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Original article

Population trends in the incidence and initial management of osteoarthritis: age-period-cohort analysis of the Clinical Practice Research Datalink, 1992–2013

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Abstract

Objective. To determine recent trends in the rate and management of new cases of OA presenting to primary healthcare using UK nationally representative data.

Methods. Using the Clinical Practice Research Datalink we identified new cases of diagnosed OA and clinical OA (including OA-relevant peripheral joint pain in those aged over 45 years) using established code lists. For both definitions we estimated annual incidence density using exact person-time, and undertook descriptive analysis and age-period-cohort modelling. Demographic characteristics and management were described for incident cases in each calendar year. Sensitivity analyses explored the robustness of the findings to key assumptions.

Results. Between 1992 and 2013 the annual age-sex standardized incidence rate for clinical OA increased from 29.2 to 40.5/1000 person-years. After controlling for period effects, the consultation incidence of clinical OA was higher for successive cohorts born after the mid-1950s, particularly women. In contrast, with the exception of hand OA, we observed no increase in the incidence of diagnosed OA: 8.6/1000 person-years in 2004 down to 6.3 in 2013. In 2013, 16.4% of clinical OA cases had an X-ray referral. While NSAID prescriptions fell from 2004, the proportion prescribed opioid analgesia rose markedly (0.1% of diagnosed OA in 1992 to 1.9% in 2013).

Conclusion. Rising rates of clinical OA, continued use of plain radiography and a shift towards opioid analgesic prescription are concerning. Our findings support the search for policies to tackle this common problem that promote joint pain prevention while avoiding excessive and inappropriate health care.

Key words: osteoarthritis, incidence, primary care, analgesics

CLINICAL SCIENCE

Rheumatology key messages

- Incidence of OA presenting and diagnosed in UK primary care has not risen.
- New presentations of joint-pain are increasing among younger OA cohorts.

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Introduction

Dramatic increases over the past two decades have been reported in the population burden and healthcare demand associated with OA. The Global Burden of Disease project recently estimated that crude disability-adjusted life-years attributed to OA increased by 34% between 1990 and 2015, among the largest increases seen for any non-communicable disease [1]. Within the same period, data available from many high-income countries show significant increases in the numbers and rates of primary hip and knee arthroplasty [2–6], over 90% of which are performed for OA [7]. Total direct and indirect costs associated with OA are now conservatively estimated at 0.25–0.50% gross domestic product in high-income countries [8, 9].

The rate of new cases of symptomatic OA arising in the population provides crucial information for health-policy makers, responding more quickly to changes in risk factors and being less influenced by disease duration. However, obtaining reliable incidence estimates for OA in general population cohort studies is challenging and the Global Burden of Disease project found previous estimates to be scarce and unusable [10]. As primary care is the first point of contact with formal healthcare services, the rate of new cases presenting and recorded in this setting (consultation incidence) provides one of the few continuous, ongoing sources of data with which to evaluate trends over time in the incidence of OA, albeit subject to the prevailing propensity to consult primary healthcare and coding systems and behaviour. To date, only two published studies worldwide, both using the same subnational administrative healthcare database in British Columbia, have estimated trends in the incidence of OA [11, 12]. These showed annual increases in crude OA incidence rates averaging 1.3–3.3% between 1996–97 and 2008–09, dropping to $<1\%$ per year after age-standardization. In the UK, we found an increase in OA consultation incidence between 2003 and 2010 among 35–44 year olds but based on small numbers within a regional network of general practices [13].

Our study sought to provide the first national and subnational estimates of trends in the consultation incidence of OA and patterns of initial management between 1992 and 2013 in the UK using a large nationally representative primary care database.

Methods

Study design and setting

We undertook a descriptive study using routinely collected longitudinal data from the UK Clinical Practice Research Datalink (CPRD), which contains computerized primary care records from general practices covering around 7% of the UK population [14]. CPRD records anonymized patient demographics, consultations, diagnoses, prescriptions and tests from primary care, and also includes those referrals to specialists, hospital admissions and diagnoses made in secondary care, reported back to the general practitioners and recorded by them within their computerized records. CPRD has reported high validity for a range of diagnoses [15]. The study was approved by the independent scientific advisory committee for CPRD research (protocol reference: 14_09010_193 R). No further ethical permissions were required for the analyses of these anonymized patient level data.

Definition of incident cases and at-risk population

Several algorithms have been used in previous studies, predominantly from Canada and the USA, to define OA cases in electronic health record and administrative databases [16, 17]. In line with a Swedish report [18], we chose case definitions requiring a single record of a relevant code within the primary care electronic health record within a calendar year of interest. Less restrictive definitions such as these have been used in previous studies of OA incidence in Canada [11, 12, 19, 20], the Netherlands [21–23] and Spain [24], and of OA consultation prevalence in UK primary care [25, 26] and have generally higher sensitivity but lower specificity than more restrictive algorithms requiring multiple records [17].

Using established Read code lists [26] (code lists available from www.keele.ac.uk/mrr) we defined cases of OA in two ways: firstly, to maximize sensitivity and capture the greatest number of new consulting cases of OA, cases were defined as having either at least one consultation with a recorded diagnosis of OA or, in adults aged over 45 years, at least one consultation with a recorded peripheral joint pain symptom code affecting the knee, hip and hand/wrist likely to reflect OA (clinical OA); secondly, cases of OA were defined more narrowly as having at least one consultation with a recorded diagnosis of OA (OA). We excluded cases with a record of a systemic inflammatory disease, spondyloarthropathy or crystal disease in the previous 3 years or following 1 year, or a record of another specific non-OA diagnosis (soft-tissue disorders, other bone/cartilage diseases) at the same joint in the 6 months before or after the recorded OA/joint pain consultation.

The at-risk population in each calendar year was defined as all patients with complete registration history within CPRD in the previous 3 calendar years and no OA consultation in that period. Incident cases among the at-risk population in each calendar year were defined as a coded record during the year (supplementary Fig. S1, available at *Rheumatology* Online).

Descriptive characteristics and management of incident cases

To explore the changing characteristics of incident cases of OA and their pharmacological management we described the age and gender distribution of cases, and the proportion of cases with: $\geqslant 5$ and $\geqslant 10$ British National Formulary chapters prescribed in the 1 year prior to the diagnosis date (a measure of multimorbidity) [27]; a record of an X-ray referral within 30 days before or after diagnosis date; a prescription for an NSAID, cyclooxygenase-2

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(COX-2) inhibitor, or opioid analgesic within 14 days after diagnosis date. Opioid analgesics were sub-classified into weak (e.g. codeine 8 mg + paracetamol), moderate (e.g. dihydrocodeine 20 mg), strong (e.g. tramadol 50 mg) and very strong (e.g. oxycodone) [28].

Statistical analysis

Patients consulting for OA in a given year will be a mixture of new (incident) cases and ongoing (prevalent) cases. We used the run-in period method to look back in the medical record to exclude prevalent cases and to define the at-risk population. Run-in periods from 1 to 10 years were compared using time series models and 3 years was selected as optimal in this data source for OA [13]. Annual crude incidence was defined by incidence density as the number of incident cases divided by observed person-time in each calendar year with persons censored by death, moving practice, or OA diagnosis (supplementary Fig. S1 and supplementary Table S1, available at *Rheumatology* Online). Annual incidence was stratified by gender, age group (35–44, 45–54, 55–64, 65–74, 75–84, 85+ years) and geographical region. Age–sex-standardized incidence rates were estimated using the mid-2013 UK population as the standard (supplementary Methods, available at *Rheumatology* Online) with 95% CIs estimated by Poisson regression. We estimated the total numbers of newly diagnosed cases of OA and clinical OA presenting to UK primary care in 2013 by multiplying the incidence rates in 2013 from this study and estimated size of the at-risk population in the UK in 2013 based on mid-2013 population size and 6.9% population coverage by CPRD in the same year [14].

To explore age-period-cohort effects, we first described and plotted the age-stratified incidence of clinical OA in 14 birth cohorts: cohort-1915, cohort-1920, cohort-1925, cohort-1930, cohort-1935, cohort-1940, cohort-1945, cohort-1950, cohort-1955, cohort-1960, cohort-1965, cohort-1970 and cohort-1975. We then modelled age-period-cohort effects (in calendar years) on clinical OA and OA from 1992 to 2013. Two approaches to age-period-cohort analysis were used to provide a robust check on results. OA and clinical OA incidence rates were estimated using parametric smooth functions based on natural cubic splines with knots each for age, period and cohort variables to detect nonlinear effects [29]. In the analysis of period effect, the calendar year of 2000 was used as the period referent group.

Sensitivity analyses

Incidence estimates are sensitive to the length of run-in period [20, 30] and so we repeated the analyses using a 10 year run-in period [20]. General practice membership of CPRD is dynamic (i.e. open to practices joining and leaving) and so to evaluate the potential impact of this, we estimated the incidence in four fixed practice cohorts that joined at different periods but contributed continuously thereafter to 2013: cohort 1 (102 practices providing incidence estimates from 1994 to 2013), cohort 2 (73 practices, 2000–13), cohort 3 (163 practices, 2004–13), cohort 4 (130 practices, 2009–13) (supplementary Table S2, available at *Rheumatology* Online). Data management and analysis were performed using Stata MP Software V14.1 (StataCorp, College Station, TX, USA).

Results

We analysed 1 716 253 incident cases of clinical OA and 432 163 incident cases of OA recorded between 1992 and 2013. In 2013, age–sex standardized incidence rates for clinical OA and OA were 40.5 (95% CI: 40.3, 40.7) and 6.3 (95% CI: 6.2, 6.4) per 1000 person-years, respectively. For both case definitions, age-standardized incidence rates were higher among women than men [46.2 (45.9, 46.5) *vs* 35.0 (34.7, 35.3) and 7.6 (7.5, 7.7) *vs* 4.9 (4.8, 5.0)], and peaked at 75–84 years in women and in men. The mean age of incident cases of clinical OA was 52.7 years (56.1% women) compared with 67.2 years (61.6% women) among incident cases of OA. A record of an X-ray referral at time of diagnosis was found in 16.4% of clinical OA cases and 22.0% of incidence OA cases. Multimorbidity was common, with 51.0% of incident cases of clinical OA and 74.9% of OA cases prescribed $\geqslant$5 unique categories of drug in the preceding year ($\geqslant$10 drug categories: 22.5% and 40.2%, respectively).

Joint-specific standardized incidence estimates in 2013 for knee OA were as follows: clinical knee OA: 19.7 (overall), 20.8 (women), 18.5 (men); knee OA: 1.9, 2.1, 1.6; clinical hip OA: 8.0, 10.4, 5.5; hip OA: 1.3, 1.6, 0.9; clinical hand OA: 4.3, 5.2, 3.3; hand OA: 2.5, 3.5, 1.5. Similar patterns of age-specific incidence were found for clinical knee OA, knee OA, clinical hip OA and hip OA: a progressive increase from age 35–44 years, peaking at 75–84 years in men and women. A different age-specific pattern was observed for clinical hand OA and hand OA, which showed an early peak in age group 55–64 years in women.

Temporal trend in OA incidence and management, 1992–2013: descriptive analyses

Annual age–sex standardized incidence rates of diagnosed OA showed a small increase over the period 1992–2004 but decreased thereafter (Table 1). The annual standardized incidence rates of clinical OA were also largely stable from 1992 to 2000 but then increased markedly to 2009 after which they dropped slightly. Similar trends for both case definitions were observed in women and men and in each age stratum (Fig. 1).

The trends of clinical OA and OA incidence rates differed by joint. In keeping with the trend seen for clinical OA in general, both clinical knee OA and clinical hip OA increased markedly from 2000 reaching a plateau in 2009–13 whereas clinical hand OA increased steadily from 2000 to 2013. Knee OA and hip OA remained relatively stable from 2000 to 2013, while hand OA increased steadily over the same period (supplementary Table S3 and supplementary Fig. S2, available at *Rheumatology* Online). The fluctuating incidence of hip OA and hand OA we interpret as reflecting variable use joint-specific OA codes before 2000.

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Table 1 Primary care consultation incidence of OA: UK, 1992–2013

	Clinical OA				OA			
Year	Cases	Person-years	Crude incidence IR (95% CI)	Age–sex-standardized incidence IR (95% CI)	Cases	Person-years	Crude incidence IR (95% CI)	Age–sex-standardized incidence IR (95% CI)
1992	2318	73 491	31.5 (30.3, 32.8)	29.2 (28.8, 29.5)	733	82 537	8.9 (8.2, 9.5)	8.1 (7.9, 8.2)
1993	11 101	322 990	34.4 (33.7, 35.0)	30.8 (30.5, 31.2)	3323	379 343	8.8 (8.5, 9.1)	7.7 (7.5, 7.8)
1994	20 590	648 338	31.8 (31.3, 32.2)	28.4 (28.1, 28.7)	6064	737 338	8.2 (8.0, 8.4)	7.0 (6.9, 7.2)
1995	24 091	774 073	31.1 (30.7, 31.5)	27.9 (27.6, 28.2)	7432	889 694	8.4 (8.2, 8.5)	7.2 (7.0, 7.3)
1996	28 019	893 210	31.4 (31.0, 31.7)	28.3 (28.0, 28.6)	9111	1 028 858	8.9 (8.7, 9.0)	7.7 (7.5, 7.8)
1997	31 163	974 392	32.0 (31.6, 32.3)	28.8 (28.6, 29.1)	10 350	1 110 627	9.3 (9.1, 9.5)	8.1 (8.0, 8.2)
1998	33 127	1 059 208	31.3 (30.9, 31.6)	28.4 (28.1, 28.6)	11 266	1 212 876	9.3 (9.1, 9.5)	8.1 (7.9, 8.2)
1999	33 820	1 127 813	30.0 (29.7, 30.3)	27.2 (27.0, 27.4)	12 101	1 280 607	9.4 (9.3, 9.6)	8.2 (8.1, 8.3)
2000	39 529	1 301 151	30.4 (30.1, 30.7)	27.2 (27.0, 27.4)	14 021	1 501 032	9.3 (9.2, 9.5)	7.9 (7.8, 8.0)
2001	48 723	1 510 687	32.3 (32.0, 32.5)	28.7 (28.5, 28.8)	16 731	1 735 259	9.6 (9.5, 9.8)	8.0 (8.0, 8.1)
2002	62 760	1 766 502	35.5 (35.2, 35.8)	31.3 (31.2, 31.5)	19 326	2 029 507	9.5 (9.4, 9.7)	7.9 (7.8, 8.0)
2003	83 876	2 117 343	39.6 (39.3, 39.9)	35.0 (34.8, 35.2)	24 269	2 445 042	9.9 (9.8, 10.1)	8.3 (8.3, 8.4)
2004	102 518	2 427 299	42.2 (42.0, 42.5)	37.3 (37.1, 37.5)	28 438	2 780 331	10.2 (10.1, 10.3)	8.6 (8.6, 8.7)
2005	112 689	2 662 777	42.3 (42.1, 42.6)	37.4 (37.3, 37.6)	30 828	3 092 892	10.0 (9.9, 10.1)	8.5 (8.4, 8.6)
2006	122 610	2 861 320	42.9 (42.6, 43.1)	37.8 (37.6, 37.9)	30 663	3 318 065	9.2 (9.1, 9.3)	7.8 (7.7, 7.9)
2007	132 437	2 966 799	44.6 (44.4, 44.9)	39.5 (39.3, 39.7)	31 174	3 450 533	9.0 (8.9, 9.1)	7.6 (7.6, 7.7)
2008	141 177	3 015 423	46.8 (46.6, 47.1)	41.6 (41.4, 41.8)	32 364	3 525 583	9.2 (9.1, 9.3)	7.8 (7.7, 7.9)
2009	145 550	3 005 688	48.4 (48.2, 48.7)	42.9 (42.7, 43.1)	31 889	3 549 708	9.0 (8.9, 9.1)	7.6 (7.5, 7.7)
2010	139 784	2 964 794	47.1 (46.9, 47.4)	41.3 (41.2, 41.5)	30 004	3 534 196	8.5 (8.4, 8.6)	7.1 (7.0, 7.2)
2011	138 460	2 914 140	47.5 (47.3, 47.8)	41.4 (41.2, 41.6)	29 448	3 495 697	8.4 (8.3, 8.5)	7.0 (7.0, 7.1)
2012	133 409	2 863 873	46.6 (46.3, 46.8)	41.2 (41.0, 41.4)	27 483	3 437 897	8.0 (7.9, 8.1)	6.7 (6.7, 6.8)
2013	128 502	2 695 583	47.7 (47.4, 47.9)	40.5 (40.3, 40.7)	25 145	3 191 331	7.9 (7.8, 8.0)	6.3 (6.2, 6.4)

Incidence rates are presented as age–sex standardized incidence (95% CI) per 1000 person-years, with mid-2013 UK population as standard population. IR: incidence rate.

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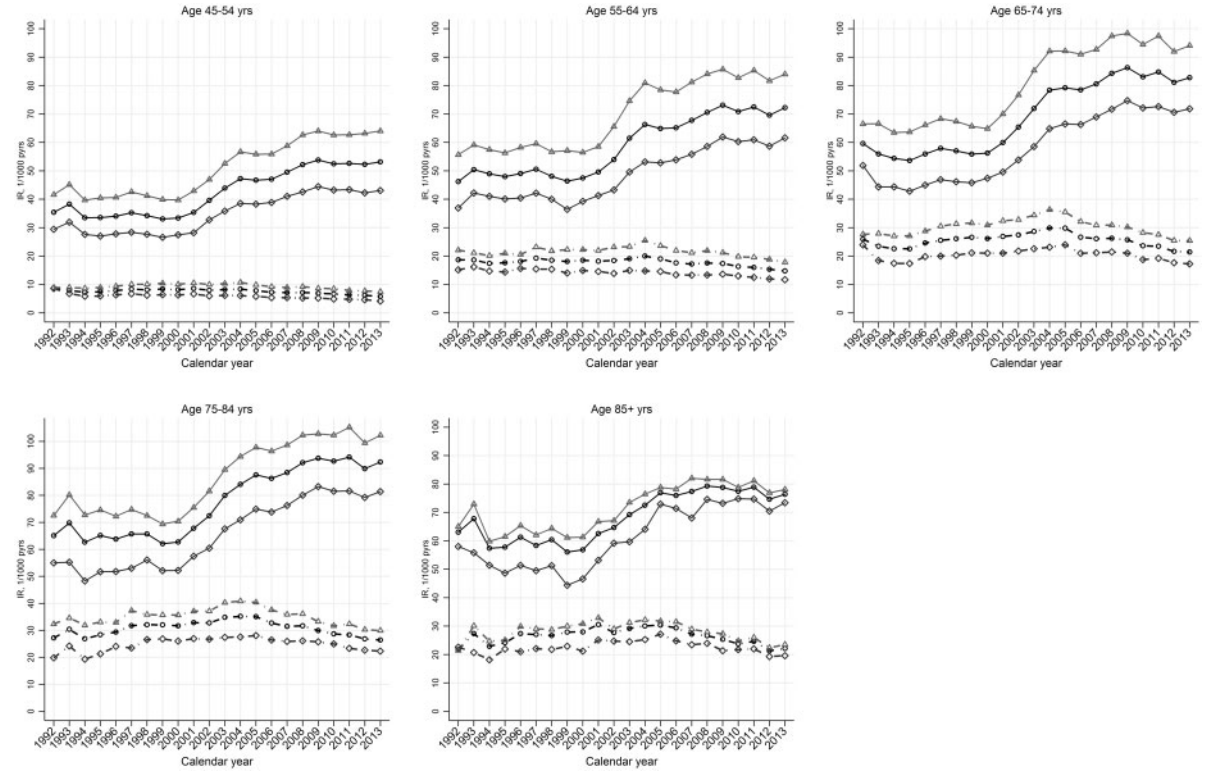
Fig. 1 Age-specific temporal trend in incidence rate of OA, by gender: UK, 1992–2013



Solid line and dotted line represent the incidence rates for clinical OA and OA, respectively. Light grey triangle, dark grey diamond and black circle indicate estimates for women, men and all, respectively.

The increase in incidence of clinical OA between 2000 and 2009 was more marked in regions with comparatively low incidence rates in 2000, such that regional variation was reduced in 2009 (Fig. 2; supplementary Fig. S3, available at *Rheumatology* Online).

In our sensitivity analyses, similar trends of incidence rates for both clinical OA and OA were observed when the run-in period was extended to 10 years (supplementary Fig. S4, available at *Rheumatology* Online), but with lower incidence for clinical OA suggesting that a run-in period longer than 3 years is needed to identify first consultation for this case definition (clinical OA: 32.9/1000 person-years; OA: 6.6/1000 person-years, in 2013). Based on this conservative 10-year run-in period, we estimate that in 2013 approximately 1 209 594 new cases of clinical OA presented to UK primary care, of whom 432 804 received the diagnosis of OA. A similar trend in incidence rate was also identified when analysis was restricted to the four fixed cohorts of practices who contributed to incidence estimates continuously from joining to 2013 (supplementary Fig. S5, available at *Rheumatology* Online).

Temporal trend in OA incidence, 1992–2013: age-period-cohort analyses

Figure 3 (supplementary Fig. S6, available at *Rheumatology* Online) shows plots of clinical OA and OA incidence by age for the six selected birth cohorts. At virtually every age, later birth cohorts had higher rates of incidence of clinical OA than earlier birth cohorts. Cohorts born after the mid-1950s showed an increased incidence of clinical OA particularly in females while a decline in the incidence of OA was seen (Fig. 4; supplementary Fig. S7, available at *Rheumatology* Online).

Trends in characteristics and prescribed analgesia among incident cases of OA, 1992–2013

All forms of analgesia were more likely to be prescribed to incident cases of OA than cases with clinical OA. Cox-2 prescriptions among incident cases increased in 1999–2004 and declined sharply afterwards (coinciding with withdrawal of rofecoxib [31] and safety advice on all selective Cox-2 inhibitors issued by the Medicines & Healthcare Products Regulatory Agency [32]). The proportion of incident cases receiving a prescription for oral NSAID also declined after 2004 with weak combination opioids becoming the most common class of prescribed analgesia from 2005 onwards. The proportion of incident cases of OA receiving a prescription for very strong opioids increased from 0.1% in 2004 to 0.5% in 2013 for clinical OA; 0.6% in 2006 to 1.2% in 2013 for OA (Table 2).

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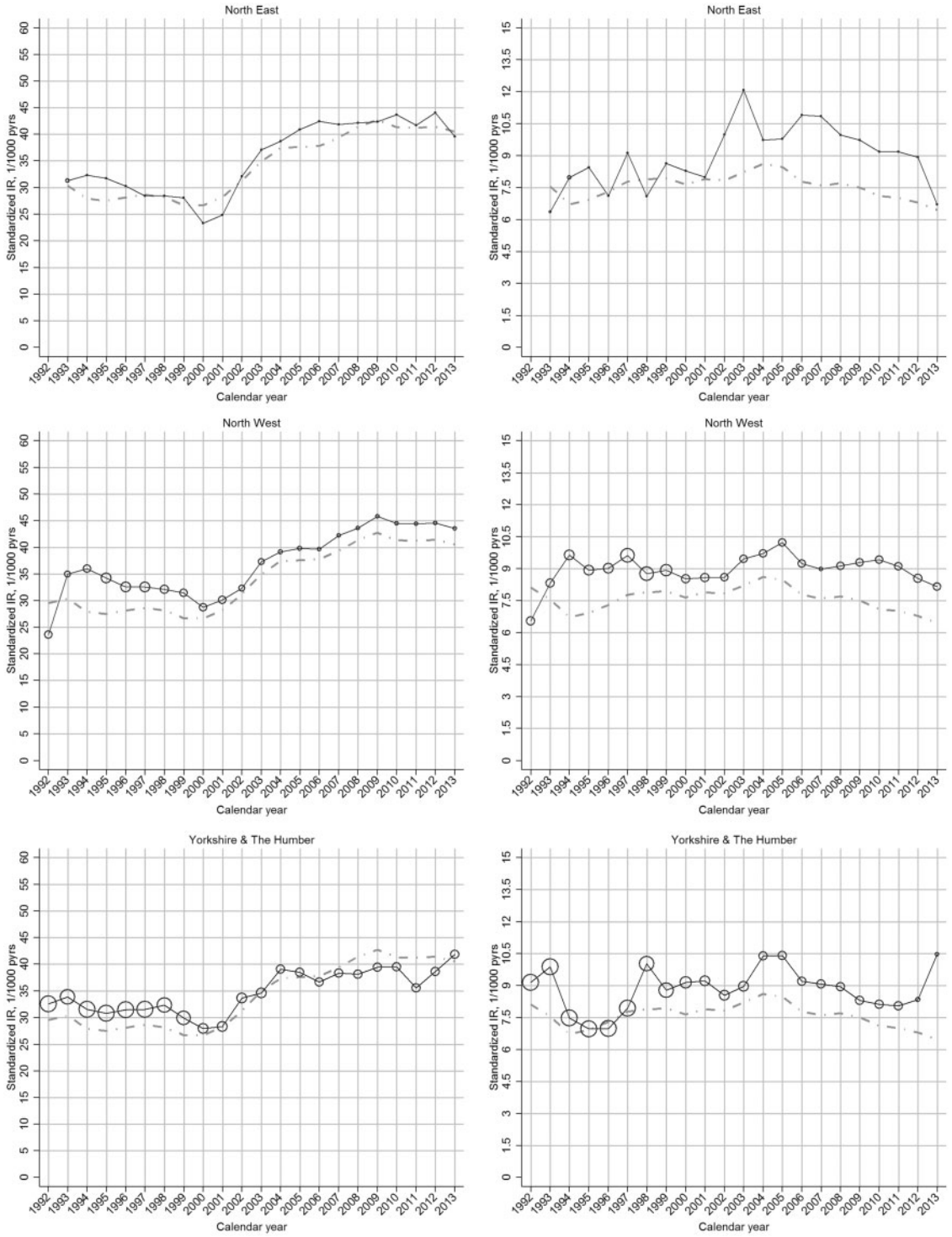
Fig. 2 Region-specific temporal trend in incidence rate of OA, by gender: UK, 1992–2013



Left panel: clinical OA; right panel: OA. In each plot, the black line represents the trend of overall incidence in the specific region; the grey line represents the general trend of overall incidence in the UK; the bubble size in each calendar year is determined by the proportion of the overall at-risk population within that region.

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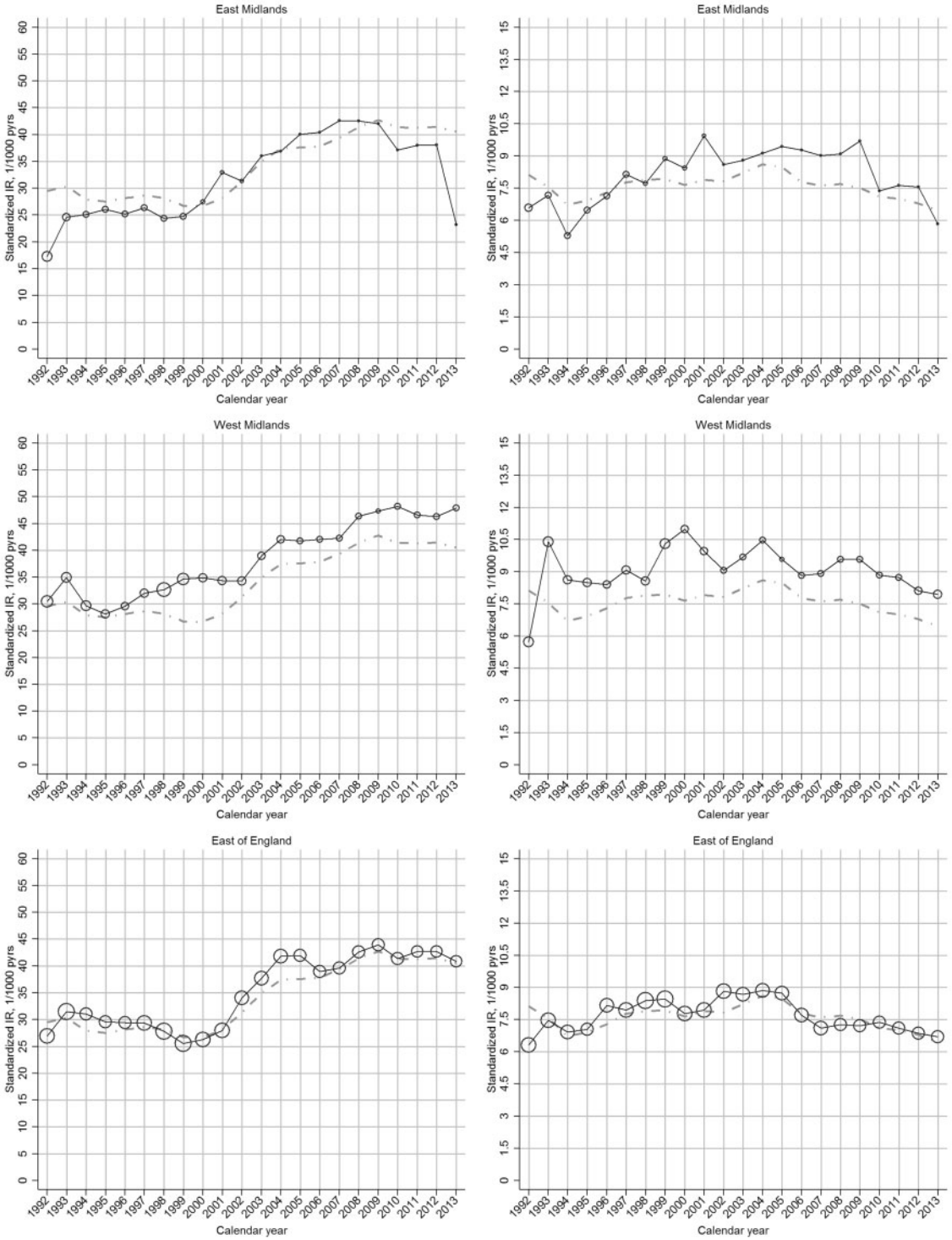
Fig. 2 Continued



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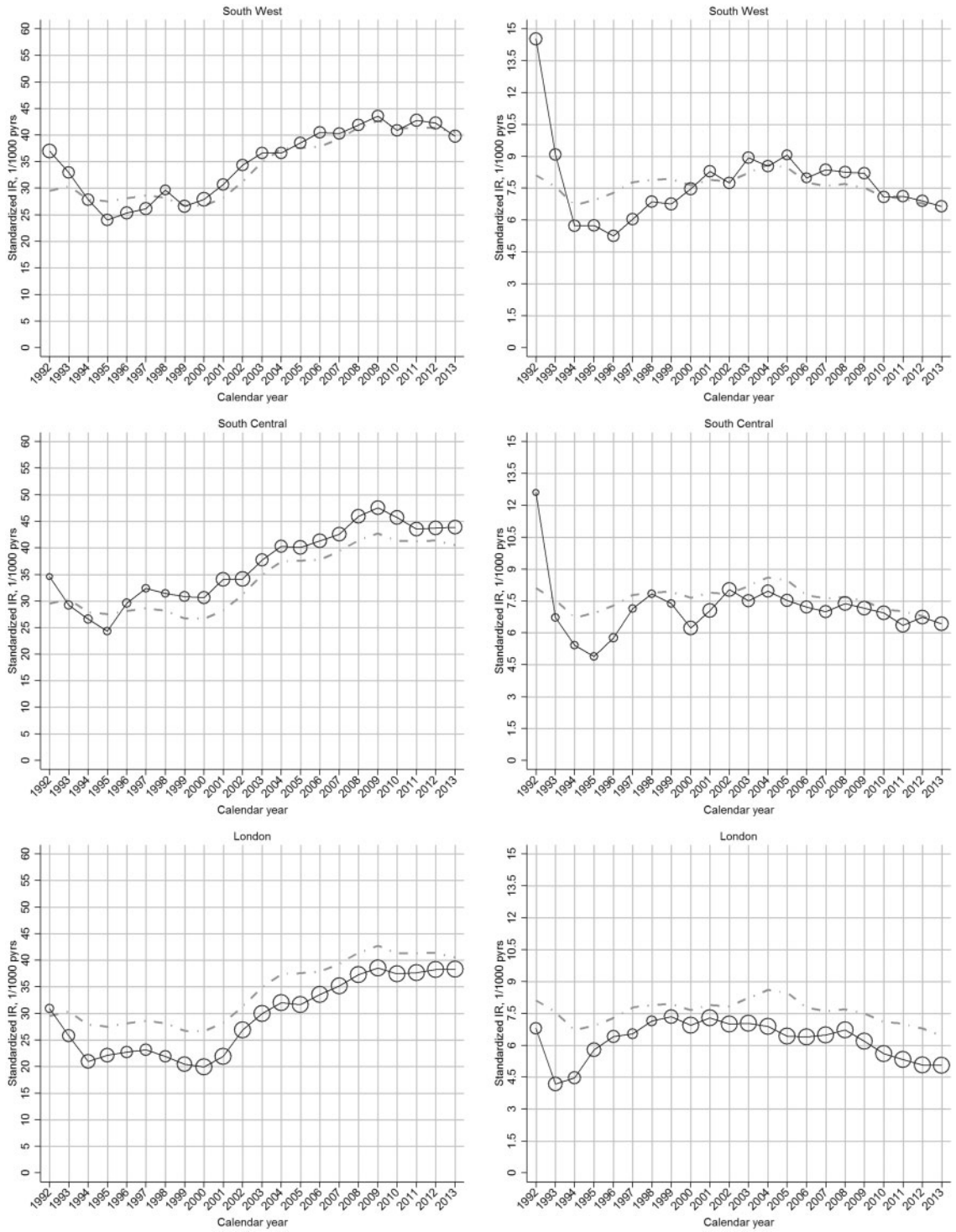

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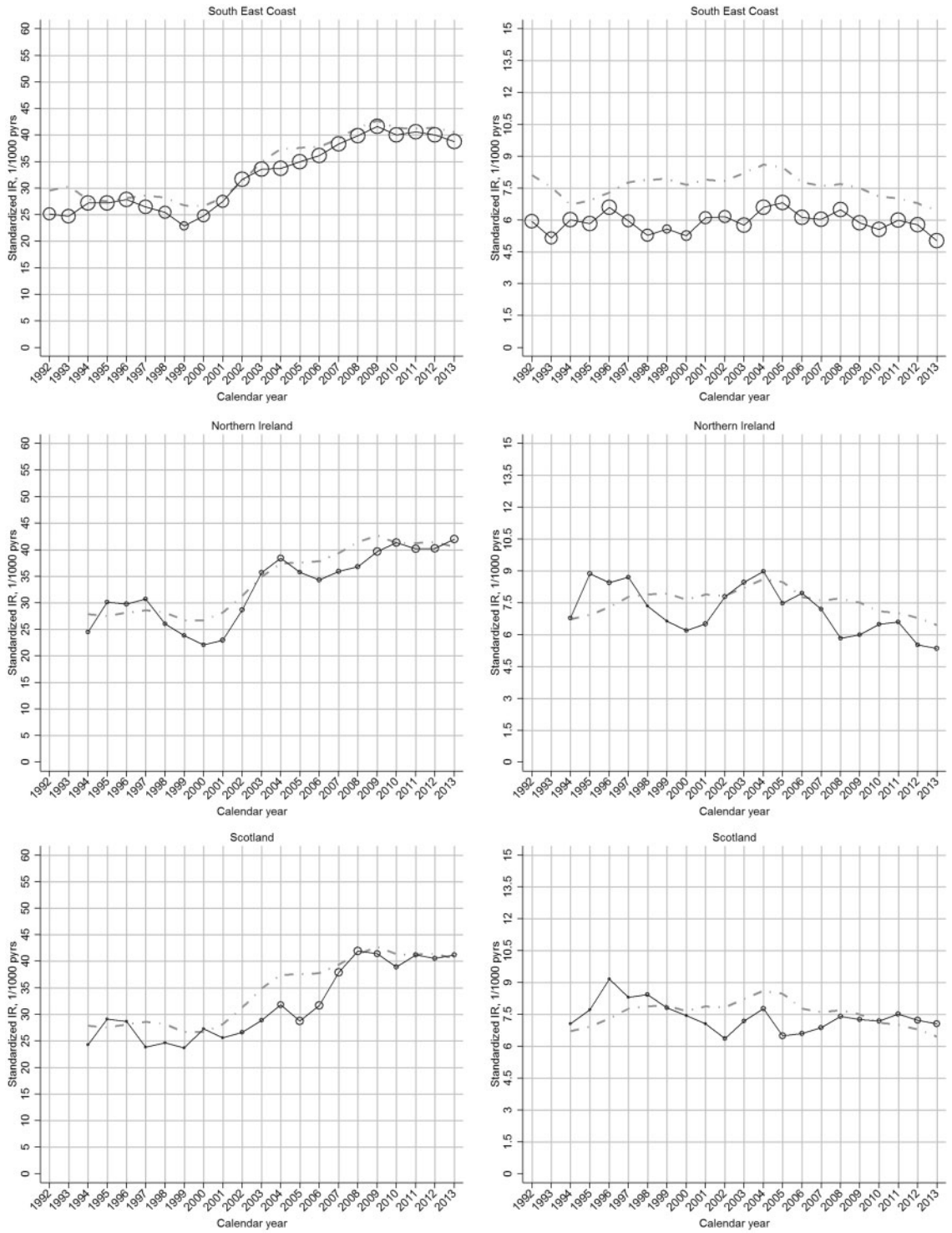

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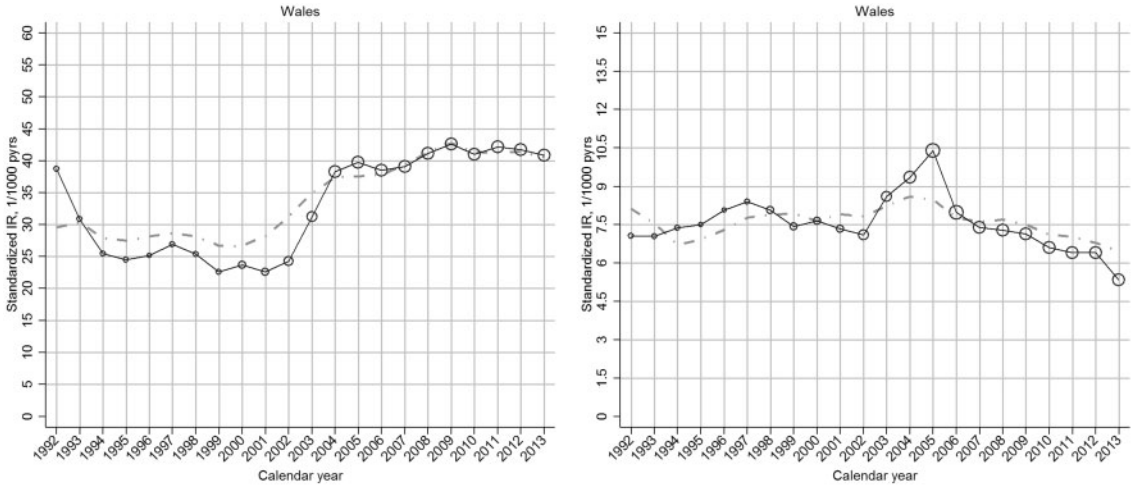

Discussion

OA is a significant and growing problem worldwide whether measured in terms of population burden or joint arthroplasty procedures. Primary care occupies a critical role in the response of healthcare systems to this public health challenge [33]. Our UK national study found that the incidence of clinical OA presenting to primary care—measured broadly as new cases of diagnosed OA and peripheral joint pain in patients aged over 45 years—increased between 1992 and 2013, reaching 40.5/1000 person-years in 2013. The majority of this increase was seen between 2000 and 2009 and affected all ages, birth cohorts and geographical regions, particularly those regions with the lowest rates before 2000. Beyond this strong period effect, however, we saw a continued increase in the consultation incidence of clinical OA for successive cohorts born after the mid-1950s, particularly women. In contrast, with the exception of hand OA, we observed no increase in the annual incidence of diagnosed cases of OA over the same period. Instead, rates declined from a high of 8.6/1000 person-years in 2004 to 6.3 in 2013.

Age-standardized incidence rates for physician-diagnosed OA reported in previous studies of health administrative and primary care electronic health record data in Canada [11, 12, 19, 20, 30], the Netherlands [21–23] and the UK [13] range between 5 and 17 cases per 1000 person-years. It is well-recognized that such rates are sensitive to the specific case definition adopted, the length of run-in period used to exclude prevalent cases, the capture and linkage of hospital data and other databases, population structure and the particular characteristics and incentives for coding behavior within different healthcare systems and databases. Against previously reported incidence rates, those in the current study for diagnosed OA in CPRD are comparatively low, something we also observed for estimates of consultation prevalence of musculoskeletal disorders [25]. It is notable that the average age at diagnosis of OA was 67.2 years in 2013—only 1 or 2 years less than the mean age of patients undergoing primary hip or knee arthroplasty for OA in the UK [34]. Attending only to consultations recorded with the diagnostic code of OA may therefore provide a late and partial view of demand for primary care in the UK. Incidence rate estimates for clinical OA are substantially higher, required a longer run-in period to exclude prevalent cases, showed stronger period effects, and most likely represent the upper limits of new cases of OA presenting to primary care. Importantly, observed trends in incidence rates of OA and clinical OA in the current study were not sensitive to the length of run-in period or to the dynamic nature of practice membership within CPRD over time.

An increasing incidence of clinical OA among recent birth cohorts is consistent with similar trends in obesity [35, 36]—a potent risk factor for OA [37, 38]—and the increased reporting and presentation of painful symptoms in general. In contrast, the relative stability of diagnosed OA rates argues against there having been major changes in the incidence of more severe OA in recent decades. In one of the few population-based studies of changes in the prevalence of knee OA symptoms and radiographic changes in the USA, Nguyen *et al.* [39] found substantial increases in self-reported knee pain but not radiographic OA between 1974 and 1994 after adjusting for changing distribution of BMI. Nevertheless, the observed trend of increasing incidence of clinical OA in recent birth cohorts may translate into future increased demand for joint arthroplasty beyond that driven by demographic change, and in the context of changing indications of the proportion of all clinical OA who may benefit from surgery or be referred for this.

The rising use of prescribed opioid analgesia is not limited to OA but has been previously highlighted in the UK and other high-income countries [28, 40–44]. This trend

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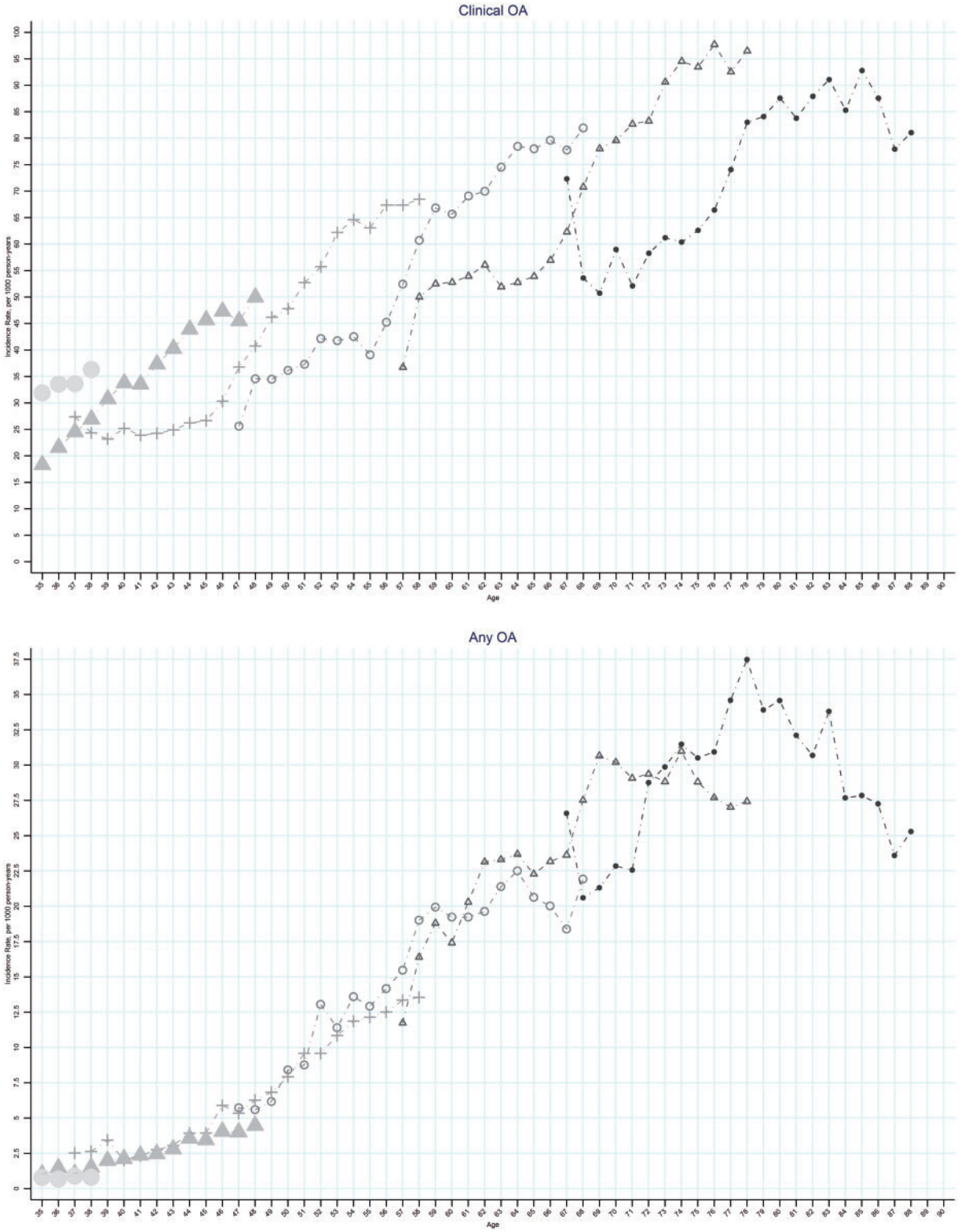
Fig. 3 Age-specific incidence rate of OA, by selected birth cohorts: UK, 1992–2013



Left panel: clinical OA; right panel: OA. Small circle indicates the birth cohort 1925; small open triangle indicates the birth cohort 1935; small open circle indicates the births cohort 1945; plus symbol indicates the birth cohort 1955; large solid triangle indicates the birth cohort 1965; large solid circle indicates the birth cohort 1975.

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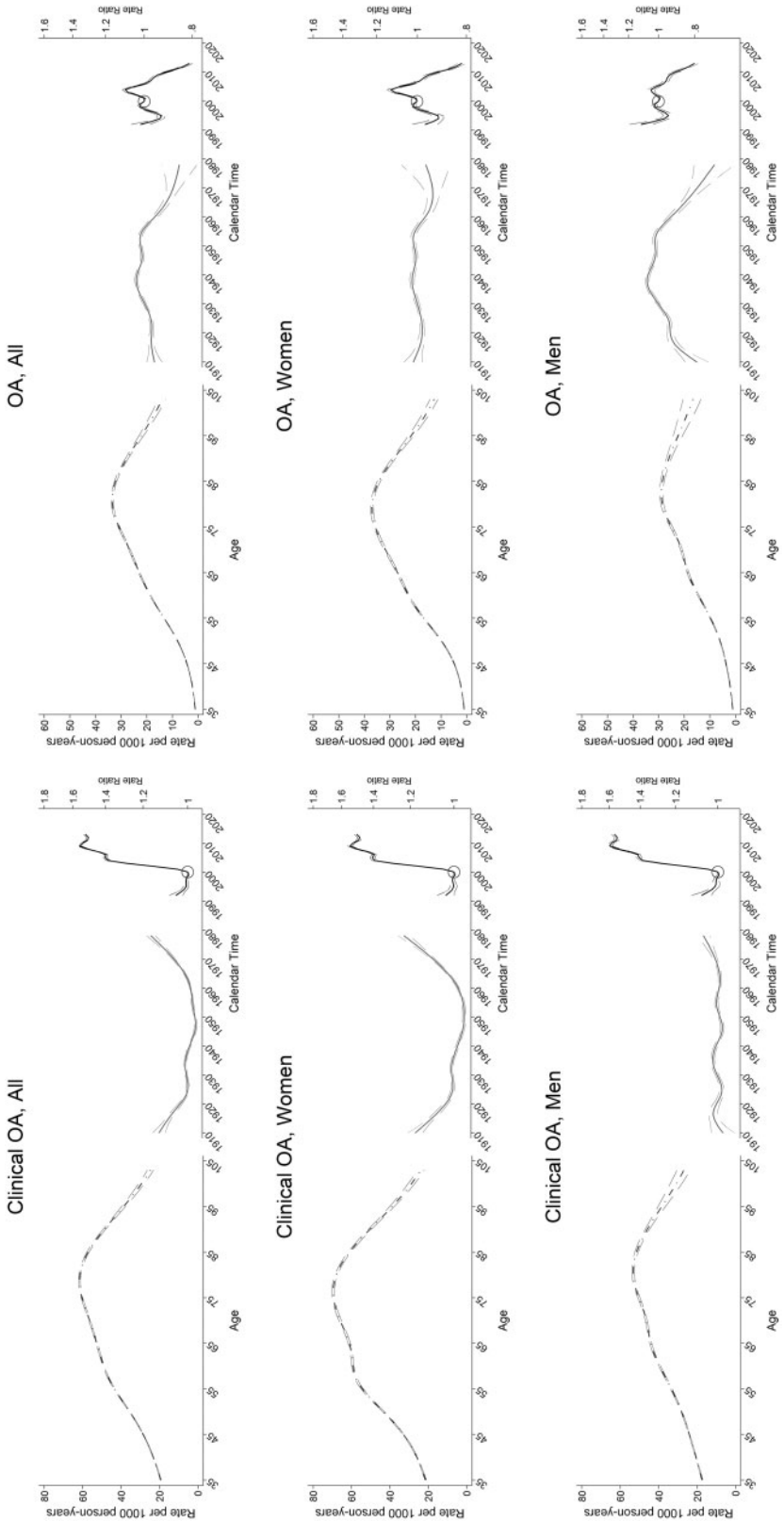

Fig. 4 Age-period-cohort influences on OA incidence, by gender: UK, 1992–2013

Left panel: clinical OA; right panel: OA. The age-specific rates (dark grey curve) are cross-sectional, referring to 2000 (open circle). Adjusted risk ratio (black curve) represents the period effect in 1992–2013, with 2000 as the reference. Adjusted risk ratio (light grey curve) represents the birth cohort from 1910 to 1980.

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Table 2 Analgesic prescriptions[a] among incident cases of OA: UK, 1992–2013

				Prescribed analgesia, %					
						Analgesics			
Year	Incident cases, n	Mean age, years	Female, %	COX-2	NSAIDs	Weak combination opioids	Moderate combination opioids	Strong combination opioids	Very strong single opioids
Case definition: clinical OA									
1992	2318	52.3	58.3	0.0	19.9	14.0	0.01	0.1	0.1
1993	11 101	51.9	57.5	0.0	21.3	14.0	0.1	0.1	0.1
1994	20 590	52.5	57.7	0.0	20.9	14.1	0.04	0.1	0.04
1995	24 091	53.2	58.4	0.0	20.4	15.6	0.1	0.1	0.1
1996	28 019	53.8	54.4	0.0	21.2	15.7	0.1	0.1	0.1
1997	31 163	53.9	58.0	0.0	21.5	15.4	0.2	0.1	0.1
1998	33 127	54.1	58.2	0.0	20.7	15.4	0.2	0.1	0.1
1999	33 820	54.3	58.4	0.3	20.0	14.5	0.2	0.1	0.1
2000	39 529	54.3	57.6	1.9	19.0	14.7	0.2	0.1	0.1
2001	48 723	54.6	57.8	3.5	19.3	14.3	0.3	0.04	0.1
2002	62 760	54.1	57.5	5.5	19.7	14.4	0.3	0.04	0.1
2003	83 876	53.7	57.1	6.6	19.8	13.8	0.3	0.1	0.1
2004	102 518	53.6	57.3	7.0	20.7	14.0	0.3	0.1	0.1
2005	112 689	53.6	56.8	0.9	19.4	14.2	0.4	0.1	0.2
2006	122 610	53.1	56.2	0.9	18.7	13.7	0.3	0.1	0.3
2007	132 437	53.0	56.0	1.0	18.6	14.1	0.4	0.1	0.3
2008	141 177	52.8	56.2	0.9	17.2	14.0	0.3	0.1	0.4
2009	145 550	52.7	55.6	0.8	16.6	14.0	0.3	0.1	0.4
2010	139 784	52.6	55.4	0.7	16.2	13.9	0.3	0.1	0.5
2011	138 460	53.0	56.0	0.5	15.6	14.2	0.3	0.1	0.5
2012	133 409	52.6	56.0	0.4	15.3	14.0	0.3	0.1	0.5
2013	128 502	52.7	56.1	0.4	14.9	14.0	0.3	0.1	0.5
Case definition: OA									
1992	733	64.2	59.6	0.0	22.9	18.1	0.0	0.1	0.0
1993	3323	65.3	60.7	0.0	25.6	20.1	0.0	0.1	0.1
1994	6064	65.4	62.7	0.0	26.0	19.6	0.0	0.1	0.0
1995	7432	65.7	63.2	0.0	23.7	21.8	0.1	0.0	0.1
1996	9111	66.0	61.9	0.0	25.8	22.7	0.2	0.1	0.0
1997	10 350	66.1	63.5	0.0	26.0	22.6	0.2	0.1	0.1
1998	11 266	66.3	62.6	0.0	24.3	23.0	0.3	0.0	0.1
1999	12 101	66.3	62.8	0.7	24.3	21.4	0.3	0.0	0.0
2000	14 021	66.2	62.4	3.8	24.6	22.1	0.4	0.1	0.0
2001	16 731	66.5	62.6	6.9	25.4	21.3	0.4	0.1	0.1

(continued)

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Table 2 Continued

Year	Incident cases, n	Mean age, years	Female, %	Prescribed analgesia, %						
							Analgesics			
				COX-2	NSAIDs	Weak combination opioids	Moderate combination opioids	Strong combination opioids	Very strong single opioids
2002	19 326	66.5	62.9	10.3	27.2	21.6	0.6	0.1	0.1
2003	24 269	66.6	62.8	12.1	26.9	21.6	0.6	0.1	0.2
2004	28 438	66.6	63.8	12.4	27.0	21.8	0.6	0.1	0.2
2005	30 828	66.8	62.6	1.8	21.0	22.6	0.9	0.1	0.4
2006	30 663	66.9	62.7	1.5	18.2	21.7	0.7	0.1	0.6
2007	31 174	66.8	61.8	1.7	17.5	21.5	0.7	0.2	0.7
2008	32 364	66.7	62.0	1.6	16.0	21.2	0.7	0.1	0.9
2009	31 889	66.6	61.2	1.5	14.9	21.3	0.7	0.2	1.1
2010	30 004	66.7	61.2	1.3	14.2	20.6	0.7	0.2	1.3
2011	29 448	67.0	61.5	1.1	13.5	20.9	0.6	0.2	1.2
2012	27 483	66.8	61.3	0.9	12.9	20.2	0.6	0.1	1.3
2013	25 145	67.2	61.6	0.6	12.5	19.7	0.5	0.2	1.2

[a]Prescriptions issued within 14 days after incident OA consultation.

needs to be seen also in the context of rising levels of multimorbidity and co-pharmacy among cases of OA. We found that new cases of OA will often have multiple different prescribed medicines. While the definition used in our study could include short-term prescriptions and different analgesic prescriptions, nevertheless we interpret these data as consistent with the findings of Melzer *et al*. [45] who reported high and rising prevalence of polypharmacy and multimorbidity in patients aged >65 years, and particularly aged >85 years in the period 2003–04 to 2011–12. This trend is likely to present increasing challenges for the selection and use of pharmacological, non-pharmacological and surgical treatments for OA. The temporal pattern of paracetamol use was not presented in this study because a large fraction of paracetamol use would be from over-the-counter supply and the prescribed supply would largely reflect the age of exemption from prescription costs. Less well-documented is the continued high use of radiographic investigations despite guidelines over the past two decades consistently highlighting their limited role in the assessment and diagnosis of OA [46–48]. Utilization of MRI to aid OA diagnosis was not part of our original protocol submitted to, and approved, by the Independent Scientific Advisory Committee: the validity of coding MRI has yet to be investigated in CPRD and this is perhaps a future study. We also refrained from analysing the temporal pattern of BMI among incident cases, because in CPRD, the completeness of BMI changed over time, that is, 37% in 1990–94 and 77% in 2005–11, and varied by female and age (higher in female gender and increased with age) [14]. The trend of BMI/obesity among incident OA cases would be significantly affected by the completeness of BMI, which is almost certainly missing not at random (i.e. the reason for not having a recorded BMI is related to your BMI; for example, only people who are overweight or have some other risk factors or health conditions will have their BMI recorded).

Some additional limitations should be mentioned. The true incidence of joint-specific OA will be underestimated due to practitioners using general codes (e.g. OA), particularly for patients presenting with multiple affected joints. Our estimates of knee OA in particular are low by comparison with other published primary care incidence rates [24]. We used a stand-alone primary care database and in other health conditions the importance of linked secondary care records for complete capture of cases has been demonstrated [49]. The proportion of cases of OA diagnosed in secondary care and not recorded in the CPRD primary care database is not known but in the Canadian studies, physician claims accounted for 80–90% of cases [30] and the general practitioner for 84% of all cases identified from visits to health professionals [11]. A similar contribution from secondary care diagnoses to OA prevalence estimates was seen in Swedish healthcare registry data [26]. Cases diagnosed as OA in secondary care are nevertheless likely to be captured within the primary care health record using our broader definition of clinical OA.

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Conclusions

Between 1992 and 2013, the age-standardized incidence of all clinical OA increased while that of diagnosed OA remained stable or even declined. Amid strong period effects, cohorts born after the mid-1950s are showing higher incidence rates of clinical OA than previous generations at the same age. Prescribed opioid analgesia and plain radiography appear to be over-used.

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Supplementary data

Supplementary data are available at *Rheumatology* Online.

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