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Rates of knee arthroplasty within one-year of undergoing arthroscopic partial meniscectomy in England: temporal trends, regional and age-group variation in conversion rates

1. S.G.F. Abram, MRCS[1]
2. A. Judge, PhD[1, 2]
3. D.J. Beard, DPhil[1]
4. A.J. Price, DPhil[1]

Author affiliations:

[1]NIHR Biomedical Research Centre, Oxford & Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford

[2]NIHR Biomedical Research Centre, Bristol & Musculoskeletal Research Unit, University of Bristol

Author titles:

SA: NIHR Doctoral Research Fellow
AJ: Professor of Translational Statistics
DB: Professor of Musculoskeletal Sciences
AP: Professor of Orthopaedics

Corresponding author:

Simon Abram

E: simon.abram@ndorms.ox.ac.uk

T: 01865 223425

Botnar Research Centre, University of Oxford

Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences

Windmill Road, Oxford OX3 7LD. UK

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ABSTRACT

OBJECTIVE

The aim of this study was to determine the proportion of patients undergoing arthroscopic partial meniscectomy (APM) then subsequently receiving a knee arthroplasty within one or two years, with focus on patients over the age of 60 years and regional variation.

METHODS

Patients undergoing APM in England over 20-years (01-April-1997 to 31-March 2017) were identified in the national Hospital Episode Statistics. The proportion of patients undergoing arthroplasty in the same knee within one or two years of APM was determined and trends were analysed over time nationally and by NHS Clinical Commissioning Group (CCG) region.

RESULTS

806,195 APM patients were eligible for analysis with at least one-year of follow up and 746,630 with two-years. The odds of arthroplasty conversion within one year increased over the study period (OR 3.10 within 1-year in 2014 versus 2000; 95% CI 2.75-3.50). For patients undergoing APM aged 60 years or older in 2015-16, 9.9% (1689/17043; 95% CI 9.5-10.4) underwent arthroplasty within 1-year and, in 2014-15, 16.6% (3100/18734; 95% CI 16.0-17.1) underwent arthroplasty within 2-years. There was greater than 10-fold variation by CCG.

CONCLUSIONS

Over the study period, the proportion of patients undergoing arthroplasty within one-year of APM increased. In 2015-16, of patients aged sixty years or older who underwent APM, 10% subsequently underwent knee arthroplasty within one year (17% within two years in 2014-15) and there was a high level of regional variation in this outcome. The development and adoption of national treatment guidance is recommended to improve and standardise treatment selection.

INTRODUCTION

Meniscal tears are common and strongly associated with knee osteoarthritis.[1] More than 60% of patients with radiographic osteoarthritis have a meniscal tear detectable on magnetic resonance imaging (MRI).[1] Many of these meniscal tears are asymptomatic but when a meniscal tear is considered the cause of symptoms, arthroscopic partial meniscectomy (APM) may be recommended to excise the unstable meniscal tissue.[1–4] Recent clinical trials published between 2007 and 2016 have challenged the effectiveness of APM for the treatment of meniscal tears in some patient groups.[5–13] These trials had a number of limitations but the findings broadly suggest that APM is less effective in patients with osteoarthritis in comparison to those without osteoarthritis.[14] In response to the publication of this high-level evidence and guidelines, a change in treatment selection would be anticipated and, indeed, there has been some decline in the rate of APM since 2013 in England, although APM is still one of the most commonly performed types of orthopaedic surgery, worldwide.[15–17] In England, APM surgery was most commonly performed in the 40-59-year and 60-79-year age groups in 2016-17 and the rate of intervention in these age groups increased considerably over the preceding 20-years.[15]

The proportion of patients undergoing knee arthroplasty within a year of knee arthroscopy has previously been proposed as one indicator of potential overuse of knee arthroscopy in patients with osteoarthritis, however this has not been evaluated specifically for APM.[18] Knee arthroplasty may be considered the undesirable outcome of end-stage symptomatic osteoarthritis and, in the context of APM surgery, may indicate that APM was performed in a patient with already advanced osteoarthritis, or that the outcome following APM was characterised by rapidly progressive osteoarthritis. An understanding of the rates and variation in this outcome was required to inform the development of new national society led treatment guidance in this population and also of importance to health commissioners and the NHS Getting It Right First Time (GIRFT) Programme.[19]

The purpose of this study was to investigate the proportion of patients undergoing knee arthroplasty within 1-year or 2-years of APM in England between 1997/98 and 2016/17. Specific focus is given to patients undergoing APM over the age of sixty years who may be at greater risk of subsequent knee arthroplasty, and to investigating other patient-specific prognostic factors associated with this undesirable outcome. Trends and regional variation in practice are analysed and discussed.

METHODS

Data source

National Hospital Episode Statistics (HES) data, which contains a record of all patient attendances at NHS hospitals in England, was obtained from NHS Digital (application DARS-NIC-68703).[20] HES includes episodes of care delivered in treatment centres (including those in the independent sectors) funded by the NHS, episodes of care in England where patients are resident outside of England, and privately funded patients treated within NHS England hospitals only. The data is submitted by hospital trusts for financial remuneration for treatment delivered, including surgical procedures. HES includes codes for each hospital treatment episode including patient demographics, region of patient residence and hospital treatment, diagnoses (including comorbid conditions), procedures, area deprivation, rurality, and patient ethnicity

Participants

All patients undergoing APM between 1 April 1997 and 31 March 2017 were identified. Patients undergoing concurrent intra-articular ligament reconstruction were excluded. For patients undergoing multiple APMs, the 'index' APM procedure for analysis was defined as the latest APM. Episodes were identified from the Classification of Surgical Operations and Procedures (OPCS-4) codes in the procedure fields within the HES data (see Appendix 1 for OPCS code list).[21] All prior and subsequent hospital episodes were identified for each of these patients and any subsequent knee arthroplasty (total or partial) in the same knee (using the OPCS-4 laterality codes) was identified.

Outcomes

The primary outcome analysed was arthroplasty (partial or total, in the same knee) within 1 year or 2 years of the index APM. Secondary outcomes investigated were variation in the proportion of APM patients undergoing subsequent knee arthroplasty over time, by age-group and other patient factors, and NHS Clinical Commissioning Group (CCG) region where the APM was performed. In England, CCGs were created as part of the Health and Social Care Act 2012, replacing Primary Care Trusts in April 2013, and are now responsible for healthcare provision in their local area.[22]

Statistical analysis

Stata v15.1 (StataCorp, College Station, Texas, USA) was used to perform all statistical analysis. In accordance with ONS and NHS Digital guidance, rates where the number of events was less than six were suppressed.[23] Cases with date errors or missing the side of intervention were excluded. The percentage of the total number of APMs in each group undergoing arthroplasty was analysed and reported with descriptive statistics (proportion and corresponding 95% confidence interval). Sensitivity analysis was performed analysing the 1-year outcome by age group for first APM by patient excluding prior procedures, in comparison to the primary results for the most recent APM per patient (no material difference in results). Trends in this outcome were analysed over time.

Logistic regression modelling was used to first determine the unadjusted odds of undergoing knee arthroplasty (within 1-year or 2-years) following APM by age, sex, year of treatment, modified Charlson co-morbidity index (Summary Hospital-level Mortality Indicator Specification; derived with maximum 5-year diagnosis code lookback period),[24–26] index of multiple deprivation (quintile derived from regional factors in England including average income, employment, education, housing, and crime; 1=least deprived area, 5=most deprived), rurality, and ethnicity. These variables were then included together in the model to calculate adjusted odds ratios.

The CCG of treatment (for the index APM) recorded in HES was used to determine the overall rate of arthroplasty following APM by the CCG delivering the APM. A Geographic Information System, QGIS v3.0 (qgis.org), was used to graphically summarise these rates on a map of England, using the April 2017 CCG boundaries.[27]

Patient involvement

Patients were involved in the conception of this study, providing feedback on the concept of the investigation as part of an ongoing research programme (National Institute for Health Research DRF-2017-10-030).

RESULTS

Between 1 April 1997 and 31 March 2017, a total of 938,612 patients underwent at least one APM, of which 883,930 patients were eligible for inclusion (Figure 1). Of these, 806,195 patients had at least one-year of follow up in the cohort and 746,630 with at least two-years (Figure 1). The demographics of the cohort are summarised in Table 1; APM was most frequently performed in patients aged 40-59 years (47.81%) and male patients (63.33%).

The rate of arthroplasty by age-group, sex, Charlson comorbidity index, deprivation, rurality and ethnicity is summarised in Table 1. For all patients (aged 20 years or older), 4.2% (33,637/806,195; 95% confidence interval [CI] 4.1 to 4.2) underwent arthroplasty within 1 year of their APM (1997-2016) and 7.1% (52,604/746,630; 95% CI 7.0 to 7.1) within 2 years of their APM (1997-2015) (Table 1). For patients aged 60 years or greater in 2015-16, 9.9% (1689/17043; 95% CI 9.5-10.4) underwent arthroplasty within 1-year of APM. In 2014-15, 16.6% (3100/18734; 95% CI 16.0-17.1) of patients aged 60 years or greater underwent arthroplasty within 2-years of APM. Sensitivity analysis (first APM by patient, excluding prior procedures) confirmed no material difference in outcomes: 1-year rates all less than 0.6% lower than primary results for each age group.

Figure 2 summarises the trend in the proportion of patients undergoing subsequent arthroplasty over time. By year of treatment, the proportion of patients subsequently undergoing knee arthroplasty increased from 1.7% (95% CI 1.5 to 2.0) in 1997-98 to a peak of 5.0% (95% CI 4.8 to 5.1) in 2009-10, before declining to 4.2% (95% CI 4.0 to 4.3) in 2015-16. The 2-year proportion increased from 4.7% (95% CI 4.3 to 5.1) in 1997-98 to a peak of 7.8% (95% CI 7.6 to 8.0) in 2009-10, before declining to 7.3% (95% CI 7.1 to 7.5) in 2014-15.

The unadjusted and adjusted odds of arthroplasty by age, sex, Charlson comorbidity index, deprivation, rurality and ethnicity are summarised in Table 2. Adjustment for age attenuated the odds associated with female sex, Charlson comorbidity index, and year of treatment although these remained significant. Adjustment for age also resulted in changes to the odds of arthroplasty associated with social deprivation: from negative odds with greater social deprivation, to positive odds. In the full adjusted model, the odds of patients undergoing subsequent arthroplasty within 1-year increased by year of APM over the study period (adjusted odds ratio [OR] 3.10 in 2014 versus 2000; 95% CI 2.75 to 3.50). Increasing age was associated with increased odds of arthroplasty at 1-year (adjusted OR 1.48 per five years; 95% CI 1.47 to 1.49) and 2-years (adjusted OR 1.47 per five years; 95% CI 1.47 to 1.48). Female patients were more likely to undergo arthroplasty at both 1-year (adjusted OR 1.48; 95% CI 1.45 to 1.52) and 2-years (adjusted OR 1.55; 95% CI 1.52 to 1.58). In the fully adjusted model, patients from the most deprived regions were more likely to undergo subsequent arthroplasty in comparison to the least deprived regions at both 1-year and 2-years

(Table 2). Patients with a greater Charlson co-morbidity index and patients of white ethnicity were also more likely to undergo subsequent arthroplasty at both 1-year and 2-years (Table 2).

Regional variation in the age-sex standardised rate of subsequent arthroplasty within 1-year of APM in 2015-16 is shown in Figure 3. In 2015-16, there was ten-fold variation in arthroplasty conversion rates and 16/207 CCGs (7.7%) had a rate at least 50% greater than the national average. The regional variation in 1-year and 2-year conversions rates is also summarised in the maps shown in Figure 4.

DISCUSSION

Principal findings

Our study reports an increase in the proportion of patients undergoing knee arthroplasty within 1-year or 2-years of APM and high rates of arthroplasty conversion in patients over the age of sixty years. Overall, the proportion of patients undergoing arthroplasty within 1-year of APM has increased by 141% between 1997/98 and 2015/16 and there was ten-fold variation in the conversion rate between healthcare regions delivering the primary APM. Age had one of the strongest associations with outcome and for patients over the age of sixty years, the rate of arthroplasty conversion was 10% at one-year from 2015-16, and 17% at two-years from 2014-15. The regional variation in outcomes suggests that there is a need for standardised national treatment and commissioning guidance. Routine monitoring and healthcare provider feedback based upon this undesirable outcome may improve care over time.

Comparison with other studies

One previous study investigated the association between general knee arthroscopy (including washout for osteoarthritis) and subsequent arthroplasty in England.[18] This study reported that 4.8% of patients (aged 20 years or older) that underwent any type of knee arthroscopy for the treatment of osteoarthritis in 1997 subsequently received knee arthroplasty within 1 year.[18] The equivalent 1-year arthroplasty rate following APM in our study, without restriction by age or to patients with a diagnosis of osteoarthritis, was 4.2% in 2015/16. In England, whilst rates of knee washout and diagnostic arthroscopy have declined dramatically, the rate of APM surgery increased in the same 20-year period as the current study, especially in the 40-59-year and 60-79-year age groups which were the most common age groups for APM surgery in 2016-17.[15] A partial decline in the rate of APM being performed has been observed since 2013 and this seems to have been driven by the publication of high-level evidence.[14] The recent decline in intervention rate was seemingly broadly correlated with a slight decline in the rate of subsequent arthroplasty in our study.[15] The proportion of arthroplasty conversions remains considerably higher, however, than prior to the rapid increase in the rate of APM observed since 2001.[15]

In our cohort, overall 16.5% of patients aged 60-79 years underwent knee arthroplasty within 2-years. This rate is less than a rate of 21.5% reported for patients aged over 65 in an Australian knee arthroscopy cohort in 2006 but greater than a rate of 13.7% for knee arthroscopy patients over the age of 50 years in the United States.[28,29] The proportion of APM patients undergoing subsequent arthroplasty was greater in older age groups as might be expected due to higher rates of degenerative knee disease in this population, however APM is not considered appropriate in patients with advanced osteoarthritis and early conversion to arthroplasty after APM is concerning in this context.[30–32]

Previously, it has been suggested that rising rates of obesity in the population may contribute to an increased incidence of osteoarthritis and associated interventions.[33] Other studies, however, have indicated that although reports of knee pain and clinical cases of suspected osteoarthritis have risen in recent years, the rate of diagnosed and advanced radiographic osteoarthritis has remained relatively unchanged.[34,35] Nevertheless, it is possible that an increased burden of knee pain could have resulted in a greater rate of interventions such as knee arthroscopy, perhaps in an attempt to delay or avoid subsequent arthroplasty. Additionally, the temporal trend in conversion rate could be explained by lower thresholds for knee arthroplasty over time, but would still be suggestive of the APM being performed in patients with advanced osteoarthritis.

Our study demonstrated a higher rate of subsequent arthroplasty in female patients, patients from more deprived regions of England, and patients of white ethnicity. The reason for these observations is likely to be multi-factorial. For example, individual patients may or may not choose to seek care, influenced by factors including culture, social and economic status, occupation, and relative perceptions of symptom severity or disability, or access to care may play a part.[36–38] The threshold for surgery may, therefore, be different for a number of reasons and indeed the relative threshold for undergoing a perceived more minor intervention such as APM versus any subsequent arthroplasty must also be considered. It was interesting that in fully adjusted models, age was more strongly associated with subsequent arthroplasty rates than co-morbidity but whether this reflects baseline characteristics (osteoarthritis severity) or other factors is unclear. Sex and deprivation differences are also not easily explained. Previous evidence has suggested that knee arthroplasty may be underused in women at a population level but, in our cohort, after undergoing APM, women were more likely to undergo arthroplasty within 1-2-years than men.[39]

There was considerable regional variation in practice, with ten-fold differences in the 1-year arthroplasty rate by CCG. Factors underlying variation have been previously investigated and, to some extent, trends and regional variation can be explained by population and service delivery differences, surgeon beliefs and patient preference influences.[40,41] The regional disparity in arthroplasty rates suggests there is a need for more standardised patient selection. To facilitate this, national specialist association guidelines are currently under development for meniscal surgery in the United Kingdom and this work is supported in the NHS by the Getting It Right First Time (GIRFT) Programme.[19]

Strengths and limitations

Our large sample size of prospectively recorded data enhanced the precision of our findings and ability to analyse trends over time as well as investigate associations with patient-specific factors and regional variation. Our study is strengthened by the exclusion of patients undergoing ligament reconstruction, as ligament injury may independently increase the risk of osteoarthritis.[42] Despite the exclusions, this is the largest cohort of APM patients analysed for this purpose and we were able to control against a number of potential confounding factors. Nevertheless, there are potential sources of unmeasured confounding such as body mass index which may partly explain the slightly increased rate of subsequent arthroplasty in patients with a higher Charlson comorbidity index. Except for ligament reconstruction, patients undergoing other concurrent procedures were not excluded as secondary procedure coding could be inconsistent and inclusion of these cases ensured our cohort remained representative of clinical practice and patient selection over time.

Observational HES data is recorded by hospitals in England for the purposes of reimbursement for treatment, clinical audit and research.[20] Whilst some coding errors are inevitable, as hospitals rely on the coding of procedures for financial reimbursement, this is a strong incentive for coding accuracy, and the APM OPCS-4 code has not changed over time. Although the coding of arthroscopic and arthroplasty procedures has not been specifically validated, studies of the Charlson co-morbidity index as calculated from HES diagnosis fields and records of serious vascular complications have been shown to correlate strongly with primary care records.[43,44] HES covers all NHS hospitals in England, reducing the chances of regional migration impacting upon our results, but patients undergoing APM in an NHS hospital but subsequently undergoing knee arthroplasty in a private healthcare setting would not be captured. Approximately one-third of hip and knee arthroplasty procedures are performed in the private healthcare setting in England but the relationship with knee arthroscopy numbers is currently unknown.[45] This is an important consideration that could have led to some underestimation of the proportion of subsequent arthroplasty procedures but we believe the impact is likely to be minimal as the number of these patients moving from the NHS to the private sector over a two-year period is likely to be small. The generalisability of our findings to other healthcare settings, including private practice, is also unknown, and the specific factors underlying the variation in arthroplasty rates warrant further investigation.

In this observational cohort it was not possible to determine an individual patient's relative risk of undergoing knee arthroplasty had they not received an APM. Some previous studies have suggested that APM itself might increase the risk of progression of radiographic osteoarthritis and subsequent arthroplasty in patients with a meniscal tear, but these studies were also limited by potential selection effects.[46–51] Even without alteration of the natural history, it is also possible that some patients received APM for appropriate indications with pre-existent osteoarthritis, for example a "locked knee" with a displaced "bucket-handle" meniscal tear, and then later progressed to end-stage osteoarthritis within 2 years.[19,52] Finally, patients might have undergone an otherwise "diagnostic" arthroscopy for decision making regarding suitability for either a partial or total knee arthroplasty, or arthroscopy for other reasons such a removal of intra-articular implants or loose bodies.[53] Diagnostic arthroscopy is, however, becoming less common with increased utilisation of magnetic resonance imaging (MRI) and radiographic decision aids.[15,19,54–56] Also, to minimise the impact from these potential cases, purely diagnostic arthroscopies were excluded from this study and patients documented as undergoing knee arthroplasty on the same day (or before) an APM were excluded as probable cases of miscoding.

For regional analysis over time, CCG boundaries were standardised to those in April 2017. Index APM cases were linked to the CCG delivering this initial arthroscopy whereas subsequent arthroplasty procedures were identified at a national level, irrespective of the CCG performing the arthroplasty, to maximise data capture. A number of unmeasured factors may underlie regional variation such as surgeon beliefs and patient choice – these factors may influence both the decision to undergo the index APM procedure and also the threshold at which patients choose to undergo a subsequent arthroplasty.[40,41] Patients with functional disability and pain but either unwilling to undergo joint arthroplasty or assessed to be clinically ineligible for arthroplasty, may agree to undergo APM as a perceived more minor intervention.[34,35] Female patients and those from more deprived regions were more likely to undergo subsequent arthroplasty after APM but it is unknown whether this might reflect APM being offered with worse baseline osteoarthritis or a lower threshold for arthroplasty in these groups. More work is required to fully understand differences in patient-preferences and thresholds for treatment that may be associated with sex, co-morbidity, deprivation, ethnicity, and other factors. Based upon the latest evidence, however, there is consensus that APM in the presence of advanced structural osteoarthritis is generally not appropriate.[32,52,57] Whilst our study could not determine the true reason for regional variation, our findings do support a case for standardising patient selection, where possible at a national level, and for routine monitoring and feedback of outcomes to improve practice over time.

Conclusion

Over the period of this study, the proportion of patients undergoing arthroplasty with one or two years of APM increased and there was up to ten-fold regional variation in this outcome. Nationally, including all patients (aged 20 years or older), 4% underwent arthroplasty within 1 year of their APM and 7% within 2 years. For patients over 60-years, the rates rose to 10% within one year and 17% within two years. Informed by this work, national specialist association guidelines are under development and, given the regional variation observed, may help to standardise patient selection practices. Given that APM is not considered beneficial for patients with advanced osteoarthritis, routine monitoring of arthroplasty conversion rates may be considered in the future assessment of effective care commissioning.

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Details of contributors

SA: concept, methodology, analysis, writing and editing paper, guarantor.

AJ: methodology, analysis, editing paper.

DB: concept, editing paper.

AP: concept, methodology, editing paper.

Transparency declaration

The lead author (SA) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and registered) have been explained.

Competing interests

Andrew Judge has received consultancy fees from Freshfields Bruckhaus Deringer (on behalf of Smith & Nephew Orthopaedics Limited), and is a member of the Data Safety and Monitoring Board (which involved receipt of fees) from Anthera Pharmaceuticals, Inc.

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Ethical approval

Not required.

Data sharing

No additional data available.

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TABLES

Table 1: Demographics and descriptive statistics

	All index procedures *		1-year outcome cohort †			2-year outcome cohort ‡		
	n	**%**	**n**	**n TKA**	**% (95% CI)**	**n**	**n TKA**	**% (95% CI)**
Total								
Overall	883,930	100%	806,195	33,637	4.2% (4.1, 4.2)	746,630	52,604	7.1% (7.0, 7.1)
Sex								
Male	559,791	63.3	509,617	14,427	2.8% (2.8, 2.9)	473,490	22,666	4.8% (4.7, 4.9)
Female	324,139	36.7	296,578	19,210	6.5% (6.4, 6.6)	273,140	29,938	11.0% (10.8, 11.1)
Age group (years)								
< 20	23,643	2.67	-	-	-	-	-	-
20 - 39	196,847	22.3	186,270	136	0.1% (0.1, 0.1)	175,050	267	0.2% (0.1, 0.2)
40 - 59	422,621	47.8	393,809	10,184	2.6% (2.5, 2.6)	362,507	17,315	4.8% (4.7, 4.9)
60 - 79	230,248	26.1	216,067	21,793	10.1% (10.0, 10.2)	199,602	32,962	16.5% (16.4, 16.7)
80 +	10,571	1.20	10,049	1,524	15.2% (14.5, 15.9)	9,471	2,060	21.8% (20.9, 22.6)
Charlson comorbidity index								
0	736,832	83.4	673,865	23,787	3.5% (3.5, 3.6)	628,098	38,147	6.1% (6.0, 6.1)
1 - 15	141,275	16.0	127,063	9,265	7.3% (7.2, 7.4)	113,875	13,648	12.0% (11.8, 12.2)
16 - 30	5,434	0.61	4,919	549	11.2% (10.3, 12.1)	4,349	759	17.5% (16.3, 18.6)
31 - 50	389	0.04	348	36	10.3% (7.4, 14.0)	308	50	16.2% (12.3, 20.8)
Index of multiple deprivation (quintiles)								
1 = least deprived	196,587	22.2	180,097	7,633	4.2% (4.2, 4.3)	167,375	11,756	7.0% (6.9, 7.2)
2	193,030	21.8	176,639	7,772	4.4% (4.3, 4.5)	163,871	12,004	7.3% (7.2, 7.5)
3	185,527	21.0	169,880	7,283	4.3% (4.2, 4.4)	157,485	11,425	7.3% (7.1, 7.4)
4	161,628	18.3	146,916	5,826	4.0% (3.9, 4.1)	135,920	9,394	6.9% (6.8, 7.1)
5 = most deprived	138,247	15.6	125,010	4,854	3.9% (3.8, 4.0)	114,940	7,596	6.6% (6.5, 6.8)
Missing	8,911							
Rurality								
Urban	676,253	76.5	616,524	25,069	4.1% (4.0, 4.1)	570,250	39,360	6.9% (6.8, 7.0)
Rural	203,131	23.0	186,041	8,461	4.6% (4.5, 4.6)	173,113	13,106	7.6% (7.5, 7.7)
Missing	4,546							
Ethnicity								
White	780,685	88.3	714,522	32,299	4.5% (4.5, 4.6)	662,430	50,455	7.6% (7.6, 7.7)
Asian	24,010	2.72	21,262	587	2.8% (2.5, 3.0)	19,135	996	5.2% (4.9, 5.5)
Black	12,837	1.45	11,328	150	1.3% (1.1, 1.6)	10,254	273	2.7% (2.4, 3.0)
Mixed	5,137	0.58	4,372	90	2.1% (1.7, 2.5)	3,929	140	3.6% (3.0, 4.2)
Other	5,664	0.64	4,964	50	1.0% (0.8, 1.3)	4,498	77	1.7% (1.4, 2.1)
Missing	55,597	6.29						

- = suppressed due to small numbers; CI = confidence interval;

** 1-April-1997 to 31-March-2017; † 1-April-1997 to 31-March-2016; ‡ 1-April-1997 to 31-March-2015.*

Table 2: Unadjusted and adjusted* odds of undergoing subsequent knee arthroplasty after APM by sex, age group, and year of APM treatment.

	Odds of undergoing arthroplasty within 1 year				Odds of undergoing arthroplasty within 2 years			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Sex								
Male	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female	2.38	2.33, 2.43	1.48	1.45, 1.52	2.45	2.40, 2.49	1.55	1.52, 1.58
Age undergoing APM (per 5 years) *								
Age	1.52	1.52, 1.52	1.48	1.47, 1.49	1.52	1.51, 1.52	1.47	1.47, 1.48
Year of treatment (APM) †								
2000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2007	4.16	3.69, 4.69	3.24	2.87, 3.67	2.19	2.03, 2.36	1.67	1.55, 1.81
2014	3.94	3.50, 4.43	3.10	2.75, 3.50	2.17	2.02, 2.33	1.68	1.55, 1.81
Charlson comorbidity index (per 5 units)								
Charlson index	1.48	1.47, 1.50	1.04	1.02, 1.05	1.49	1.47, 1.51	1.04	1.03, 1.06
Index of multiple deprivation (quintile)								
1 = least deprived	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.04	1.01, 1.07	1.08	1.05, 1.12	1.05	1.02, 1.07	1.09	1.06, 1.12
3	1.01	0.98, 1.05	1.13	1.09, 1.16	1.04	1.01, 1.06	1.15	1.12, 1.18
4	0.93	0.90, 0.97	1.17	1.13, 1.21	0.98	0.96, 1.01	1.23	1.19, 1.27
5 = most deprived	0.91	0.88, 0.95	1.30	1.25, 1.35	0.94	0.91, 0.97	1.33	1.28, 1.37
Rurality								
Urban	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.12	1.10, 1.15	1.02	0.99, 1.05	1.10	1.08, 1.13	1.01	0.98, 1.03
Ethnicity								
White	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Asian	0.60	0.55, 0.65	0.73	0.67, 0.79	0.67	0.62, 0.71	0.81	0.76, 0.87
Mixed	0.44	0.36, 0.55	0.66	0.53, 0.82	0.45	0.38, 0.53	0.66	0.56, 0.79
Black	0.28	0.24, 0.33	0.37	0.31, 0.44	0.33	0.29, 0.37	0.43	0.38, 0.49
Other	0.21	0.16, 0.28	0.38	0.29, 0.51	0.21	0.17, 0.26	0.37	0.29, 0.46

** adjusted logistic regression model including all variables in the table; † all years were included in model; ‡ age < 20 years suppressed due to small numbers; OR = odds ratio; CI = confidence interval; APM = arthroscopic partial meniscectomy*

FIGURES

Figure 1: Flow diagram illustrating cohort extraction

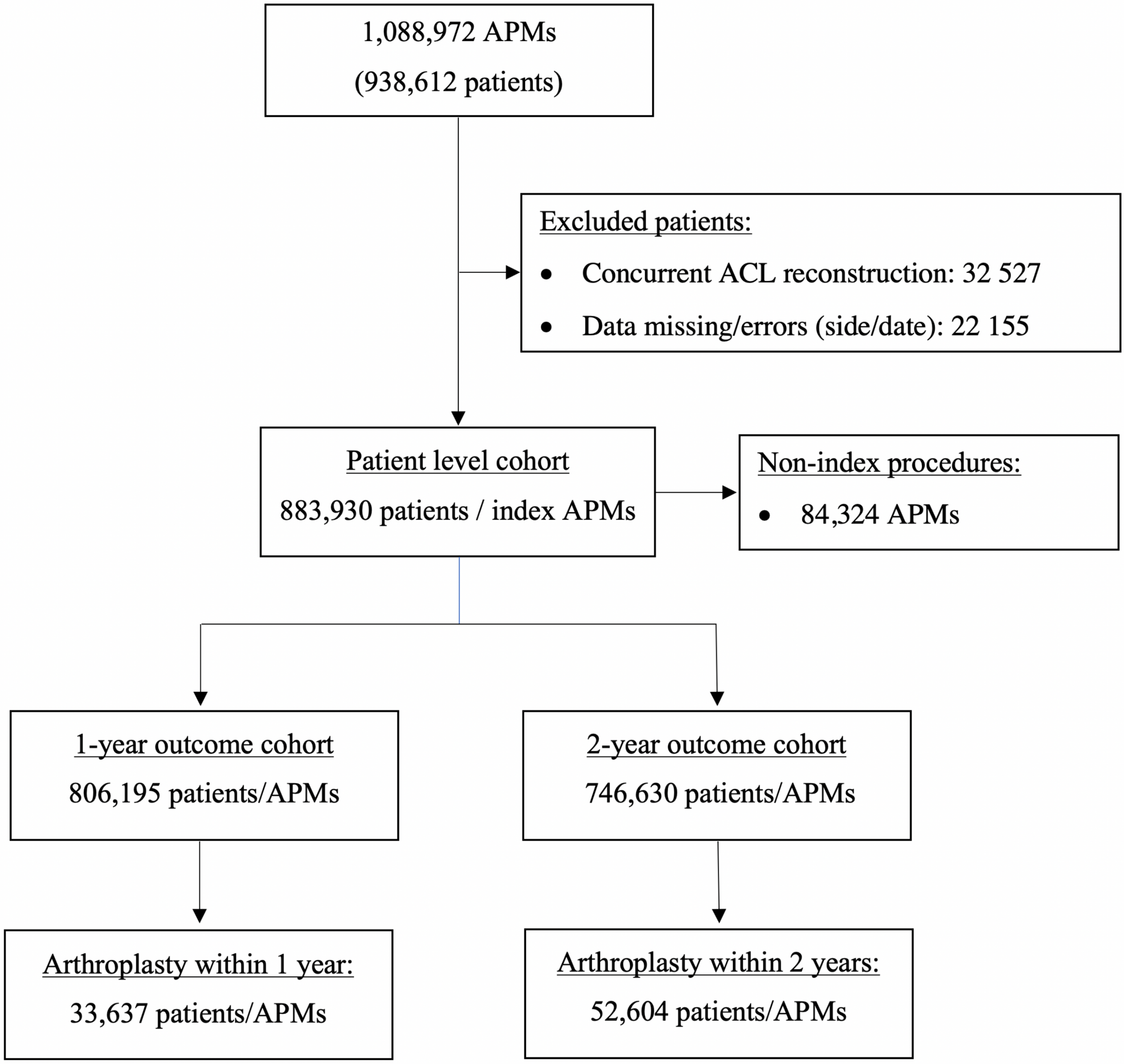

Figure 2: The proportion of patients undergoing knee arthroplasty within 1-year or 2-years of APM over time with 95% confidence intervals

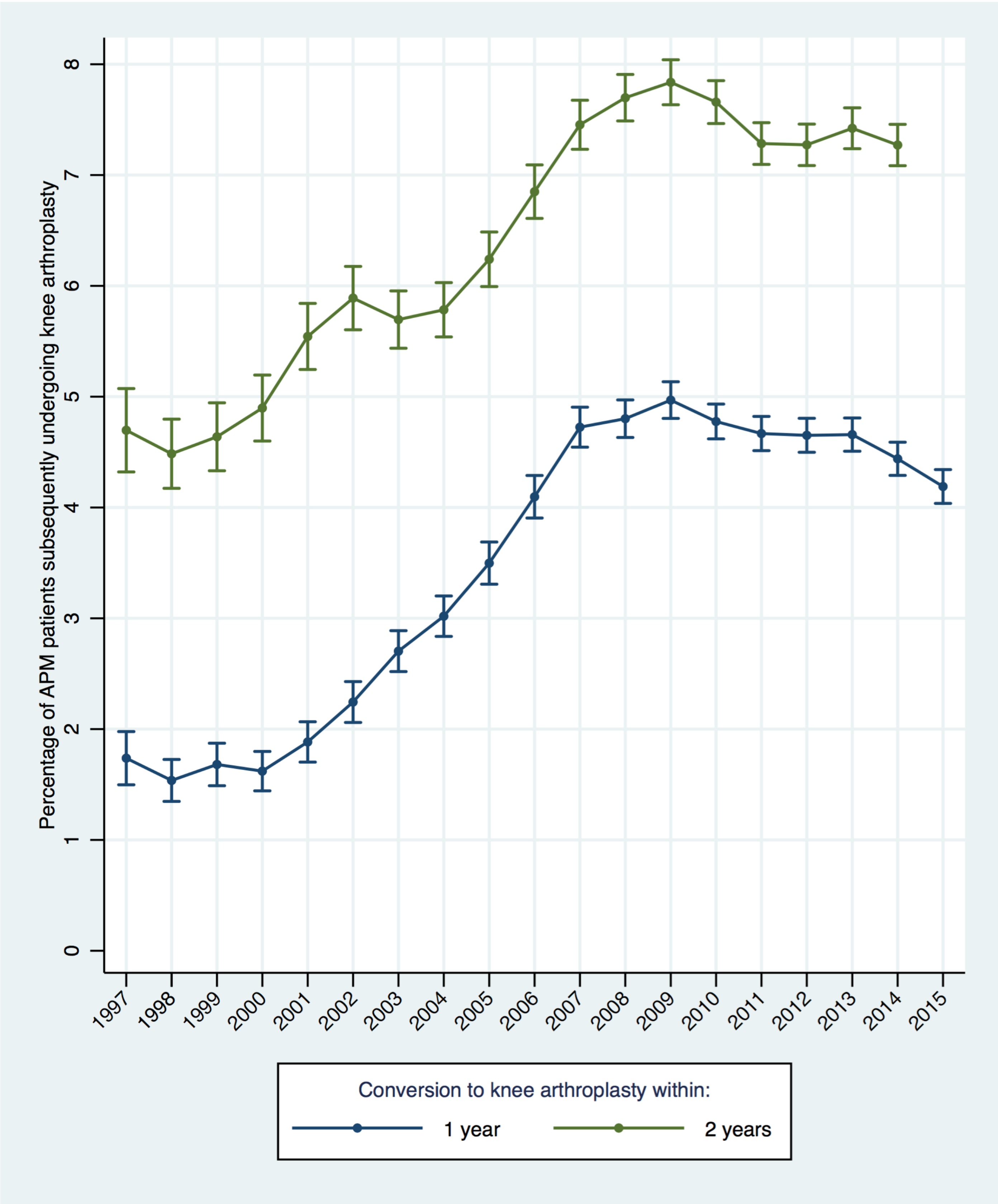

Figure 3: Variation in the proportion of patients undergoing arthroplasty within 1-year of APM by treating CCG in 2015-16

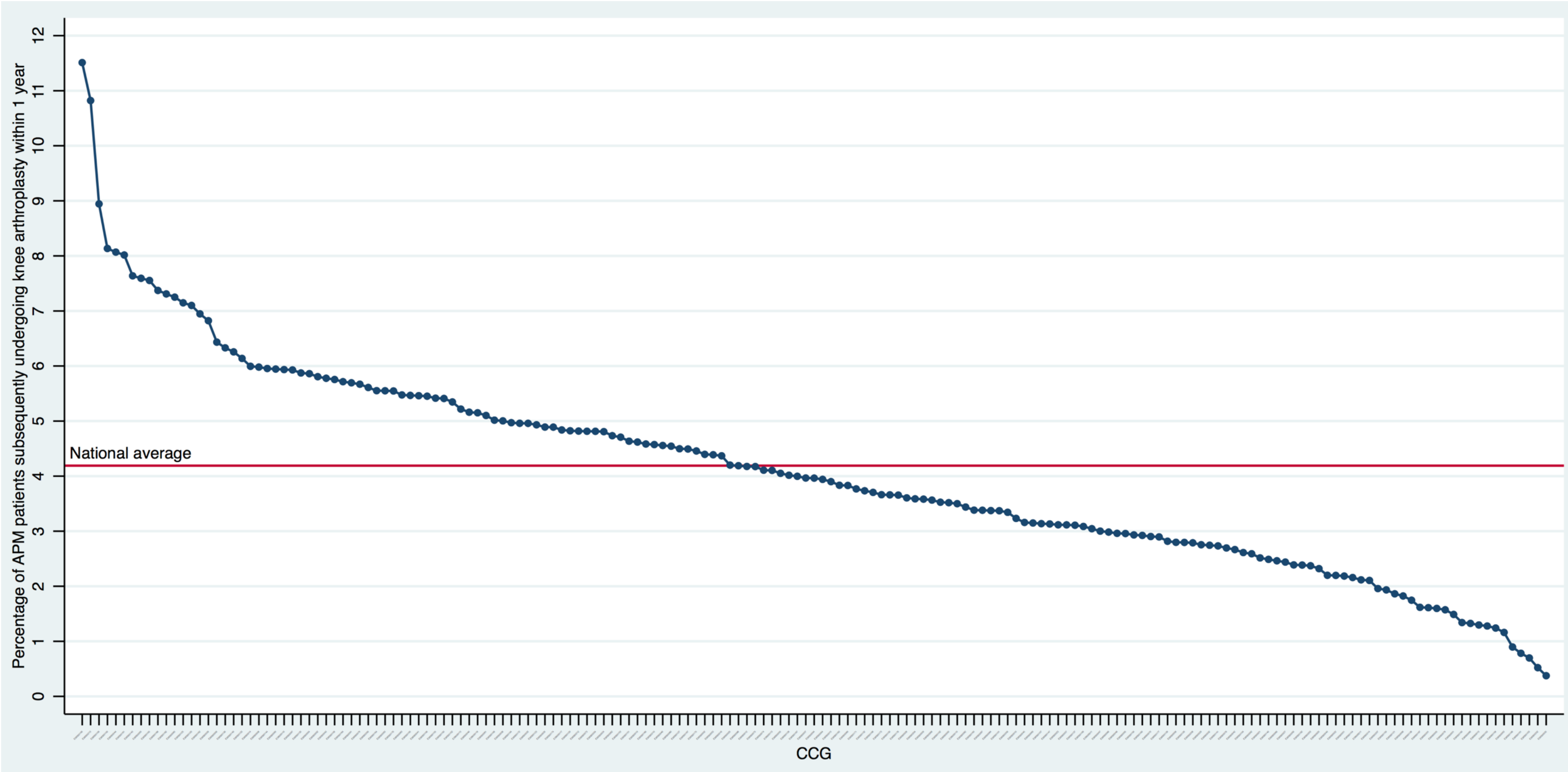

Figure 4: Regional variation in the percentage of patients undergoing arthroplasty within 1-year or 2-years of index APM

(latest data, by Clinical Commissioning Group of original treatment)