.8 points lower [25]. Parry et al. reported lower KSSs with longer durations of past use among former smokers [54]. Neither finding is equivalent to pack-years, and no functional study modeled pack-years or time since quitting; therefore, a dose-response relationship cannot be assessed.

*Former Smokers*

Former smokers generally had better outcomes than current smokers. In the national cohort, ex-smokers had higher postoperative OHS and OKS than current smokers, and in single-center TKA cohorts, former smokers had better KSSs and were more likely to reach an acceptable pain state [7,54,57]. In the latter cohort, their mean pain scores were close to those of never-smokers. These comparisons do not show that quitting caused better recovery. Former-smoker groups combine long-term and recent quitters, may be under-recorded, and can differ from current smokers in age, deprivation, and other health behaviors [7].

*Intervention Evidence*

The only randomized trial identified exclusively in arthroplasty patients tested counseling with nicotine replacement, starting six to eight weeks before THA or TKA, in 120 patients [66]. Among the 108 patients analyzed, overall complications occurred in 18% of the intervention group and 52% of controls. The trial did not measure function, so it supports cessation for perioperative risk reduction rather than functional recovery.

*Observational Evidence on Abstinence and Function*

One small study linked sustained abstinence to function. Kim et al. surveyed 37 of 88 eligible patients with a recorded tobacco cessation date within three months of THA or TKA, at a mean of 2.85 years after surgery; 27 (73.0%) reported complete abstinence before surgery [50]. Sixteen (43.2%) remained abstinent; relapse occurred at a mean of 2.73 months. HOOS JR scores were higher in abstinent than relapsed patients (82.05 vs. 63.12, P=0.02; 11 and 9 THA patients), whereas KOOS JR and PROMIS physical function did not differ significantly. Abstinent patients also had higher PROMIS-10 mental health scores (57.79 vs. 48.58, P<0.01), which could reflect confounding. Preoperative scores were not reported, and there was no continuing-smoker control group. Selection of patients who recovered well or chose to respond cannot be excluded.

*Relapse*

Relapse after preoperative cessation is common, so exposure classified only before surgery may be misclassified. Of 101 patients asked to quit before arthroplasty, 62% quit, and 51% of these remained abstinent six months after surgery [67]. After mandatory cessation before hip preservation surgery or THA, 46.7% remained nicotine-free at a mean of 35 months, with relapse occurring at a mean of 2.4 months [68]. In an institutional registry of 28,758 arthroplasties, 86% of those who quit within the year before surgery were abstinent at one year, but only 45% were abstinent at eight years [69]. At one institution, 23% of 93 patients who quit for surgery never resumed smoking [59]. None of these studies measured function.

*Other Nicotine and Tobacco Exposures*

Evidence for non-tobacco nicotine dependence, smokeless tobacco, and vaping is limited to complications reported in database or institutional studies, and diagnosis-code-based exposures are not equivalent to measured smoking [70-75]. One unreplicated study associated heavy passive smoke exposure with worse pain, range of motion, and knee scores three months after TKA in 216 nonsmoking women [55].

## Interpretation, plausible mechanisms, and conflicting findings

*Why Findings Conflict*

Comparators ranged from never-smokers to combined former and never-smokers and undefined nonsmokers [18,25]. Associations were most consistent for pain-specific outcomes [43,57]. Baseline status differed in most cohorts [7,46,48] but not in one, and follow-up ranged from six weeks to five years [18,44,45,54]. Outcome data were often incomplete: PROMs were available for 8.6% of the national cohort, 60.4% of six-month PROMs were missing in the linked knee data, one survey had a 19.5% response rate, and 78.4% of one THA cohort had one-year data [7,35,43,56]. Response itself varied with smoking: current smokers were overrepresented among patients without the required PROMs in one TKA cohort, and patients with complete registry PROMs were more often nonsmokers in a THA cohort [40,52]. If response also depends on outcome, these losses could bias differences in either direction.

*Plausible Mechanisms*

A systematic review of pathophysiological studies, mostly outside arthroplasty, found that smoking transiently reduces tissue oxygenation and impairs inflammatory and proliferative healing; cessation restored oxygenation rapidly and inflammatory function within about four weeks, but proliferative responses remained impaired [76]. Such effects could delay rehabilitation through wound complications, but no included study tested mediation. A small physiological study found lower muscle protein synthesis and higher expression of muscle-wasting regulators in heavy smokers than in matched nonsmokers, an indirect route to slower recovery of strength [77]. Smokers also used more analgesics after arthroplasty, and persistent opioid use was more frequent in pooled data, but neither has been shown to mediate functional differences [4,7]. Because complications and early revision may lie on the pathway between smoking and function, models that adjust for them or exclude early revisions, as one trajectory analysis did, estimate only part of the total association [40].

*Confounding and Selection*

In the national cohort, smokers were about six to seven years younger and more often lived in the most deprived areas, and deprivation was independently associated with poor pain outcomes in linked data from the same sources [7,43]. Mental health, alcohol use, preoperative opioid exposure, employment, and access to rehabilitation are also plausible confounders, but few studies adjusted for several of these factors together. Selection into surgery may also differ: in a population cohort of 54,288 older adults, smoking was inversely associated with undergoing joint replacement for osteoarthritis, so smokers who reach surgery may differ in disease severity, comorbidity, or health care contact [78]. The associations are therefore best described as adjusted associations rather than independent effects of smoking.

## Clinical implications

*Expected Functional Benefit*

Smokers considering THA or TKA can be told that substantial improvement in pain and function is expected, and that average postoperative scores in smokers have been modestly lower than in nonsmokers [7]. In one registry analysis, every recovery class improved, and in two, smoking was associated with less favorable classes, whereas two TKA studies found no difference in recovery over one year [39,40,51,52]. In two cohorts, preoperative scores predicted attainment of clinically important improvement, whereas smoking did not [33,34].

*Perioperative Risk*

The case for offering cessation support before arthroplasty rests mainly on complication evidence, including a randomized trial showing fewer complications after an intensive preoperative intervention and consistent observational associations with wound complications, infection, and systemic events [1,4,66]. However, cessation should not be presented to patients as a demonstrated route to better function because no study has shown that cessation improves functional recovery, and former-smoker comparisons cannot establish this.

*Access to Surgery*

The functional evidence does not support withholding or delaying surgery on the expectation that smokers will not benefit, consistent with NICE's position that smoking should not be a barrier to referral [6]. A 2023 North American guideline conditionally recommended delaying arthroplasty for nicotine reduction or cessation, with the evidence for all its recommendations graded as low or very low [79]. Where commissioning policies require cessation or add waiting time, their justification is perioperative risk rather than functional benefit, and the effect of such delays on pain and function in smokers has not been studied [5].

*Practical Points*

Smoking status should be recorded precisely at listing, surgery, and follow-up (current, former with quit date, or never; intensity; other nicotine products), with biochemical confirmation where cessation is required [59,60]. Because relapse after preoperative quitting is common and often early, although rates vary, relapse-prevention support in the early postoperative period is reasonable, though its effect on function is untested [50,59,67-69]. Postoperative PROMs in smokers should be read alongside their usually worse baseline scores [46,48]. Postoperative scores may also reflect coexisting conditions, such as pathology in other joints or the spine, rather than the replaced joint alone.

## Limitations

*Limitations of the Evidence*

All functional evidence identified is observational, and the only randomized trial exclusively in arthroplasty patients did not measure function [66]. Exposure definitions were heterogeneous, comparators sometimes combined former and never-smokers, and smoking was usually self-reported or taken from routine records without verification [25]. PROM completeness was low in the largest datasets, and the two studies that reported it found smokers underrepresented among patients with complete PROMs [7,40,43,52]. Datasets overlap: the national cohort and the knee pain analysis used the same linked UK sources and period, the two trajectory analyses used the same national register, and four studies came from one North American institution and overlapping years [7,35,39,40,43,46-48]. Two cessation series came from one US institution, two hip studies from one practice, and two TKA studies from one center [58,59,61,62,67,68]. The two longitudinal TKA analyses that found no association were underpowered for current smoking: one combined current and former smokers, and the other analyzed only 22 current smokers [51,52]. Registry and linked-record evidence came from the UK and the Netherlands; no Scandinavian or Australasian registry analysis of PROMs by smoking status was identified. The cessation evidence is thin, comprising one randomized trial that did not measure function and a few small observational series [66].

*Limitations of This Review*

Only PubMed was searched; Embase, Scopus, Web of Science, the Cochrane Library, and gray literature were not, so the statements that all functional evidence is observational and that no trial has measured function after cessation apply to the PubMed-indexed literature. The broad exposure-plus-procedure query (1,056 records) was not screened record by record; the ten narrower queries were screened in full except for 88 records from two title-restricted queries that lacked arthroplasty or joint-replacement terms in the title (Appendix 1). Because smoking may have been reported only as a covariate in the full text, some relevant studies may have been missed by this query structure. Forward citation searching was not performed. The

synthesis is narrative rather than quantitative.

### Research priorities

The main gaps concern causal inference, exposure measurement, and the interpretation of group differences (Table 3). Existing registries with PROMs linked to primary-care smoking records could estimate joint-specific differences with full confounder adjustment, report distributions as well as means, and model time since quitting. The key causal question, whether cessation improves function, requires a randomized design in which PROMs are measured, ideally embedded in existing perioperative optimization pathways. Prospective cohorts with biochemically verified, repeatedly measured smoking status would address relapse and exposure misclassification. Such cohorts will need to recruit smokers deliberately: in one UK feasibility cohort of 40 patients awaiting TKA, only two smoked tobacco [80].

| Unresolved question | Why it matters | Study design that could answer it |
|---|---|---|
| Whether a subgroup of smokers has clinically important deficits | Mean differences in the largest analysis were below the between-group MID but can hide poor recovery in some patients | Linked registry analysis of score distributions and trajectories with full confounder adjustment, by joint |
| Whether PROM non-response differs by smoking status | Selective non-response can bias differences in either direction | Report response by smoking status; multiple imputation or inverse probability weighting in registry analyses |
| Whether cessation improves function | Programs and access policies assume benefit that is untested | Pragmatic randomized trial of perioperative cessation support with OHS/OKS or HOOS/KOOS function subscales at  and 12 months as key outcomes |
| Effect of timing, duration, and relapse | Preoperative status misclassifies postoperative exposure | Prospective cohort with biochemical verification at listing, surgery, 6 weeks, 3, 6, and 12 months, analyzed using time-varying exposure |
| Dose-response | Risk stratification needs intensity data | Registry collection of pack-years and time since quitting at listing |
| THA vs. TKA differences | Joint-specific counseling | Large-dataset analyses with formal interaction tests |
| Long-term function | Durability of benefit in smokers | Five- and ten-year registry PROMs with attrition analysis by smoking status |
| Objective function and range of motion | PROMs combine pain and function | Cohorts with performance tests and goniometry stratified by smoking status |
| Vaping, smokeless tobacco, and nicotine replacement | Use is changing, and evidence is limited to complications | Product-specific fields in registries linked to PROMs |
| Mechanisms | Identifies modifiable targets | Formal mediation analysis of complications, analgesic use and pain sensitisation in linked data |
| Impact of access policies | Equity and harm from delay | Natural-experiment comparison of commissioning areas with and without cessation requirements on waiting time, preoperative PROMs and postoperative function |

**TABLE 3: Unresolved questions about smoking and function after hip and knee arthroplasty, why each matters, and study designs that could answer them**

Original table created by the authors based on the evidence reviewed; no material has been reproduced or adapted from another source.

HOOS, Hip Disability and Osteoarthritis Outcome Score; KOOS, Knee Injury and Osteoarthritis Outcome Score; MID, minimal important difference; OHS, Oxford Hip Score; OKS, Oxford Knee Score; PROM(s), patient-reported outcome measure(s); THA, total hip arthroplasty; TKA, total knee arthroplasty

## Conclusions

In adults undergoing primary THA or TKA, current smoking is associated with worse preoperative status and, on average, modestly lower postoperative functional scores, but smokers still gain substantially from surgery. In the largest baseline-adjusted analysis, the six-month deficit was about 2.5 OHS and 3.2 OKS

points, below the between-group MID. However, this estimate comes from one dataset in which only 8.6% of the cohort had Oxford scores before and after surgery, and the upper confidence limit for TKA exceeded the 4-point threshold used by the original authors. Smaller studies often reported significant deficits without adjusted effect sizes, responder analyses were mixed, and two longitudinal TKA analyses with few current smokers were inconclusive. Former smokers tend to do better than current smokers, but this observational contrast does not show that quitting improves function, and no trial identified has tested this. Evidence on intensity, long-term function, objective performance, and noncombustible nicotine products is sparse. Cessation support before arthroplasty is justified by perioperative risk, whereas the functional evidence does not justify withholding surgery from smokers.

# Appendices

## PubMed search strategy

All searches were run in PubMed on 2 November 2026, without language limits, as separate queries; record counts are those returned on that date. Queries S2 to S11 returned 469 unique records, of which 381 were screened by title and abstract; the 88 records not screened came from S3 and S4 and lacked arthroplasty or joint-replacement terms in the title.

S1. Broad exposure plus procedure (1,056 records; not screened individually): (smoking[tiab] OR smoker[tiab] OR smokers[tiab] OR tobacco[tiab] OR cigarette[tiab] OR cigarettes[tiab] OR nicotine[tiab] OR "Smoking"[MeSH] OR "Tobacco Use"[MeSH]) AND ("total hip arthroplasty"[tiab] OR "total hip replacement"[tiab] OR "total knee arthroplasty"[tiab] OR "total knee replacement"[tiab] OR "total joint arthroplasty"[tiab] OR "Arthroplasty, Replacement, Hip"[MeSH] OR "Arthroplasty, Replacement, Knee"[MeSH])

S2. Outcome-focused (patient-reported outcome measures and instruments) (136 records; all screened): (smoking[tiab] OR smokers[tiab] OR tobacco[tiab] OR nicotine[tiab]) AND (arthroplasty[tiab] OR replacement[tiab]) AND (hip[tiab] OR knee[tiab]) AND ("patient-reported"[tiab] OR "patient reported"[tiab] OR PROMs[tiab] OR WOMAC[tiab] OR "Oxford Hip Score"[tiab] OR "Oxford Knee Score"[tiab] OR KOOS[tiab] OR HOOS[tiab] OR "Harris Hip Score"[tiab] OR "Knee Society"[tiab] OR PROMIS[tiab])

S3. Smoking in title (169 records; 115 screened, the remainder lacking joint-replacement terms in the title): (smoking[ti] OR smokers[ti] OR smoker[ti] OR tobacco[ti] OR nicotine[ti] OR cigarette[ti]) AND (arthroplasty[tiab] OR replacement[tiab]) AND (hip[tiab] OR knee[tiab] OR joint[tiab])

S4. Smoking in title, with function terms (72 records; 33 screened; the remainder, mainly on nicotine or hormone replacement, lacked arthroplasty or joint-replacement terms in the title): (smoking[ti] OR smokers[ti] OR smoker[ti] OR tobacco[ti] OR nicotine[ti]) AND (arthroplasty[ti] OR replacement[ti]) AND ("patient-reported"[tiab] OR "patient reported"[tiab] OR functional[tiab] OR function[tiab] OR WOMAC[tiab] OR KOOS[tiab] OR HOOS[tiab] OR Oxford[tiab] OR "Harris Hip Score"[tiab] OR "Knee Society"[tiab])

S5. Core title query (83 records; all screened): (smoking[ti] OR smokers[ti] OR smoker[ti] OR tobacco[ti] OR nicotine[ti]) AND (arthroplasty[ti] OR "joint replacement"[ti] OR "hip replacement"[ti] OR "knee replacement"[ti]) AND (hip[tiab] OR knee[tiab]) NOT shoulder[ti] NOT spine[ti]

S6. Cessation and abstinence (96 records; all screened): ("smoking cessation"[tiab] OR "quit smoking"[tiab] OR abstinence[tiab] OR "former smokers"[tiab] OR "ex-smokers"[tiab]) AND arthroplasty[tiab] AND (hip[tiab] OR knee[tiab] OR joint[tiab])

S7. Other nicotine products (34 records; all screened): (vaping[tiab] OR "e-cigarette"[tiab] OR "electronic cigarette"[tiab] OR "smokeless tobacco"[tiab] OR "nicotine replacement"[tiab] OR "nicotine dependence"[tiab]) AND arthroplasty[tiab]

S8. Stiffness, range of motion, walking and return to work (60 records; all screened): (smoking[tiab] OR smokers[tiab] OR tobacco[tiab]) AND (arthroplasty[tiab]) AND (knee[tiab] OR hip[tiab]) AND ("range of motion"[tiab] OR stiffness[tiab] OR arthrofibrosis[tiab] OR "manipulation under anesthesia"[tiab] OR "return to work"[tiab] OR "walking"[tiab] OR gait[tiab])

S9. Existing reviews (13 records; all screened): (smoking[tiab] OR tobacco[tiab]) AND arthroplasty[tiab] AND (hip[tiab] OR knee[tiab]) AND ("patient-reported"[tiab] OR functional[tiab] OR "functional outcomes"[tiab]) AND (review[pt] OR "systematic review"[tiab] OR "meta-analysis"[tiab])

S10. Intensity and biochemical verification (9 records; all screened): (smoking[tiab] OR smokers[tiab] OR tobacco[tiab]) AND (arthroplasty[tiab]) AND (hip[tiab] OR knee[tiab]) AND ("pack-years"[tiab] OR "pack years"[tiab] OR "packs per day"[tiab] OR "cigarettes per day"[tiab] OR cotinine[tiab] OR anabasine[tiab])

S11. Abbreviated procedure terms in title (10 records; all screened, none added): (smoking[ti] OR smokers[ti] OR smoker[ti] OR tobacco[ti] OR nicotine[ti] OR cigarette[ti]) AND (TKA[ti] OR THA[ti] OR TJA[ti] OR TKR[ti]

OR THR[ti] OR arthroplasties[ti] OR "joint replacements"[ti] OR "knee replacements"[ti] OR "hip replacements"[ti])

S12. Retraction and correction check (5 records; none concerned an included study): (smoking[tiab] OR tobacco[tiab] OR nicotine[tiab]) AND arthroplasty[tiab] AND ("retracted publication"[pt] OR "retraction of publication"[pt] OR "expression of concern"[pt] OR "published erratum"[pt])

S13. Tracing two studies listed in a previous review (3 records; none reported function): (Debreuve-Theresette[Author] AND arthroplasty) OR (Hassan[Author] AND smoking AND arthroplasty AND Denmark)

Related articles. The PubMed similar-articles lists for PMIDs 30482415, 42606635, 39989994 and 40743830 were checked, and the 20 most similar records were screened; none were added. The included-study table of a 2022 review [4] was also checked.

# Additional Information

## Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Adnan Kussad

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## Disclosures

**AI use statement:** The authors have declared that no AI tools were used during the work or in the drafting of this article. The authors take full responsibility for the work. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

# References

1. Singh JA: Smoking and outcomes after knee and hip arthroplasty: a systematic review . J Rheumatol. 2011, 38:1824-34. 10.3899/jrheum.101221
2. Teng S, Yi C, Krettek C, Jagodzinski M: Smoking and risk of prosthesis-related complications after total hip arthroplasty: a meta-analysis of cohort studies. PLoS One. 2015, 10:e0125294. 10.1371/journal.pone.0125294
3. He Y, Omar M, Feng X, Neunaber C, Jagodzinski M: Impact of smoking on the incidence and post-operative complications of total knee arthroplasty: a systematic review and meta-analysis of cohort studies. Bosn J Basic Med Sci. 2022, 22:353-65. 10.17305/bjbms.2021.6538
4. Yue C, Cui G, Ma M, Tang Y, Li H, Liu Y, Zhang X: Associations between smoking and clinical outcomes after total hip and knee arthroplasty: a systematic review and meta-analysis. Front Surg. 2022, 9:970537. 10.3389/fsurg.2022.970537
5. McLaughlin J, Elsey J, Kipping R, Owen-Smith A, Judge A, McLeod H: Access to hip and knee arthroplasty in England: commissioners' policies for body mass index and smoking status and implications for integrated care systems. BMC Health Serv Res. 2023, 23:77. 10.1186/s12913-022-08999-9
6. National Institute for Health and Care Excellence: osteoarthritis in over 16s . (2022). Accessed: November 2, 2026: https://www.nice.org.uk/guidance/QS87/chapter/quality-statement-8-referral-for-consideration-of-joint-surgery.
7. Matharu GS, Mouchti S, Twigg S, Delmestri A, Murray DW, Judge A, Pandit HG: The effect of smoking on outcomes following primary total hip and knee arthroplasty: a population-based cohort study of 117,024 patients. Acta Orthop. 2019, 90:559-67. 10.1080/17453674.2019.1649510
8. Baethge C, Goldbeck-Wood S, Mertens S: SANRA-a scale for the quality assessment of narrative review articles. Res Integr Peer Rev. 2019, 4:5. 10.1186/s41073-019-0064-8
9. Dawson J, Fitzpatrick R, Carr A, Murray D: Questionnaire on the perceptions of patients about total hip replacement. J Bone Joint Surg Br. 1996, 78:185-90.

10. Dawson J, Fitzpatrick R, Murray D, Carr A: Questionnaire on the perceptions of patients about total knee replacement. J Bone Joint Surg Br. 1998, 80:63-9. 10.1302/0301-620x.80b1.7859
11. Harris K, Dawson J, Doll H, et al.: Can pain and function be distinguished in the Oxford Knee Score in a meaningful way? An exploratory and confirmatory factor analysis. Qual Life Res. 2013, 22:2561-8. 10.1007/s11136-013-0393-x
12. Harris WH: Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am. 1969, 51:737-55.
13. Insall JN, Dorr LD, Scott RD, Scott WN: Rationale of the Knee Society clinical rating system . Clin Orthop Relat Res. 1989, 248:13-4.
14. Scuderi GR, Bourne RB, Noble PC, Benjamin JB, Lonner JH, Scott WN: The new Knee Society Knee Scoring System. Clin Orthop Relat Res. 2012, 470:3-19. 10.1007/s11999-011-2135-0
15. Insall JN, Ranawat CS, Aglietti P, Shine J: A comparison of four models of total knee-replacement prostheses. J Bone Joint Surg Am. 1976, 58:754-65.
16. Nilsdotter AK, Lohmander LS, Klässbo M, Roos EM: Hip Disability and Osteoarthritis Outcome Score (HOOS)-validity and responsiveness in total hip replacement. BMC Musculoskelet Disord. 2003, 4:10. 10.1186/1471-2474-4-10
17. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD: Knee Injury and Osteoarthritis Outcome Score (KOOS)-development of a self-administered outcome measure. J Orthop Sports Phys Ther. 1998, 28:88-96. 10.2519/jospt.1998.28.2.88
18. Ergin M, Canbaz SB, Budin M, Terzi MM, Gehrke T, Citak M: Do smokers achieve the same clinically meaningful improvement after total hip arthroplasty?. Eur J Orthop Surg Traumatol. 2026, 36:340. 10.1007/s00590-026-04924-6
19. Davis AM, Perruccio AV, Canizares M, et al.: The development of a short measure of physical function for hip OA HOOS-Physical Function Shortform (HOOS-PS): an OARSI/OMERACT initiative. Osteoarthritis Cartilage. 2008, 16:551-9. 10.1016/j.joca.2007.12.016
20. Perruccio AV, Stefan Lohmander L, Canizares M, et al.: The development of a short measure of physical function for knee OA KOOS-Physical Function Shortform (KOOS-PS) - an OARSI/OMERACT initiative. Osteoarthritis Cartilage. 2008, 16:542-50. 10.1016/j.joca.2007.12.014
21. Lyman S, Lee YY, Franklin PD, Li W, Mayman DJ, Padgett DE: Validation of the HOOS, Jr: a short-form hip replacement survey. Clin Orthop Relat Res. 2016, 474:1472-82. 10.1007/s11999-016-4718-2
22. Validation of the KOOS, JR: a short-form knee arthroplasty outcomes survey: Validation of the KOOS, JR: a short-form knee arthroplasty outcomes survey. Clin Orthop Relat Res. 2016, 474:1461-71. 10.1007/s11999-016-4719-1
23. Couture A, Derefinko KJ, Ford MC, et al.: Smoking cessation and relapse effects on patient-reported outcomes after total knee arthroplasty. J Long Term Eff Med Implants. 2025, 35:71-5. 10.1615/JLongTermEffMedImplants.2025055608
24. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW: Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol. 1988, 15:1833-40.
25. Halawi MJ, Allen DA, Baron S, Savoy L, Williams VJ, Cote MP: Tobacco smoking independently predicts lower patient-reported outcomes: new insights on a forgotten epidemic. J Arthroplasty. 2019, 34:S144-7. 10.1016/j.arth.2018.10.036
26. Rose M, Bjorner JB, Gandek B, Bruce B, Fries JF, Ware JE Jr: The PROMIS Physical Function item bank was calibrated to a standardized metric and shown to improve measurement efficiency. J Clin Epidemiol. 2014, 67:516-26. 10.1016/j.jclinepi.2013.10.024
27. Hays RD, Bjorner JB, Revicki DA, Spritzer KL, Cella D: Development of physical and mental health summary scores from the patient-reported outcomes measurement information system (PROMIS) global items. Qual Life Res. 2009, 18:873-80. 10.1007/s11136-009-9496-9
28. Ware JE Jr, Sherbourne CD: The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care. 1992, 30:473-83.
29. Ware J Jr, Kosinski M, Keller SD: A 12-item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care. 1996, 34:220-33. 10.1097/00005650-199603000-00003
30. Herdman M, Gudex C, Lloyd A, et al.: Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). Qual Life Res. 2011, 20:1727-36. 10.1007/s11136-011-9903-x
31. Huskisson EC: Measurement of pain. Lancet. 1974, 2:1127-31. 10.1016/s0140-6736(74)90884-8
32. Saleh KJ, Mulhall KJ, Bershadsky B, Ghomrawi HM, White LE, Buyea CM, Krackow KA: Development and validation of a lower-extremity activity scale. Use for patients treated with revision total knee arthroplasty. J Bone Joint Surg Am. 2005, 87:1985-94. 10.2106/JBJS.D.02564
33. Goh GS, Tarabichi S, Baker CM, Qadiri QS, Austin MS: Should we aim to help patients "feel better" or "feel good" after total hip arthroplasty? Determining factors affecting the achievement of the minimal clinically important difference and patient acceptable symptom state. J Arthroplasty. 2023, 38:293-9. 10.1016/j.arth.2022.08.014
34. Goh GS, Baker CM, Tarabichi S, Clark SC, Austin MS, Lonner JH: The paradox of patient-reported outcome measures: should we prioritize "feeling better" or "feeling good" after total knee arthroplasty?. J Arthroplasty. 2022, 37:1751-8. 10.1016/j.arth.2022.04.017
35. Pasqualini I, Elmenawi KA, Khan ST, Hadad MJ, Piuzzi NS: Substantial clinical benefit thresholds for Hip Disability and Osteoarthritis Outcome Score subscales and associated risk factors for nonattainment after total hip arthroplasty: a prospective cohort study of 9,229 patients. J Arthroplasty. 2026, 41:2640-5. 10.1016/j.arth.2025.11.052
36. Jaeschke R, Singer J, Guyatt GH: Measurement of health status: ascertaining the minimal clinically important difference. Control Clin Trials. 1989, 10:407-15. 10.1016/0197-2456(89)90005-6
37. Tubach F, Ravaud P, Baron G, et al.: Evaluation of clinically relevant states in patient reported outcomes in knee and hip osteoarthritis: the patient acceptable symptom state. Ann Rheum Dis. 2005, 64:34-7.

10.1136/ard.2004.023028
38. Glassman SD, Copay AG, Berven SH, Polly DW, Subach BR, Carreon LY: Defining substantial clinical benefit following lumbar spine arthrodesis. J Bone Joint Surg Am. 2008, 90:1839-47. 10.2106/JBJS.G.01095
39. Hesseling B, Mathijssen NM, Van Steenbergen LN, Melles M, Vehmeijer SB, Porsius JT: Fast starters, slow starters, and late dippers: trajectories of patient-reported outcomes after total hip arthroplasty: results from a Dutch nationwide database. J Bone Joint Surg Am. 2019, 101:2175-86. 10.2106/JBJS.19.00234
40. Kuijpers MF, Van Steenbergen LN, Schreurs BW, Hannink G: Patient-reported outcome of 95% of young patients improves after primary total hip arthroplasty: identification of 3 recovery trajectories in 3,207 patients younger than 55 years from the Dutch Arthroplasty Register. Acta Orthop. 2022, 93:560-7. 10.2340/17453674.2022.3140
41. Beard DJ, Harris K, Dawson J, Doll H, Murray DW, Carr AJ, Price AJ: Meaningful changes for the Oxford hip and knee scores after joint replacement surgery. J Clin Epidemiol. 2015, 68:73-9. 10.1016/j.jclinepi.2014.08.009
42. Sabah SA, Alvand A, Beard DJ, Price AJ: Minimal important changes and differences were estimated for Oxford hip and knee scores following primary and revision arthroplasty. J Clin Epidemiol. 2022, 143:159-68. 10.1016/j.jclinepi.2021.12.016
43. Mohammad HR, Gooberman-Hill R, Delmestri A, et al.: Risk factors associated with poor pain outcomes following primary knee replacement surgery: analysis of data from the clinical practice research datalink, hospital episode statistics and patient reported outcomes as part of the STAR research programme. PLoS One. 2021, 16:e0261850. 10.1371/journal.pone.0261850
44. Khan LA, Cowie JG, Ballantyne JA, Brenkel IJ: The complication rate and medium-term functional outcome after total hip replacement in smokers. Hip Int. 2009, 19:47-51. 10.1177/112070000901900109
45. Yousef M, Zheng H, Yang W, Ayers DC: Predictive factors of pain and functional outcome 5 years following total hip arthroplasty: a prospective Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement cohort study. J Arthroplasty. 2024, 39:S105-11. 10.1016/j.arth.2024.02.050
46. Emara AK, Orr MN, Klika AK, McLaughlin JP, Molloy RM, Piuzzi NS: When is surgery performed? Trends, demographic associations, and phenotypical characterization of baseline patient-reported outcomes before total hip arthroplasty. J Arthroplasty. 2022, 37:1083-91.e3. 10.1016/j.arth.2022.02.063
47. Khan ST, Pasqualini I, Jin Y, Klika AK, Piuzzi NS: Readmission within 90 days after primary THA is associated with decreased improvement in 1-year patient-reported outcome measures and increased reoperation rates. Clin Orthop Relat Res. 2025, 483:1438-52. 10.1097/CORR.0000000000003429
48. Vega J, Emara AK, Orr M, Klika AK, Piuzzi NS: Demographic and socioeconomic determinants are associated with poor preoperative patient-reported pain and function in primary TKA: a cohort study of 14,079 patients. J Bone Joint Surg Am. 2023, 105:286-92. 10.2106/JBJS.22.00645
49. Sato EH, Stevenson KL, Blackburn BE, et al.: Impact of demographic variables on recovery after total hip arthroplasty. J Arthroplasty. 2024, 39:721-6. 10.1016/j.arth.2023.09.012
50. Kim BI, O'Donnell J, Wixted CM, Seyler TM, Jiranek WA, Bolognesi MP, Ryan SP: Smoking cessation prior to elective total joint arthroplasty results in sustained abstinence postoperatively. World J Orthop. 2024, 15:627-34. 10.5312/wjo.v15.i7.627
51. Rainey JP, Blackburn BE, Kapron CR, et al.: Stratified recovery curves for patient-reported outcomes after primary total knee arthroplasty. Arthroplast Today. 2026, 39:102002. 10.1016/j.artd.2026.102002
52. Omran K, Wixted C, Waren D, Rozell JC, Schwarzkopf R: Growth mixture modeling of patient-reported outcomes after total knee arthroplasty: no recovery trajectory shows postoperative decline or stagnation. J Am Acad Orthop Surg Glob Res Rev. 2025, 9:10.5435/JAAOSGlobal-D-25-00107
53. Baum G, Jacobs H, Lazovic D, Maus U, Hoffmann F, Seeber GH: The influence of obesity on functional outcomes and patient satisfaction 8 weeks after total knee arthroplasty: results of the prospective FInGK study. BMC Musculoskelet Disord. 2022, 23:949. 10.1186/s12891-022-05874-w
54. Parry D, Allen J, Henderson B, Kassab J, Hernandez E, Brindley G: The effect of tobacco use on clinical outcomes in total knee arthroplasty patients. Proc (Bayl Univ Med Cent). 2025, 38:171-4. 10.1080/08998280.2024.2441633
55. An X, Wang J, Shi W, et al.: The effect of passive smoking on early clinical outcomes after total knee arthroplasty among female patients. Risk Manag Healthc Policy. 2021, 14:2407-19. 10.2147/RMHP.S309893
56. Penrose CT, George SZ, Bolognesi MP, Bhavsar NA, Horn ME: Do you PROMIS (Patient Reported Outcomes Measurement Information System)? Physical function and pain interference scores after total knee and hip arthroplasty. Arthroplast Today. 2023, 23:101208. 10.1016/j.artd.2023.101208
57. Major EL III, Goetz JR, Stone HT, Hawk GS, Duncan ST, Selby JB: Impact of smoking status on early outcomes and healthcare utilization following primary total knee arthroplasty: a retrospective cohort study. J Arthroplasty. 2026, 10.1016/j.arth.2026.04.018
58. Issa K, Jauregui JJ, Given K, Harwin SF, Mont MA: A prospective, longitudinal study of patient activity levels following total knee arthroplasty stratified by demographic and comorbid factors. J Knee Surg. 2015, 28:343-7. 10.1055/s-0034-1388658
59. Hall JR, Metcalf R, Leisinger E, An Q, Bedard NA, Brown TS: Does smoking cessation prior to elective total joint arthroplasty result in continued abstinence?. Iowa Orthop J. 2021, 41:141-4.
60. Hennekes ME, Pang A, Raja HM, Rasheed H, Darrith B, North WT, Charters MA: Smoking cessation success: total joint arthroplasty as a powerful motivator. J Am Acad Orthop Surg. 2026, 34:e1288-95. 10.5435/JAAOS-D-25-00059
61. Ellis ST, Rao BM, Kohlrieser D, Kollmorgen RC, Sochacki KR: Validation of self-reported smoking status among orthopedic hip surgery patients. Cureus. 2020, 12:e10753. 10.7759/cureus.10753
62. Issa K, Rifai A, Boylan MR, Pourtaheri S, McInerney VK, Mont MA: Do various factors affect the frequency of manipulation under anesthesia after primary total knee arthroplasty?. Clin Orthop Relat Res. 2015, 473:143-7. 10.1007/s11999-014-3772-x
63. Patel S, Tran S, Overbey J, et al.: Risk factors for the need for manipulation under anesthesia following total knee arthroplasty: a systematic review and meta-analysis. J Arthroplasty. 2025, 40:2498-2509.e3. 10.1016/j.arth.2025.03.064

64. Knapp P, Weishuhn L, Pizzimenti N, Markel DC: Risk factors for manipulation under anaesthesia after total knee arthroplasty. Bone Joint J. 2020, 102-B:66-72. 10.1302/0301-620X.102B6.BJJ-2019-1580.R1
65. Van de Ven MP, Bongers J, Spekenbrink-Spooren A, Koëter S: Factors associated with arthrofibrosis-related revision following 14,325 total or unicompartmental knee arthro-plasties: an analysis from the Dutch Arthroplasty Registry. Acta Orthop. 2024, 95:607-11. 10.2340/17453674.2024.41988
66. Møller AM, Villebro N, Pedersen T, Tønnesen H: Effect of preoperative smoking intervention on postoperative complications: a randomised clinical trial. Lancet. 2002, 359:114-7. 10.1016/S0140-6736(02)07369-5
67. Koschmeder KT, Carender CN, Noiseux NO, Elkins JM, Brown TS, Bedard NA: What is the fate of total joint arthroplasty patients who are asked to quit smoking prior to surgery?. Arthroplast Today. 2023, 19:101087. 10.1016/j.artd.2022.101087
68. Rao BM, Moylan DD, Sochacki KR, Kollmorgen RC, Atwal L, Ellis TJ: Mandatory nicotine cessation for elective orthopedic hip procedures results in reduction in postoperative nicotine use. Cureus. 2020, 12:e12158. 10.7759/cureus.12158
69. Hart A, Rainer WG, Taunton MJ, Mabry TM, Berry DJ, Abdel MP: Smoking cessation before and after total joint arthroplasty: an uphill battle. J Arthroplasty. 2019, 34:S140-3. 10.1016/j.arth.2019.01.073
70. Good LM, Blackburn CW, Adelstein JM, Berk AN, Florentino SA, Jawanda HS, Cohen-Levy WB: What is the association between nontobacco nicotine dependence and postoperative complications in total hip arthroplasty? A large propensity-matched cohort study. Arthroplast Today. 2025, 34:101743. 10.1016/j.artd.2025.101743
71. Fuller Z, Chopra A, Thomas JJ, Oliver D, Fisher M, Abdo ZE: Increased postoperative complications in nontobacco nicotine users following total hip arthroplasty. J Arthroplasty. 2026, 41:2113-8.e1. 10.1016/j.arth.2025.10.032
72. DeShazo SJ, Crossnoe RC, Bailey LC, Rogers JM, Naeger PA: Non-tobacco nicotine dependence and rates of postoperative complications in total knee arthroplasty: a propensity-matched comparison. J Am Acad Orthop Surg. 2024, 32:1032-7. 10.5435/JAAOS-D-23-01053
73. Waters TL, Collins LK, Cole MW, Springer BD, Salas Z, Sherman WF: Smokeless tobacco use is associated with worse medical and surgical outcomes following total hip arthroplasty. J Arthroplasty. 2024, 39:441-7. 10.1016/j.arth.2023.05.041
74. Waters TL, Collins LK, Cole MW, Salas Z, Springer BD, Sherman WF: Smokeless tobacco use is associated with worse outcomes following total knee arthroplasty. J Arthroplasty. 2023, 38:1281-6. 10.1016/j.arth.2023.01.035
75. Bieganowski T, Singh V, Kugelman DN, Rozell JC, Schwarzkopf R, Lajam CM: Vaping trends and outcomes in primary total joint arthroplasty patients: an analysis of 21,341 patients. J Am Acad Orthop Surg Glob Res Rev. 2023, 7:10.5435/JAAOSGlobal-D-22-00110
76. Sørensen LT: Wound healing and infection in surgery: the pathophysiological impact of smoking, smoking cessation, and nicotine replacement therapy: a systematic review. Ann Surg. 2012, 255:1069-79. 10.1097/SLA.0b013e31824f632d
77. Petersen AM, Magkos F, Atherton P, et al.: Smoking impairs muscle protein synthesis and increases the expression of myostatin and MAFbx in muscle. Am J Physiol Endocrinol Metab. 2007, 293:E843-8. 10.1152/ajpendo.00301.2007
78. Mnatzaganian G, Ryan P, Reid CM, Davidson DC, Hiller JE: Smoking and primary total hip or knee replacement due to osteoarthritis in 54,288 elderly men and women. BMC Musculoskelet Disord. 2013, 14:262. 10.1186/1471-2474-14-262
79. Hannon CP, Goodman SM, Austin MS, et al.: The 2023 American College of Rheumatology and American Association of Hip and Knee Surgeons clinical practice guideline for the optimal timing of elective hip or knee arthroplasty for patients with symptomatic moderate-to-severe osteoarthritis or advanced symptomatic osteonecrosis with secondary arthritis for whom nonoperative therapy is ineffective. J Arthroplasty. 2023, 38:2193-201. 10.1016/j.arth.2023.09.003
80. Stephens G, Liloglou T, Moffatt M, Littlewood C: Do lifestyle factors affect patient reported clinical outcomes after total knee replacement surgery? A feasibility cohort study (PRO-Knee). PLoS One. 2025, 20:e0332953. 10.1371/journal.pone.0332953