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Road to Total Knee Replacement: Utilization of Knee Surgeries Up to Ten Years Before Total Knee Replacement in England and Sweden

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Objective. To compare the prevalence and timing of knee surgery (including meniscal, ligamentous, synovial, and osteotomy) in the 10 years prior to primary total knee replacement (TKR) between England and Sweden.

Methods. This was a population-based, case–control study within England and southern Sweden using electronic health care databases. Patients underwent primary TKR between 2015 and 2019. Risk-set sampling showed that general population controls matched 1:1 by age, sex, and practice/municipality. The annual prevalence and prevalence ratio of having at least 1 recorded surgery in each of the 10 years preceding TKR was estimated using Poisson regressions.

Results. We included 6,308 and 47,010 TKR cases in Sweden and England, respectively. Meniscal surgeries were the most frequent procedure prior to TKR in both countries; prevalence was higher in England across all time points. The prevalence of meniscal surgery increased in both countries in the years approaching TKR, reaching 33.2 (95% confidence interval [95% CI] 31.6–34.9) per 1,000 persons in England, and 9.83 (95% CI 7.66–12.61) in Sweden. In England, we observed a decrease from 2014 to 2018 in the utilization of this procedure in the 4 years preceding a TKR. The prevalence of all analyzed surgeries was consistently lower in controls.

Conclusion. There are comparable trends in the use of knee surgery in the years preceding TKR across England and Sweden. Of note, meniscal surgeries remain common, even within the year prior to TKR, highlighting that these patients may experience low-value care. Careful consideration of knee surgery in those with late-stage disease is required.

INTRODUCTION

Primary total knee replacement (TKR) is one of the most common orthopedic procedures in the world, performed in 95% of cases for end-stage osteoarthritis (OA) (1). In the UK alone, >100,000 TKRs are performed each year (2). Even though TKR is so common, there are no definitive and shared recommendations for the timing at which patients should be considered for TKR, potentially resulting in differences in referral patterns, for instance, by geographic area or the preferences of clinicians and patients (3–5). The National Institute for Health and Care Excellence (NICE) in England and the National Board of Health and Welfare (Socialstyrelsen) in Sweden describe a schematic care pathway commencing with a diagnosis of OA and proceeding through a holistic approach and self-management to core nonsurgical treatments (information, exercise, weight loss) and then a wide range of conservative and pharmacologic treatments (including adjuncts), along with a referral for consideration of joint surgery (6,7).

Studies have shown an underutilization of first-line interventions such as exercise and education in favor of pharmacologic and surgical management in the years preceding TKR (8,9).

The interpretation and conclusions herein are those of the authors alone.

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SIGNIFICANCE & INNOVATIONS

- Our comparative study showed that the utilization of knee surgery rises substantially 1–2 years prior to a primary total knee replacement (TKR) in both England and Sweden, 2 high-income countries with publicly funded health care systems.
- The trend showing higher utilization of knee operations near TKR was particularly evident for meniscus surgery, which is not recommended for the treatment of individuals with osteoarthritis or degenerative change. Stratified analyses showed a larger discrepancy in the prevalence of meniscus surgery between age groups in England, with higher prevalence in individuals age <65 years, suggesting a strong referral pattern.
- We highlighted a period effect signifying a decrease in the utilization of meniscal surgery in England from 2014 to 2018 exclusively in the 2 years prior to TKR. Despite this decrease, the trend of increased utilization in the year preceding TKR was still observable, and the prevalence in England was still higher than in Sweden.

Nevertheless, the use of arthroscopies in individuals with knee OA is not recommended due to a lack of evidence supporting its effectiveness in improving symptoms or reducing the rates of subsequent TKR (10,11). In contrast, multiple studies have shown an increased risk of structural progression and TKR after arthroscopic partial meniscectomy (12–15). In addition, recent reports have suggested that arthroscopies may negatively influence the subsequent joint replacement, including higher rates of complication, revision, and periprosthetic joint infection (16,17). Overall, arthroscopies have a yearly rate of progression to TKR of 2.6%, with this figure nearly doubling in cohorts age ≥65 years or in those with more severe OA (18). Considering this, the proportion of patients undergoing knee arthroplasty within 1 year of knee arthroscopy has previously been proposed as an indicator of potential overuse of knee arthroscopy in patients with OA (10). Thus, in light of the lack of shared decision rules guiding TKR referrals and evidence supporting the use of arthroscopies, more information regarding the management of individuals with OA is strongly needed.

International comparative studies offer precious insights into how patients are managed in different health care systems, permitting opportunities to compare and contrast the care of patients. England and Sweden are 2 high-income countries with publicly funded health care systems where health care for OA, including surgery, prescribed drugs, and physical therapy, are free of charge or, as is the case in Sweden, requires a contribution from the patient that can reach up to a maximum of 1,200 Swedish Krona (equivalent to ~$120) a year (19). Previous literature suggests a lower rate of arthroscopies in Sweden than in other European countries including England (10,20,21), although it remains unclear whether this trend is also seen in patients who undergo TKR. Establishing aspects of management that differ between countries may suggest that change is not only required but may be feasible to implement. In this study, we aimed to investigate the prevalence pattern of common knee surgeries in the 10 years prior to TKR, comparing England to Sweden and also to the general population of individuals who do not undergo TKR.

MATERIALS AND METHODS

Study design and data source. This was a multinational, population-based, case–control study. The study was set within English and Swedish health care databases. Sweden and England are 2 European countries with similar health system structures; both countries provide free health care at the point of use, funded via taxation (see Supplementary Table 1, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). Furthermore, while both countries have subtle differences in the recording of information, both provide comprehensive data available for analysis and comparable rates of TKR and OA management strategies (22).

In Sweden, we used 3 registers comprising the entire population of Skåne, the southernmost region in Sweden with ~1.4 million inhabitants (13% of the total Swedish population as of December 2020) (23). From the Swedish Population Register, we retrieved data on age, sex, residential address, and deaths, while individual-level data on income, education, marital status, and country of birth were retrieved from the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA, by Swedish acronym). Last, from the Skåne Healthcare Register we extracted information about diagnoses provided at health care visits to a physician. Data from the 3 registers were linked using patients' pseudo-anonymized personal unique identification number, which is assigned to all residents in Sweden by the Swedish Tax Agency. In England, anonymized data of patients newly undergoing TKR and with linkage consent to Hospital Episode Statistics (HES) Admitted Patient Care (APC) were extracted from the Clinical Practice Research Datalink's (CPRD) Aurum and HES APC data. The CPRD Aurum database includes routinely collected primary care data from general practices using the EMIS software system and at the time of extraction included data on 23.1 million patients, of which 2.5 million were active (24). Surgical procedures in the study period prior to TKR were identified using Office of Population Censuses and Surveys Classification of Surgical Operations and Procedures (OPCS) codes, extracted from the HES APC database (25,26).

The study was approved by the regional ethical review board in Lund, Sweden, and scientific and ethical approval was received for use of CPRD data in England from the Independent Scientific Advisory Committee (ISAC; protocol 20_000099). We reported the study according to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines (27).

This study (ISAC reference: 20_000099) is based in part on data from the CPRD obtained under license from the UK Medicines and Healthcare Products Regulatory Agency. The data are provided by patients and collected by the National Health Service as part of their care and support. We used anonymized data on individual patients, on which the analysis, results, and conclusions reported in this study are based. The CPRD data are not distributable under license. However, the relevant data can be obtained directly from the agency (https://www.cprd.com/). Data from Sweden can be obtained directly from the agency (https://www.skane.se).

Case definition. International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) codes and Klassifikation av vårdåtgärder (KVÅ) codes in Sweden and Medcodes (coded using a combination of Systematized Nomenclature of Medicine Clinical Terms [SNOMED CT; UK edition] and Read codes) in England were used to identify subjects ages ≥45 years who underwent primary TKR between January 1, 2015 and December 31, 2019 (code lists available in Supplementary Table 2, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). To be eligible for inclusion in both England and Sweden, subjects had to be registered in the health care database for a minimum of 10 years prior to their TKR (i.e., index date). To reduce the inclusion of subjects with prevalent TKR, those who received a TKR between 2000 and 2014 were excluded.

Control definition. Population controls were selected to establish the overall prevalence of surgery in the general population. One control for each case was randomly selected, matched by 5-year age strata (45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and ≥85 years), sex, and general practice (in England) or residential area (in Sweden). We selected controls using risk set–sampling, resulting in controls having equivalent risk-free time compared to matched cases (28). Controls were assigned the same index date as their 1:1 matched cases (or the last day of the index year identical to that of corresponding cases in the UK) and, as cases, had no primary TKR within the 10-year lookback period.

Exposure definition. OPCS codes in England and ICD-10 codes in Sweden were used to identify meniscal, ligamentous (e.g., reconstruction, suture, transposition, incision), and synovial (i.e., synovectomy) knee surgeries as well as knee osteotomy (see Supplementary Tables 3–7, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). Moreover, we analyzed all knee surgeries in combination to explore the overall cumulative trend. Finally, we used total hip replacement (THR) as a control exposure to assess possible differences in knee procedures prior to TKR explained by different attitudes and approaches to surgery between Sweden and England.

Patient characteristics/covariates. Besides the matched variables (age, sex, and practice/region), index year, presence of common comorbidities (cardiovascular diseases, cancer, and diabetes mellitus), as well as lower back pain, and other musculoskeletal disorders (all musculoskeletal disorders except OA in the English data and knee OA in the Swedish data) were presented to allow comparisons between cases and controls. Comorbidities were defined by the presence of codes in patients' health records throughout the 10-year study period. Codes for comorbidities had been previously developed and used in prior studies (22).

Statistical analysis. Contingency tables were generated for both populations to describe the frequency of cases and controls by sex, age-stratification, and index year. Yearly prevalence with 95% confidence intervals (95% CIs) of having at least 1 recorded meniscal surgery, ligament surgery, synovial surgery, osteotomy, any knee surgery and THR overall and in each of the 10 years preceding TKR was estimated using Poisson regression models and presented as the number of surgeries per 1,000 people. For single procedures with an overall prevalence >200 over the study time, we estimated the overall prevalence ratio (PR) between cases and controls (reference group: prevalence in the control group) and period effects on prevalence in cases and controls based on the year of TKR (2015 to 2019), age group at the time of index date, and sex.

RESULTS

We identified 6,308 and 47,010 subjects who received a TKR between 2015 and 2019 in southern Sweden and England, respectively (Table 1). In both countries, the age and sex distributions were similar, and the annual number of new primary TKR cases remained stable throughout the study period. The comorbidity profile among cases and controls was also similar with the exception of musculoskeletal conditions, including back pain and OA in other joints, that were more common among cases. In Sweden, the prevalence of cardiovascular disease, cancer, and depression in both cases and controls was higher than in England.

Overall, knee surgeries in the 10 years prior to TKR among cases were more commonly performed in England (prevalence 19.62 [95% CI 19.23–20.03] per 1,000 persons) than in Sweden (prevalence 10.1 [95% CI 9.4–10.9]) (Table 2). Meniscal surgeries were the most common knee procedure performed in cases in the 10 years prior to TKR in both countries, but overall proportion among cases was >3 times higher in England (18.4 [95% CI 18.04–18.81]) than in Sweden (5.8 [95% CI 5.3–6.5]). Among

Table 1. Basic demographic data and number of surgeries in cases and controls*

Variables	Sweden Cases (n = 6,308)	Sweden Controls (n = 6,308)	England Cases (n = 47,010)	England Controls (n = 47,010)
Age, mean ± SD years	69.0 ± 8.9	68.9 ± 9.1	69.6 ± 9.6	69.6 ± 9.6
<65 years	1,993 (31.6)	1,978 (31.4)	19,954 (42.4)	19,954 (42.4)
≥65 years	4,315 (68.4)	4,330 (68.6)	27,091 (57.6)	27,091 (57.6)
Female	3,618 (57.3)	3,618 (57.3)	26,154 (55.6)	26,154 (55.6)
TKR performed by year				
2015	1,165 (18.5)	–	9,160 (19.5)	–
2016	1,254 (19.9)	–	9,442 (20.0)	–
2017	1,306 (20.7)	–	9,751 (20.7)	–
2018	1,273 (20.2)	–	9,189 (19.5)	–
2019	1,310 (20.8)	–	9,468 (20.1)	–
Surgeries†				
Any knee surgery	639 (10.1)	55 (0.9)	9,225 (19.6)	879 (1.9)
Meniscus	368 (5.8)	33 (0.5)	8,659 (18.0)	833 (1.8)
Ligaments	17 (0.3)	2 (<0.1)	90 (0.1)	11 (<0.1)
Synovial	158 (2.5)	11 (0.2)	369 (0.8)	30 (0.00)
Osteotomy	96 (1.5)	9 (0.1)	107 (0.2)	5 (<0.1)
Hip replacement	553 (8.8)	303 (4.8)	3,933 (8.4)	1,889 (4.0)
Comorbidities				
Cancer	1,183 (18.8)	1,159 (18.7)	4,514 (9.6)	5,148 (10.9)
Cardiovascular	1,315 (20.8)	1,400 (22.6)	5,022 (10.2)	5,738 (11.7)
Diabetes mellitus	897 (14.2)	883 (14.3)	6,710 (14.3)	6,828 (14.5)
Depression	1,016 (16.1)	907 (14.7)	5,365 (11.4)	4,505 (9.6)
Other OA	2,776 (44.0)	1,141 (18.5)	20,543 (43.7)	5,849 (12.4)
Back pain	2,176 (34.5)	1,581 (25.6)	18,321 (38.9)	14,498 (30.8)
Other MSK conditions	5,463 (86.6)	4,192 (67.8)	37,922 (80.6)	29,264 (62.2)

* Values are the number (%) unless indicated otherwise. MSK = musculoskeletal; OA = osteoarthritis; TKR = total knee replacement.
† Total number of surgeries per group during the whole study period; an individual may have received >1 surgery of the same type.

the case group, the prevalence of ligament surgery was similar in the 2 countries, while synovial surgery and osteotomy were more common in Sweden. The prevalence of all analyzed surgeries was consistently lower among controls. Nevertheless, knee surgeries were more common among controls in England than in Sweden. PRs were thus comparable between Sweden and England for all the analyzed surgeries.

Among cases, temporal trends showed a similar prevalence of knee surgeries up to 7 years before TKR, when the prevalence in England began to increase (Figure 1 and Supplementary Table 8, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). In Sweden, the prevalence of surgeries appeared stable throughout the study time, only to increase in the last year before TKR. Similarly, meniscal surgery was more prevalent in England than in Sweden throughout the studied period, with a >2-fold increase in prevalence in the 3 years prior to TKR, increasing from 16.1 (95% CI 15.0–17.3) to 33.2 (95% CI 31.6–34.9) surgeries per 1,000

Table 2. Overall prevalence of surgeries per 1,000 people >10 years preceding total knee replacement*

Surgery	Sweden Cases, prevalence (95% CI)	Sweden Controls, prevalence (95% CI)	Sweden Prevalence ratio (95% CI)†	England Cases, prevalence (95% CI)	England Controls, prevalence (95% CI)	England Prevalence ratio (95% CI)†
Any knee surgery	10.13 (9.37–10.95)	0.87 (0.67–1.14)	11.6 (8.8,15.3)	19.62 (19.23–20.03)	1.87 (1.75–2.00)	11.7 (10.9–12.5)
Meniscus	5.83 (5.27–6.46)	0.52 (0.37–0.74)	11.2 (7.8–15.9)	18.42 (18.04–18.81)	1.77 (1.66–1.90)	11.4 (10.7–12.2)
Ligaments	0.27 (0.17–0.43)	0.03 (0.01–0.13)	8.5 (2.0–36.8)	0.19 (0.16–0.24)	0.02 (0.01–0.04)	11.6 (6.3–21.5)
Synovial	2.50 (2.14–2.93)	0.17 (0.10–0.31)	14.4 (7.8–26.5)	0.78 (0.71–0.87)	0.06 (0.04–0.09)	16.9 (11.9–24.0)
Osteotomy	1.52 (1.25–1.86)	0.14 (0.07–0.27)	10.7 (5.4–21.1)	0.23 (0.19–0.28)	0.01 (0.00–0.03)	19.7 (8.7–44.7)
THR	8.77 (8.07–9.53)	4.80 (4.29–5.38)	1.8 (1.6–2.1)	8.37 (8.11–8.63)	4.02 (3.84–4.20)	2.3 (2.2–2.4)

* 95% CI = 95% confidence interval; THR = total hip replacement.
† Controls are used as the reference, with numbers >1 indicating a higher prevalence among the cases.

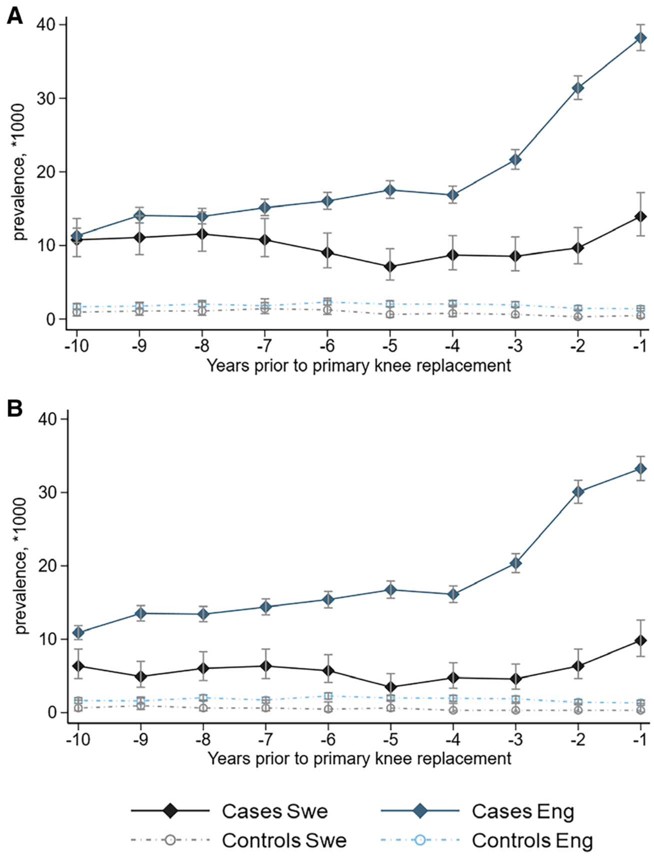

Figure 1. Prevalence of knee surgeries in the 10 years prior to total knee replacement for any knee surgery (**A**) and meniscus surgery (**B**). Eng = England; Swe = Sweden. Error bars show 95% confidence intervals.

people. In Sweden, the prevalence of meniscal surgery fluctuated between 3.5 (95% CI 2.3–5.3) and 6.3 (95% CI 6.6–8.6) surgeries per 1,000 people until the last year prior to TKR, when the prevalence increased to 9.8 (95% CI 7.7–12.6) surgeries per 1,000 people. Among controls, no trend was detectable throughout the study time in England or Sweden, although the prevalence of meniscus surgery was higher in England at most time points.

Osteotomy, synovial, and ligament surgeries were much less frequent than meniscal surgery. Due to the low number of procedures, we were not able to estimate the prevalence of osteotomy and ligament surgeries in the 10 years prior to TKR. Synovial surgery had a higher prevalence in Sweden. Nevertheless, a temporal trend with an increase in prevalence in the last year before TKR was detectable in both countries (see Supplementary Table 9, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). Due to the low number of procedures, we were not able to estimate the prevalence of osteotomy, ligament, and synovium surgeries stratified by calendar year (2015–2018) age group, or sex.

Overall, the PR for having received any knee surgery increased from 11.6 (95% CI 5.0–26.7) to 29.9 (95% CI 9.4–94.4), and from 6.7 (95% CI 5.3–8.4) to 26.8 (95% CI 21.0–34.2), 1–10 years before the index date in Sweden and England, respectively (see Supplementary Table 10 and Supplementary Figure 1, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). The PR for having received meniscal surgery followed the same pattern, as meniscal surgeries were the most common knee procedures reported prior to TKR. The PR of having received a THR increased from 1.2 (95% CI 0.7–2.0) to 2.9 (95% CI 2.0–4.2) in Sweden, whereas it increased from 1.5 (95% CI 1.2–1.9) to 4.3 (95% CI 3.7–5.0) in England (see Supplementary Table 11, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). Analyses stratified by age, calendar year, and sex were performed only for meniscal surgery (the most frequent type of surgery). In both countries, age had a strong influence on prevalence of meniscal surgery prior to TKR (Figure 2). Among individuals age <65 years, the prevalence of meniscal surgery in Sweden remained relatively stable over the study time (see Supplementary Table 12, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). In England, the prevalence at the beginning of the study time was similar to that in Sweden. However, over the 10-year period leading up to TKR, the risk of meniscal surgery increased 3-fold, peaking 2 years before TKR and remaining stable through the last year. Among individuals age ≥65 years, similar trends characterized by an increase in prevalence in the last year prior to TKR were observed in both countries. The prevalence of meniscal surgery in men and women in Sweden was similar throughout the study time (see Figure 3 and Supplementary Table 13, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). In England, men had a higher prevalence of meniscal surgeries 10 years before TKR (men 14.05 [95% CI 12.53–15.75], women 8.37 [95% CI 7.33–9.56]). This difference decreased up to 5 years before TKR, when differences in the prevalence of this procedure were no longer detectable. The pattern of surgery for each calendar year followed what was observed in the main analysis (Figure 4). Only in England could we detect a period effect showing a decrease in the utilization of meniscal surgery from 2014 to 2018 exclusively in the 2 years prior to TKR.

The prevalence of THR was similar in England and southern Sweden overall and at all time points, showing an increase most noticeable in the 3 years before TKR (see Supplementary Table 14, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). In both countries, THR was more commonly performed in individuals age ≥65 years, within which group the above temporal trend was more marked (see Supplementary Figure 2, available on the *Arthritis Care & Research* website at http://onlinelibrary.

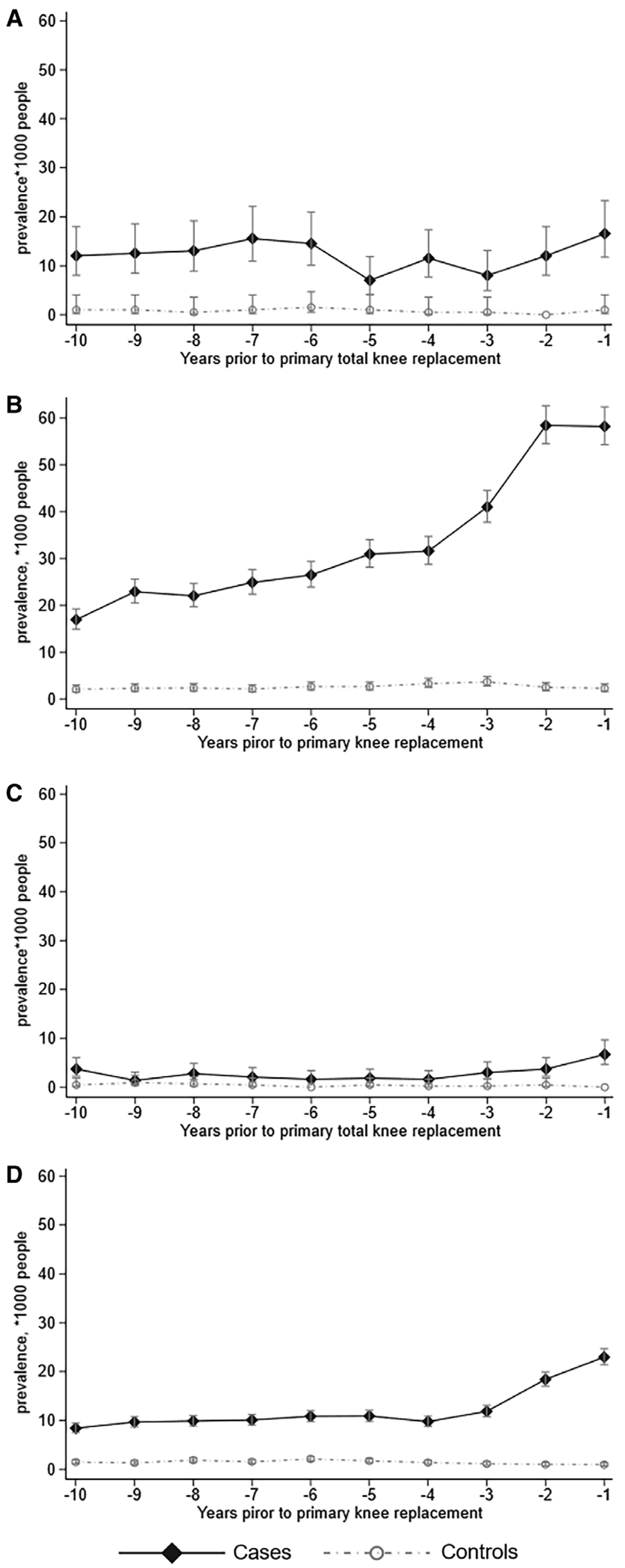

Figure 2. Prevalence of meniscus surgery in the 10 years prior to primary total knee replacement in Sweden and England, stratified by age group, for patients age <65 years in Sweden (**A**), <65 years in England (**B**), ≥65 years in Sweden (**C**), and ≥65 years in England (**D**). Error bars show 95% confidence intervals.

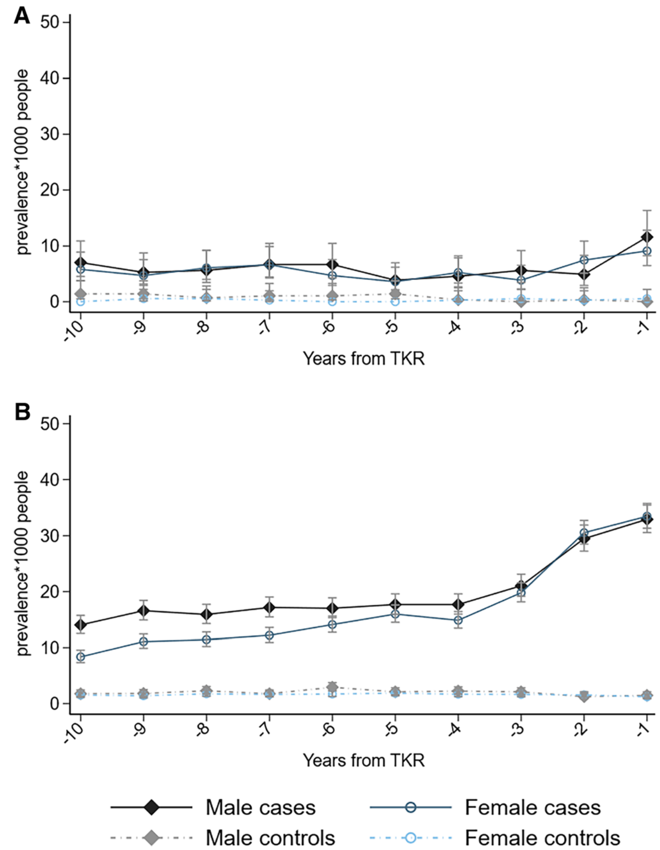

Figure 3. Prevalence of meniscus surgery in the 10 years prior to total knee replacement (TKR), stratified by sex in Sweden (**A**) and England (**B**). Error bars show 95% confidence intervals.

wiley.com/doi/10.1002/acr.25033). Prevalence of THR in men and women was similar throughout follow-up in both countries (see Supplementary Table 15 and Supplementary Figure 3, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25033). Nevertheless, in England, women showed a higher prevalence of THR 2–4 years prior to TKR.

DISCUSSION

Our comparative study, set within 2 high-income countries with publicly funded health care systems, shows that the likelihood of undergoing a knee operation rises substantially 1–2 years prior to a primary TKR. This trend was particularly evident for meniscus surgery. Moreover, stratified analyses showed a larger discrepancy in the prevalence of meniscus surgery between age groups in England, with higher prevalence in individuals age <65 years and a period effect signifying a decrease in the utilization of meniscal surgery in England from 2014 to 2018, exclusively in the 2 years prior to TKR.

These findings may have different interpretations depending on the type of surgery considered. Meniscus surgery was the

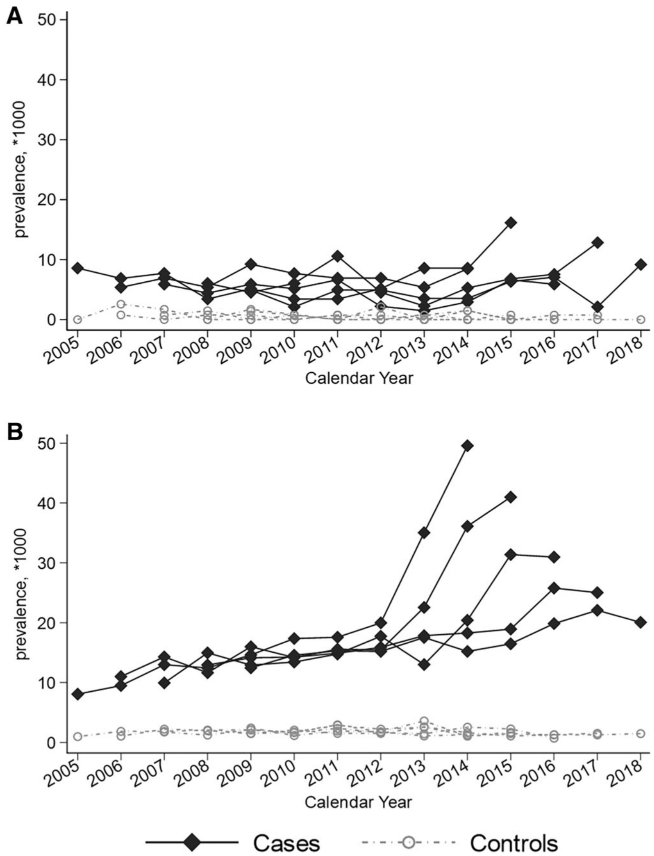

Figure 4. Prevalence of meniscus surgery for each calendar year by index year (year of primary total knee replacement) in Sweden (**A**) and England (**B**). Error bars show 95% confidence intervals.

most common knee procedure performed in both countries in the 10 years prior to TKR. Knee arthroscopies have been shown to be unable to slow the progression of OA or delay joint replacement and may even have a negative impact (12–15,29,30). There is also considerable controversy regarding the utilization of knee arthroscopy in patients with degenerative changes in the knee, as studies have shown no benefit compared to physical therapy or placebo/sham procedures (11,31). With prior studies demonstrating that close to 10% of patients undergoing arthroscopy underwent TKR within 1 year (10,29), it is reasonable to scrutinize the use of such procedures in patients with degenerative disease. Our findings further reinforce this conclusion.

It could be argued that the use of arthroscopic surgery in younger subjects may be advisable if they are able to postpone TKR, although evidence of the clinical benefits, even in these age groups, is scarce (32,33). This may explain the higher prevalence of meniscal surgery in patients age <65 years, a trend particularly noticeable in England. A further reason for meniscal surgery may be acute knee injury. While previous reports have suggested that arthroscopies performed due to injury progress less often and more slowly to TKR than those performed due to OA (34,35), we were not able to assess the reason for which the meniscus surgery was performed due to coding limitations. Nonetheless, we would expect that only a minority of subjects would undergo rapid joint degeneration progressing to TKR within a few years from an injury, which is in line with previous evidence (36). Finally, with advances in other diagnostic modalities, such as magnetic resonance imaging, it is unlikely that the arthroscopic procedures prior to TKR were performed for diagnostic purposes, particularly in recent years.

Interestingly, the pattern of meniscus surgery in England was strongly influenced by the calendar year in which the TKR was performed. The observed pattern shows a decrease from 2014 to 2018 in the utilization of meniscus surgery in the 4 years preceding a TKR. The observed reduction may coincide with growing high-quality evidence showing a lack of clinical improvement and cost-effectiveness of arthroscopies performed to treat degenerative meniscal pathology (11,31,33,37,38). While this decrease is reassuring, the use of meniscal surgery remains higher than in Sweden. This may suggest that England is lagging behind Sweden, where utilization of meniscal surgery in OA patients has been shown to be lower than in other countries (21).

In 2012, the Swedish Board of Health and Welfare issued the first national guideline containing recommendations against the use of arthroscopies in individuals with OA or degenerative meniscal lesions, which resulted in a 29% and 35% reduction in knee arthroscopies, respectively (20). In addition, the observed differences may potentially reflect the efficacy of nationally implemented management approaches focusing on exercise and education as first-line interventions for patients with OA in Sweden (39–41). Despite more conclusive evidence being needed, this exercise intervention has been found to be associated with a reduction in an individual's willingness to undergo surgery, while a similar exercise program has been shown to be able to delay TKR up to 2 years in individuals on a waiting list for the procedure (1,42–44). This temporal trend seems to justify our hypothesis that many of the observed arthroscopies performed shortly before a TKR may have been inappropriate. Finally, the PR between cases and controls was similar in Sweden and England, both overall and for each of the years preceding TKR. The large confidence intervals associated with the estimates from Sweden make interpretation of these findings challenging. Nevertheless, the similar PR together with the higher prevalence of procedures in both cases and controls in England seem to suggest that the observed trend of utilization of surgical procedure may not be specific for OA but rather reflects an overall higher use.

The prevalence of ligament and synovial surgeries, as well as osteotomy, was rare in the 10 years prior to a TKR. These findings suggest that these surgeries are not part of the management process of individuals with OA nearing TKR. This is not surprising for ligament surgery, which is more often performed after an injury, which we expect to be less common in individuals age ≥45 years. Synovial surgery was more common than osteotomy and ligament surgery, especially in Sweden. Conditions of the synovium (e.g., synovial plica syndrome, synovitis) can cause knee pain. Nevertheless, their surgical management is debated, which may explain the relatively low prevalence. Osteotomy, on the other hand, is a major surgical procedure used to reestablish correct biomechanics in case of important deformities or misalignment of the lower limb (45). For this reason, osteotomy is also a relatively rare procedure, and thus the observed prevalences appear compatible with its indication.

The comparable prevalence of THR between England and Sweden suggests a similar approach to OA surgery of the lower limb and serves to reinforce the observed trends in knee procedures as being due to differences in management rather than general attitudes to surgical intervention. OA is known to affect multiple joints, thus it is not surprising that patients received a THR in the 10 years prior to TKR.

Other factors that may influence the observed prevalence of surgery are patient preference and expectations. Reports have shown a patient's willingness to undergo surgery to be the strongest predictor of TKR, more so than pain or disability (46). Furthermore, patients willing to undergo surgery appear to experience less improvement after undergoing exercise for OA (42,47). In this context, it is possible that patients undergoing surgery (either THR or meniscus surgery) become more familiar and comfortable with the process of undergoing surgical therapy and may be more inclined to undergo TKR, potentially influencing the referral process and explaining the close occurrence of surgeries. On the other hand, patients who feel less ready to undergo a major surgery such as TKR may request arthroscopy in the hope of avoiding or delaying the replacement of the joint.

There are some notable limitations in the current study. In the English data set, we were unable to restrict TKR cases to those being performed for knee OA, but such misclassification would affect <3% of cases. Established code lists for TKR in England include joint resurfacing, but again this is unlikely to influence results. Similarly, we could not attribute the reason for the other surgeries analyzed in this study. Despite the extensive work done to match diagnostic and surgical codes between Sweden and England, differences in the way surgeries are coded and recorded may have influenced the results. Another important limitation was the inability to match the surgeries to the knee that underwent TKR. This implies that the prevalence of surgeries performed on the knee receiving TKR may be lower than estimated. Nevertheless, we expect most of the surgery to be performed in the most symptomatic knee, which is the one receiving a primary TKR. Further, even the surgeries performed on the contralateral knee are part of the patient's experience prior to TKR and contribute to the disease burden, especially when comparing with the controls from the general population. Limited by study design, other individual-level confounders (such as injury or psychological disorders) were not further investigated, as this study was aimed to describe prevalence patterns at a population level.

In conclusion, overall, we observed a higher prevalence of meniscus surgery and THR when nearing a primary TKR, while ligament and synovial surgeries, as well as osteotomy, were rare and stable over the study time. In both Sweden and England, the risk of meniscal surgery increases in the years leading up to TKR, particularly for patients age <65 years. Although decreasing over time, the prevalence of meniscal surgery within 12 months prior to TKR (a proposed indicator of low-value care) was higher in England than in Sweden. These differences in meniscus surgery were in stark contrast to the close similarities observed for patterns of THR prior to TKR. Our findings reinforce the need for continued efforts, particularly in England, to reduce low-value meniscus surgery, including providing access to cost-effective alternatives.

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All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Dell'Isola had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
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