

# Estimating smoking prevalence in general practices: an evaluation of QOF (Quality and Outcomes Framework) data

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# TITLE

- Estimating smoking prevalence in general practices: an evaluation of QOF (Quality and Outcomes Framework) data

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### **KEYWORDS**

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# ABSTRACT

### Background

Reliable estimates of smoking prevalence in general practice populations are useful when comparing practice-level health outcomes, and informing intervention targeting in primary care.

This paper explores whether data based on patients' medical records, published as part of the Quality and Outcomes

Framework (QOF), can be used to estimate smoking prevalence within practice populations, and evaluates the usefulness of these estimates.

### Methods

Cross-sectional analysis of 215 practices in three East Midlands PCTs. Simple manipulations of QOF indicator data
 provide smoking prevalence estimates in general practice populations and among patients with chronic conditions.
 Bland-Altman limits of agreement between estimates from the integrated household survey (IHS) and aggregated QOF based estimates were calculated. The impact of including smoking estimates in negative binomial regression models of
 counts of premature CHD deaths was assessed.

### Results

Median smoking prevalence in the practice populations for 2012/13 was 19.2% (range 5.8% to 43.0%). There was good agreement (mean difference: 0.39%; 95% limits of agreement (-3.77, 4.55)) between IHS estimates for local authority districts and aggregated QOF register estimates. Smoking prevalence estimates in those with chronic conditions are lower than for the general population (mean difference -3.05%), but strongly correlated (R<sub>p</sub>=0.74, p<0.0001). An important positive association between premature CHD mortality and smoking prevalence was shown when smoking prevalence was added to other population and service characteristics.

### Conclusions

Published QOF data allow useful estimation of smoking prevalence within practice populations and in those with chronic accorditions; the latter estimates may sometimes be useful in place of the former.

### Strengths and Weaknesses

- This paper clearly demonstrates that useful estimations of smoking prevalence within practice populations can be calculated from routine data published through the Quality and Outcomes Framework (QOF).
- Our analysis shows that estimates of smoking prevalence in those with chronic conditions can be used in some situations in place of an estimate for the general population, if this is not available.
- QOF data rely on self-reported smoking status, recorded in the previous 27 months, which may underestimate smoking status or the effectiveness of interventions.
- This study does not have access to individual patient data limiting our understanding of patients who do not have smoking status recorded and the possible impact of missing data on estimates of smoking prevalence.

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### Background

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2 Despite smoking prevalence in England falling "below 20% for the first time in 80 years", [1] reducing smoking remains a 3 4 key public health priority in England as in many countries, with local authorities and primary care services being 5 expected to play a key role in local tobacco control services.[2] In addition, clinical commissioning groups (CCGs), 6 membership organisations responsible for planning, organising and purchasing nationally funded healthcare within their 7 local areas have their own health targets. Reducing smoking prevalence is a key component of many targets, for 8 example reducing chronic obstructive pulmonary disease (COPD) outcomes [3] and reducing inequalities in coronary 9 heart disease (CHD).[4] Access to reliable estimates of smoking prevalence in practice populations is useful to assess 10 Protected by copyright, including for uses need, inform targeting of interventions delivered through primary care and to evaluate those interventions. In addition, 11 12 research into a variety of health outcomes and their associations with primary care needs to take characteristics of the 13 practice populations into account. Currently a variety of measures of smoking prevalence in practice populations are 14 being used [5-6] and some do not include smoking, [7-9] despite the recognized associations between smoking 15 prevalence and a range of chronic conditions.[10] 16

### **National Survey** 17

In England, there are various national surveys of smoking prevalence including the Health Survey for England; [11] the 18 General Lifestyle Survey; [12] the Smoking Toolkit Study (STS) and the Integrated Household Survey (IHS). The IHS began 19 20 in 2009; a composite survey including questions on smoking habits (over 420,000 adults in 2011). IHS statistics are 21 designated as experimental, in a 'testing phase' and not yet fully developed, [13] but estimates are available for local 22 authorities. None of these surveys aims to establish the smoking prevalence within practice populations. 23

### **Patient records** 24

Analyses of individual patient records, using the THIN (The Health Improvement Network) [14] and QRESEARCH [15] 25 databases, provide strong evidence that smoking status within primary care medical records could be used to monitor 26 27 national smoking patterns. There was good agreement between smoking prevalence based on medical records in the 28 THIN database and those predicted by GHS; 22.4% compared to 21.8% respectively in males; 18.9% compared to 20.2% 29 respectively in females.[16] Estimates of smoking prevalence based on the medical records in the QRESEARCH database 30 has also shown good agreement with national surveys, in this case the Health Survey for England.[17] 31

### QOF 32

The national Quality and Outcomes Framework (QOF) was introduced in England in 2004 to improve the quality of 33 primary care for patients. Since its inception QOF has included indicators relating to smoking.[8] The underlying aim of 34 35 these indicators has not changed over the years; a) practices should record smoking status in patient notes and, b) for 36 those who smoke, smoking cessation advice/support/treatment should have been offered. Until 2012/13 the focus was 37 on targeting smoking cessation advice to those with chronic conditions. Table 1 summarises QOF smoking indicators 38 39

on targeting smoking cessation advice to those with chronic conditions. Table 1 summarises QOF smoking indicators 2006/7 – 2014/15. The QOF indicators have not been designed to determine smoking prevalence within the practice population; indeed it is clearly stated that 'QOF provides no information on numbers of smokers and non-smokers',[19] attributing this mainly 40 41 42 to the condition-specific nature of the indicator. The wording has not changed since the inclusion of the two new and similar technologies

43 indicators which apply to the general population and are not condition-specific.

### 44 Objective

45 In this paper we aim to explore to what extent underlying data published as part of QOF can be used to estimate 46 smoking prevalence within practice populations and to evaluate the usefulness of such estimates. 47

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## **METHOD**

# Sample

All practices within three primary care trusts (PCTs) (2006/07 to 2011/12) in the East Midlands were eligible for inclusion in the study. 215 practices with QOF data available for the seven financial years were included in the analysis. 14 practices were excluded because they lacked data for all seven years. One practice was excluded from the study as it served a restricted practice list; another practice was excluded from the study as 2012/13 QOF data strongly suggested an error. 

## Manipulation of QOF data

In order to estimate smoking prevalence, both the number of people who smoke and the population from which this number is drawn must be known. Two key QOF indicators are used in the calculations of smoking prevalence in the total practice population: 

- SM07 'The percentage of patients aged 15 years and over whose notes record smoking status in the preceding 27 months'.
- SM08 'The percentage of patients aged 15 years and over who are recorded as current smokers who have a record of an offer of support and treatment within the preceding 27 months'.

Protected by copyright, including In this analysis the denominator of the smoking cessation indicator was used as a measure of the number of people who smoke; the population was based on the denominator of the smoking status indicator. 

In addition indicators of a similar nature were included but applying to those with any, or any combination, of a range of QOF specified chronic conditions (SM05 and SM06). for uses

QOF data can be downloaded from the Health and Social Care Information Centre website containing information for all practices in a region; [20] Table 2 illustrates the type of data available. 

Using the data given for these indicators it is possible to estimate the smoking prevalence in a practice population. For example, for practice A the denominator for SM07 is 3721 – the number of people for whom smoking status should be determined. This includes the whole practice population aged over 15, with the exception of people who have joined the practice in the three months prior to the data extraction point and patients who refuse to provide their smoking status. The denominator for SM08 is 1129 - indicating that there are 1129 registered patients recorded as smokers. Hence 

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A service of the practice population with a chronic "...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with districts and unitary authorities.[21] Data at practice level have been combined to ...with the setimate of smoking prevalence was included in a model to determine the associations of premature CHD (under 75) the setimate of smoking prevalence for practice population...with the setimate of smoking prevalence was included in a model to determine the associations of premature CHD (under 75) and a to premature CHD deaths (between April 2006 and March 2009) were of elevel wave been ongli and service characteristics; the methods are described by Honeyford et al.[Error] "efference source not found.] Here, counts of premature CHD deaths (between April 2006 and March 2009) were of premature CHD deaths (between April 2006 and March 2009) were of premature CHD deaths (between April 2006 and March 2009) were of set of the general population was not available for this year. 

### RESULTS

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### Estimation of overall smoking prevalence using QOF smoking indicators 2012/13

# The median underlying achievement for the recording of smoking status in the total practice population was 88.1% in

- 3 2012/13 (IQR: (83.7, 91.0)). The median estimate of smoking prevalence in practice populations was 19.2%, ranging from 4
- 5 5.8% to 43.0% (IQR: (15.1%, 22.9%)). Estimates of smoking prevalence were in line with estimates derived from the IHS.
- 6 Aggregating over the total area, smoking prevalence was 19.5%, compared to 19.3% when IHS district level data were 7 aggregated over the same area. When practice data were combined to give estimates of smoking for local authority
- 8 districts there was a strong positive correlation ( $R_p$ =0.86, p<0.0001) and good agreement (mean difference: 0.39%; 95%)
- 9 limits of agreement (-3.77, 4.55)) between estimates based on QOF registers and IHS estimates (Fig. 1).[22] 10
- Estimates of smoking prevalence in those with chronic conditions using QOF smoking indicators 2012/13 11
- The underlying achievement for recording smoking status in those with chronic conditions was higher than for the total 12 13 practices population (96.6% IQR (95.0, 97.7)). The median practice based estimate for those with any or any
- Protected by copyright, including 14 combination of a specific list of chronic conditions was 15.4% (IQR: 12.6% to 19.4%), ranging from 7.1% to 51.5%. When 15 the estimates of prevalence for those with chronic conditions were aggregated into local authority districts, estimates 16
- were lower than IHS estimates for the majority of areas. 17

### Association between smoking prevalence in the general practice population and those with chronic conditions. 18

- Smoking prevalence in those with chronic conditions is lower than in the general practice population. The mean 19
- difference between the two estimates was -3.05% (95% limits of agreement: (-8.65, 1.56)). The Bland-Altman plot does 20
- 21 not suggest a strong pattern, despite some evidence that the difference increases as the average increases (Fig. 2).
- 22 There was a strong positive correlation ( $R_p=0.92$ , p<0.0001) between the overall estimate of smoking prevalence within There was a strong positive correlation ( $R_p$ =0.92, p<0.0001) between the overall estimate of smoking prevalence within a practice population and in those with chronic conditions. A regression model was developed to predict smoking prevalence in the general population based on the prevalence in those with chronic conditions; removal of outliers improved model fit. Associations between recording of smoking status and prevalence There was a strong positive correlation between recording of smoking status in the general population and in those with the general population and in the general population and population and population and population and population and population and populati 23 24 25 26
- 27
- 28 to text 29 chronic conditions (underlying achievement for SM07 and SM05 respectively) ( $R_0$ =0.74, p<0.0001). There was no
- 30 evidence of an association between smoking prevalence in the general population and recording of smoking status (R<sub>n</sub>=-31 0.07, p=0.28) or the percentage with a chronic condition ( $R_p=0.03$ , p=0.67).
- 32 QOF smoking indicators 2006/07-2012/13 33
- The estimates of smoking prevalence in those with chronic conditions have been consistent since 2006/07, with the 34 median varying slightly during that time. Concordance was high between estimates for all years; Lin's concordance 35 coefficient [23] was greater than 0.92 and mean difference was less than one in all cases (Table S1 in Appendix for more 36 37 details).

# 38

- details). Including smoking prevalence estimates in models of mortality Table 3 shows incident rate ratios, 95% CIs and associated p values for the original and modified models. Inclusion of the smoking prevalence variable in the model reduced the strength of the associations between deprivation and premature 39 40 41 mortality, and percentage white and premature mortality. A one unit increase in smoking prevalence was associated , and similar technologies 42 with an increase of 3.2% in expected premature CHD mortality count. If a practice with a moderately high smoking 43 prevalence (75<sup>th</sup> percentile: 18.86%) is compared to one with a median level of smoking prevalence (15.09%), a 44 45 difference of 11.69% in premature CHD mortality count can be expected, after adjusting for the other variables in the 46 model.
- 47 Sensitivity analysis considering the impact of exception reporting indicates no impact on interpretation (see Doran for 48 details of exception reporting [24]). 49

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### DISCUSSION

## Principal findings

These results show how QOF registers can be used to estimate smoking prevalence in practice populations and that
 these estimates are useful when analysing patterns of mortality.

When smoking prevalence is estimated in the general population using QOF indicators there is good agreement with
 estimates of IHS smoking prevalence for similar geographical areas.

8 QOF data can also be used to estimate smoking prevalence in those with chronic conditions, which is generally lower 9 than smoking prevalence in the general population. There is good agreement between the estimates in successive years. 10 The correlation between estimates of smoking prevalence in the general population in 2012/13 and those with chronic 11 conditions is strong. These strong correlations suggest that the estimates based on previous years can be used in place 12 13 of smoking prevalence in the general population for some purposes. Regression analysis suggests that smoking 14 prevalence in those with chronic conditions can be used to predict smoking prevalence in the general practice 15 population, for practices with a typical patient list. 16

When an estimate of smoking prevalence in those with chronic conditions was used in a study of the association
 between premature CHD mortality and various population and service characteristics an important positive association
 between CHD mortality and smoking prevalence was shown.

## 22 Strengths and weaknesses

The agreement between IHS based area estimates of smoking prevalence and estimates based on combining QOF data provides evidence to suggest that manipulating QOF data results is a useful measure of smoking prevalence within practice populations when compared to other available measures. This is supported by the work of Szatkowski et al [16] which found good agreement between national smoking prevalence predicted by patient records and the General Household Survey.

29 When comparing practices and analysing patterns across practices, it is important that the estimate is consistent across 30 practices. The percentage of patients who do not have their smoking status recorded varies from 40% to less than 1%, 31 the characteristics of these patients are not known. Recording of smoking status has been shown to vary between 32 groups [17, 18, 25]; women, older people and those with chronic conditions were more likely to have their smoking 33 status recorded. National surveys suggest that smoking rates are lower in these groups and therefore smoking 34 prevalence from QOF may underestimate actual smoking prevalence. The implications of this will vary between 35 36 practices, dependent on the proportion of these groups within their practice populations. Our analysis did not find an 37 association between the percentage with a chronic condition and the recording of smoking status in the total population 38 or the estimate of smoking prevalence. 39 QOF data are based on self-reported smoking status, which has been shown to be reliable in the general population, [25] 40 but to underestimate smoking prevalence in pregnant women. [26] In addition, practices are only asked to record 41

smoking status in the preceding 27 months, meaning the estimates may be useful in assessing need and analysing associations, but will have disadvantages in assessing the effectiveness of interventions, unless practices commit to more regular recording.

Practice level data have been aggregated to local authority districts based on practice postcode rather than patient postcodes; it is relatively common for practice postcodes to be used as a proxy for patient postcodes but when used to estimate deprivation has been found to underestimate relationships between deprivation and health outcomes.[27-28] Further work using individual patient records is necessary to analyse the frequency of recording of smoking status and the characteristics of patients for whom no smoking status is recorded or have been excluded on the basis of exception reporting.

# 53 Implications

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Having estimates of the smoking prevalence in practice populations is important to those tasked with reducing smoking rates and improving the nation's health. CCGs and public health departments in local authorities need them to target smoking cessation and other additional resources. Understanding more about the patient populations would enable similar practices to be compared when considering differences in health outcomes and the apparent effectiveness of interventions.[26]

When estimates of smoking prevalence are included in the analysis of the associations between premature CHD mortality and practice population and service characteristics, there are reductions in magnitude of the incident rate ratios (IRRs) for both deprivation and percentage white. This suggests that these may be acting as surrogate markers of other lifestyle factors, such as smoking prevalence. Hence, the lack of reliable smoking information may be leading to relative over emphasis being placed on socio-economic deprivation, often described using an index of multiple factors. Similarly, it was found that social class was not linked to hospital admissions for stroke and CHD when rates were adjusted for various factors including smoking.[27] However, even with smoking prevalence included in the models, Brettell et al [29] found that increased deprivation was associated with higher heart failure admission rates, and Purdy et al [6] found that higher deprivation was associated with increased emergency admissions for myocardial infarction and angina. Unless we have reliable measures of smoking prevalence it is difficult to determine the relative importance of deprivation and other characteristics in explaining inequalities in a variety of health outcomes.

Smoking prevalence in those with chronic conditions is typically lower than in the general population. This may be due to diagnosis increasing motivation to guit smoking, [29] the increase in smoking cessation advice and support [30] or the age and gender profile of those with chronic conditions. Smoking prevalence in those with chronic conditions has not reduced over the seven year period, possibly suggesting that smoking cessation advice has limited effect, but may be due to the turnover of patients with chronic conditions as a result of both premature mortality and new diagnoses. A wide range of smoking cessation advice and support has recently been reviewed by Zwar et al;[31] consideration of how these impact on those with chronic conditions is recommended as a result of this finding. 

QOF smoking indicators have changed since 2004 and continue to change. The introduction, in 2012/13, of an indicator which allows estimates of the smoking prevalence within the general population is useful for researchers as well as CCGs and public health officials. The removal of the indicator that covers the recording of smoking status in the total population from QOF in 2014/15 will impact on the methodology described in this paper, although the number of patients who are recorded as current smokers will continue to be available. The population of the practice will need to be used as the denominator in the calculation of smoking prevalence. It will be important to determine if the smoking status declines after the removal of the indicator; a recent study suggests that removal of indicators does not lead to a decline in clinical activities.[32] 

**Conclusion** Data published through QOF allow useful estimations of smoking prevalence within practice populations and in those with chronic conditions to be made. These estimates are important in developing our understanding of differences in health outcomes between practices, and are useful to both individual practices and CCGs when comparing practice level set health outcomes, to assess need and to inform targeting. Revisions to QOF means that researchers will need to update methodology as indicators change. 

### Table 1 Summary of smoking indicators for which underlying achievement is published

	Patient group				
General form of the indicator	Patients with any, or any combination of the following conditions: coronary heart disease, stroke or TIA, hypertension, diabetes, COPD or asthma <sup>1</sup> .	All patients aged 15 years+			
% of patients whose notes record	SM01: 2006/07 & 2007/08	Records 22: 2006/07 & 2007/08			
smoking status <sup>2</sup>	SM03: 2008/09 – 2011/12	Records 23: 2008/09 – 2011/12			
	SM05: 2012/13	SM07: 2012/13			
	SMOK002: 2013/14 – 2014/15	SMOK001: 2013/14 – retired in 2014/15			
% of patients who are recorded as	SM02: 2006/07 & 2007/08	SM08: 2012/13			
current smokers whose notes	SM04: 2008/09 – 2011/12	SMOK004: 2013/14 – 2014/15			
contain a record that smoking	SM06: 2012/13				
cessation advice or referral to a	SMOK005: 2013/14 – 2014/15				
specialist service, where available,					
has been offered within the					
previous 15 months <sup>3</sup>					
The practice supports smokers in stopping smoking by a strategy		Information 5: 2006/07-2011/12 SMOK003: 2012/13 – 2014/15			
which includes providing literature		311010003. 2012/13 = 2014/13			
and offering appropriate therapy.					
<sup>1</sup> In 2008/09 CKD, asthma, schizophrenia, bipolar was added. <sup>2</sup> For those with chronic conditions, the record mo	affective disorder or other psychoses were added to th ust have been made in the past 15 months, reduced to a				
<sup>1</sup> In 2008/09 CKD, asthma, schizophrenia, bipolar was added. <sup>2</sup> For those with chronic conditions, the record m 27 months, reduced to 24 months in 2013/14.	ust have been made in the past 15 months, reduced to a offer of support and treatment within the precedir	12 months in 2013/14, for all patients the p			
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# Table 2 Example of QOF data from 2012/13, showing how it can be used to calculate smoking prevalence for individual practices.

				Example pract	ices	
QOF	Interpretation for	A	В	С	D	E
lescription	purposes of calculating smoking prevalence					
M07 Points		11	10.5	10.8	9.6	11
M07 Iumerator	Patients <sup>1</sup> whose notes contain a record of smoking status	3450	1319	6276	31948	11 6504 7212 90.20% 12
M07 Denominator	Patients who are eligible to be included in this indicator <sup>2</sup>	3721	1497	7033	37654	7212
M07 UA		92.70%	88.10%	89.20%	84.80%	90.20%
M08 Points		12	9.9	12	8.9	12
M08 Jumerator	Patients who are recorded as current smokers and have a record of an offer of support etc	1024	325	1578	8439	2165
M08 Denominator	Patients who are recorded as current smokers	1129	401	1586	10931	2373
M08 UA		90.70%	81.00%	99.50%	77.20%	91.20%
	Calculation to determine percentage who are smokers SM08 den/ SM07 den	1129/3721	401/1497	1586/7033	10931/37654	2373/7212
	Estimate of smoking prevalence	30.30%	26.80%	22.60%	29.00%	32.90%
<sup>1</sup> Patients aged ov For example patie	nts who are newly registered with the	e practices (less th	an three months)	are excluded from	n the indicator	

### Table 3 Estimated incident rate ratios (IRRs) for premature (U75) CHD mortality count (n=215)<sup>1</sup>.

	<i>without</i> smoking prevalence variable				<i>with</i> smoking prevalence variable		
Explanatory variable	IRR	95% CI	p value		IRR	95% CI	p value
Percentage white patients	1.007	(1.003,	0.002		1.001	(0.995,	0.657
		1.012)				1.007)	
Deprivation score (IMD 2007)	1.017	(1.011,	<0.0001		1.005	(0.995,	0.348
		1.024)				1.015)	
Prevalence of diabetes (QOF	1.108	(1.020,	0.015		1.095	(1.008,	0.031
2006/07)		1.203)				1.187)	
Percentage over 65	1.060	(1.038,	< 0.0001		1.067	(1.044,	< 0.000
		1.083)				1.091)	
Percentage male patients	1.073	(1.035,	< 0.0001		1.058	(1.021,	0.002
		1.111)				1.097)	
Number of GPs per 1000 patients	1.209	(0.894,	0.218		1.113	(0.821,	0.491
		1.637)		_		1.508)	
Hypertension detection 2006/07	0.984	(0.955,	0.300		0.988	(0.959,	0.416
(QOF 2006/07)	6	1.014)		_		1.018)	
% patients offered smoking	1.006	(0.996,	0.271		1.010	(1.000,	0.057
cessation advice (SM02 - QOF		1.016)		_		1.021)	
2006/07)							
% serum cholesterol (CHD08 - QOF	0.989	(0.980,	0.028		0.992	(0.983,	0.109
2006/07)		0.999)				1.002)	
% aspirin (CHD09 - QOF 2006/07)	1.007	(0.986,	0.514		1.003	(0.982,	0.777
		1.029)				1.025)	
% of patients with recalled	0.995	(0.990,	0.069		0.995	(0.990,	0.061
perception of being able to see		1.000)				1.000)	
preferred GP (QOF 2006/07)							
%smoking prevalence – estimated					1.031	(1.012,	0.002
(QOF 2006/07)						1.052)	

<sup>1</sup>IRR, 95% confidence intervals and associated p values as a result of negative binomial model of count of premature mortality caused by CHD.



### **Competing Interests**

KH had financial support from CLAHRC in the form of funding for PhD fees. RB is in receipt of an NIHR Senior Investigator award. No financial relationships with any organisations that might have an interest in the submitted work in the previous five years; no other relationships or activities that could appear to have influenced the submitted work.

### Authors' contributions

### **Contributor Statement**

The study was conceived by KH, RB, JB and DJ. KH designed the study, carried out the analysis and drafted the initial manuscript. JB and DJ contributed to the statistical analysis. RB, JB and DJ contributed to drafting and editing the final manuscript and interpreting and reviewing the results of the statistical analysis.

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### Ethical committee approval

NRES advised that NHS ethics committee was not required.

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1 2 3 4 5	<ul> <li>1 Relationship between aggregated QOF estimates and IHS estimates for local authority districts         Fig 1a Association between estimates (dashed line: estimates are equal)         Fig 1b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement)         QOF estimates based on 2012/13 data; IHS estimates based on 2011/12 survey.     </li> </ul>	
6 7 8 9 10 11 12 13	<ul> <li>2 Relationship between QOF estimates for the general population and those with chronic conditions (2012/13)</li> <li>Fig 2a Association between estimates (dashed line: estimates are equal; solid line: fitted line)</li> <li>Fig 2b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement)</li> <li>SM07 and SM08 (2012/13) used for QOF estimates for the general population;</li> <li>SM05 and SM06 (2012/13) used for QOF estimates for those with chronic conditions.</li> </ul>	Protected by
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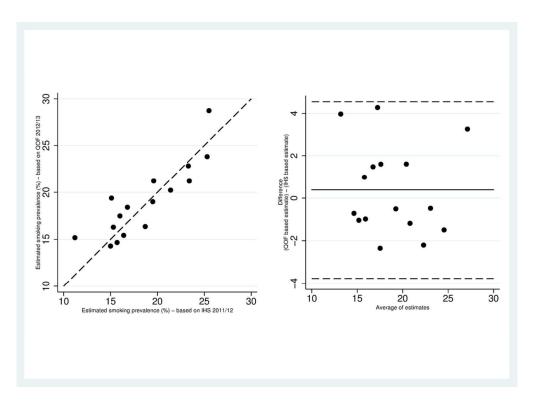


Figure 1 Relationship between aggregated QOF estimates and IHS estimates for local authority districts Legend Fig 1a Association between estimates (dashed line: estimates are equal)

Fig 1b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement)

QOF estimates based on 2012/13 data; IHS estimates based on 2011/12 survey.

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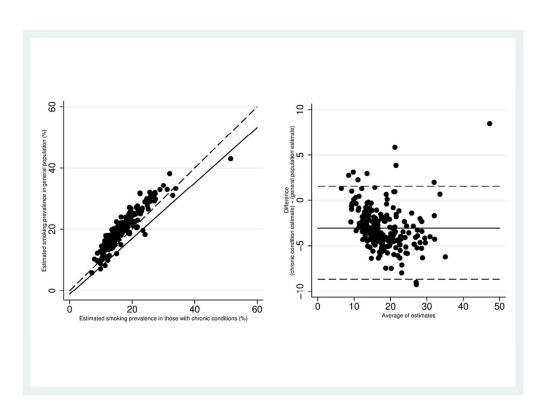


Figure 2 Relationship between QOF estimates for the general population and those with chronic conditions (2012/13)

Legend Fig 2a Association between estimates (dashed line: estimates are equal; solid line: fitted line) Fig 2b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement)

SM07 and SM08 (2012/13) used for QOF estimates for the general population; SM05 and SM06 (2012/13) used for QOF estimates for those with chronic conditions.

101x73mm (300 x 300 DPI)

Year	2012/13	2011/12	2010/11	2009/10	2008/09	2007/08
2011/12	0.97					
	-0.15 <sup>1</sup> (-2.4, 2.7) <sup>2</sup>					
2010/11	0.97	0.97				
	-0.12 (-2.8, 2.6)	0.04 (-2.6, 2.7)				
2009/10	0.96	0.96	0.99			
	-0.12 (-3.3, 3.0)	-0.03 (-3.2, 3.2)	0.00 (-2.0, 2.0)			
2008/09	0.95	0.95)	0.97	0.98		
	0.06 (-3.5, 3.7)	0.22 (-3.4, 3.8)	0.18 (-2.5, 2.9)	0.19 (-1.9, 2.3)		
2007/08	0.93	0.93	0.95	0.96	0.97	
	0.71 (-3.0, 4.6)	0.87 (-3.0, 4.8)	0.83 (-2.4, 4.0)	0.84 (-1.8, 3.5)	0.65 (-1.74, 3.0)	
2006/07	0.93	0.92	0.94	0.94	0.95	0.97
	0.64 (-3.6, 4.6)	0.79 (-3.4, 5.0)	0.76 (-2.8, 4.4)	0.76 (-2.6, 4.1)	0.57 (-2.9, 4.1)	-0.08 (-2.6, 2.5,

 Table S1 Concordance between estimates of smoking prevalence in those with chronic conditions 2006/07

 to 2012/13

Lin's concordance coefficients p<0.001 for all coefficients

Mean difference<sup>1</sup> and 95% Limits of Agreement<sup>2</sup> are given in italics

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### STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	ltem #	Recommendation	Reported on page
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	3 - abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3 - abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4 - background
Objectives	3	State specific objectives, including any prespecified hypotheses	3 - abstract 4 - background
Methods	÷		
Study design	4	Present key elements of study design early in the paper	3 -abstract
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 – methods – 'sample'
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5 – methods – 'sample'
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5 - methods
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5 - methods
Bias	9	Describe any efforts to address potential sources of bias	5 – methods & 6 – results (recording of smoking status and prevalence)
Study size	10	Explain how the study size was arrived at	5 – methods – 'sample'
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5 - methods

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Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5 – methods
		(b) Describe any methods used to examine subgroups and interactions	5 – methods
		(c) Explain how missing data were addressed	5 – methods
		(d) If applicable, describe analytical methods taking account of sampling strategy	5 – methods
		(e) Describe any sensitivity analyses	6 - results
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility,	5 - methods
		confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	5 - methods
		confounders	
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6 - results
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence	
		interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5 – methods
			6 - results
Discussion			
Key results	18	Summarise key results with reference to study objectives	7 – discussion –
			principal findings
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and	7 – discussion –
		magnitude of any potential bias	strengths and
			weaknesses
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from	7 - discussion
		similar studies, and other relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	7 - discussion
Other information			

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Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11 – competing interests
*Give information	n separately fo	or cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-section	al studies.
		pration article discusses each checklist item and gives methodological background and published examples of transparent rep	orting. The STROBE I Medicine at
http://www.anna	ls.org/, and Ep	pidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.	
		pration article discusses each checklist item and gives methodological background and published examples of transparent rep ction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Interna bidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.	
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# **BMJ Open**

# Estimating smoking prevalence in general practice using data from the Quality and Outcomes Framework (QOF)

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<b>Primary Subject Heading</b> :	Epidemiology
Secondary Subject Heading:	Health services research, Public health, Smoking and tobacco
Keywords:	EPIDEMIOLOGY, STATISTICS & RESEARCH METHODS, PUBLIC HEALTH, PRIMARY CARE



### TITLE

Estimating smoking prevalence in general practice using data from the Quality and Outcomes Framework (QOF)

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- Professor David R Jones, Dept of Health Sciences, University of Leicester, Leicester, UK.

### **KEYWORDS**

- Smoking/epidemiology
- Population surveillance
- Primary Health Care
- Cardiovascular disease

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### **Objectives**

To determine to what extent underlying data published as part of QOF can be used to estimate smoking prevalence within practice populations and local areas and to explore the usefulness of these estimates.

### Design

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Cross-sectional, observational study of QOF smoking data. Smoking prevalence in general practice populations and among patients with chronic conditions was estimated by simple manipulation of QOF indicator data. Agreement between estimates from the integrated household survey (IHS) and aggregated QOF-based estimates were calculated. The impact of including smoking estimates in negative binomial regression models of counts of premature CHD deaths was assessed.

### Setting

Primary care in the East Midlands.

### **Participants**

All general practices in the area of study were eligible for inclusion (230). 14 practices were excluded due to incomplete QOF data for the period of study (2006/07 - 2012/13). One practice was excluded as it served a restricted practice list.

### Measurements

Estimates of smoking prevalence in general practice populations and among patients with chronic conditions.

### Results

30 Median smoking prevalence in the practice populations for 2012/13 was 19.2% (range 5.8% - 43.0%). There was good 31 agreement (mean difference: 0.39%; 95% limits of agreement (-3.77, 4.55)) between IHS estimates for local authority 32 districts and aggregated QOF register estimates. Smoking prevalence estimates in those with chronic conditions were 33 34 lower than for the general population (mean difference -3.05%), but strongly correlated ( $R_p$ =0.74, p<0.0001). An 35 important positive association between premature CHD mortality and smoking prevalence was shown when smoking 36 prevalence was added to other population and service characteristics. 37

### Conclusions

traini 39 Published QOF data allow useful estimation of smoking prevalence within practice populations and in those with chronic 40 . Bu conditions; the latter estimates may sometimes be useful in place of the former. It may also provide useful estimates of and similar technologies. smoking prevalence in local areas by aggregating practice based data.

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- 59 60

### Strengths and limitations of this study

- This paper clearly demonstrates that useful estimations of smoking prevalence within practice populations can be calculated from routine data published through the Quality and Outcomes Framework (QOF).
- Our analysis shows that estimates of smoking prevalence in those with chronic conditions can be used • in some situations in place of an estimate for the general population, if this is not available.
- Comparisons with local area estimates suggest QOF-based estimates are useful for estimating smoking prevalence in both practice populations and in local areas.
- QOF data rely on self-reported smoking status, recorded in the previous 27 months, which may underestimate smoking status or the effectiveness of interventions.
- Protected by copyright, including for uses related ve a.. This study does not have access to individual patient data limiting our understanding of patients who do not have smoking status recorded and the possible impact of missing data on estimates of smoking prevalence.

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### Background

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4 5 Despite smoking prevalence in England falling "below 20% for the first time in 80 years", [1] reducing smoking remains a 6 key public health priority in England as in many countries, with local authorities and primary care services being 7 expected to play a key role in local tobacco control services.[2] In addition, clinical commissioning groups (CCGs), 8 membership organisations responsible for planning, organising and purchasing nationally funded healthcare within their 9 local areas have their own health targets. Reducing smoking prevalence is a key component of many targets, for 10 Protected example reducing chronic obstructive pulmonary disease (COPD) outcomes [3] and reducing inequalities in coronary 11 12 heart disease (CHD).[4] Reliable estimates of smoking prevalence for practice populations and local areas are useful to 13 assess need, inform targeting of interventions delivered through primary care and to evaluate those interventions. For 14 by copyright, practices and Clinical Commissioning Groups (CCGs) it is important to be able to evaluate different approaches to 15 smoking cessation and to understand the different level of risk in different practices. Practice based estimates are of 16 particular importance for research into a variety of health outcomes and their associations with primary care. Research 17 of this type generally aims to take characteristics of the practice populations into account and the inclusion of smoking 18 19 20 21 22

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prevalence has been shown to be important in the interpretation of other factors, in particular socio-economic deprivation [5-6] Currently a variety of measures of smoking prevalence in practice populations are being used [6-7] and some studies do not include a measure of smoking,[8-10] despite the recognized associations between smoking prevalence and a range of chronic conditions.[11] **National Surveys** In England, there are various national surveys of smoking prevalence including the Health Survey for England;[12] the General Lifestyle Survey;[13] the Smoking Toolkit Study (STS) and the Integrated Household Survey (IHS). The IHS began in 2009 and is a composite survey including questions on smoking habits (involving over 420,000 adults in 2011). IHS statistics are designated as experimental, in a 'testing phase' and not yet fully developed,[14] but estimates are available for local authorities. It could, therefore, be argued that there is no gold standard measure of smoking in local areas, and 24 25 26 27 28 29 to text for local authorities. It could, therefore, be argued that there is no gold standard measure of smoking in local areas, and 30 there are no surveys which aim to establish the smoking prevalence within practice populations. 31 and

### **Patient records** 32

Analyses of individual patient records, using the THIN (The Health Improvement Network) [15] and QRESEARCH [16] 33 databases, provide strong evidence that smoking status within primary care medical records could be used to monitor 34 35 national smoking patterns. There was good agreement between smoking prevalence based on medical records in the 36 THIN database and those predicted by GHS; 22.4% compared to 21.8% respectively in males; 18.9% compared to 20.2% 37 respectively in females.[17] Estimates of smoking prevalence based on the medical records in the QRESEARCH database 38 has also shown good agreement with national surveys, in this case the Health Survey for England.[18] 39

### QOF

training, and simi 40 The national Quality and Outcomes Framework (QOF) is a payment for performance system which was introduced in 41 42 England in 2004 to improve the quality of primary care for patients. Practices are awarded points for achieving targets 43 and these points are translated into financial reward. Since its inception QOF has included indicators relating to 44 smoking.[19] The underlying aim of these indicators has not changed over the years; a) practices should record smoking status in patient notes and, b) for those who smoke, smoking cessation advice/support/treatment should have been offered. Until 2012/13 the focus was on targeting smoking cessation advice to those with chronic conditions. Table 1 summarises QOF smoking indicators 2006/7 – 2014/15. The QOF indicators have not been designed to determine smoking prevalence within the practice population; indeed it is clearly stated that 'QOF provides no information on numbers of smokers and non-smokers', [20] attributing this mainly 45 46 47 48

49 50 51 to the condition-specific nature of the indicator. The wording has not changed since the inclusion of the two new 52 indicators which apply to the general population and are not condition-specific. 53

### Objective

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In this paper we aim to explore to what extent underlying data published as part of QOF can be used to estimate 56 smoking prevalence within practice populations. The usefulness of these estimates are explored by (i) comparing 57 58 aggregated data with local area estimates from other sources and (ii) including practice level estimates in a model of 59 CHD mortality. 60

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### **METHOD**

### Sample

All practices within three primary care trusts (PCTs), the organizational unit for administering general practices in England, (2006/07 to 2011/12) in the East Midlands were eligible for inclusion in the study. 215 practices with QOF data available for the seven financial years were included in the analysis. 14 practices were excluded because they lacked data for all seven years. One practice was excluded from the study as it served a restricted practice list; another practice was excluded from the study as 2012/13 QOF data strongly suggested an error.

### Manipulation of QOF data

Protected by copyright, including for uses related QOF data can be downloaded from the Health and Social Care Information Centre website containing information for all practices in a region; [22] Table 2 illustrates the type of data available.

Two key QOF indicators are used in the calculations of smoking prevalence in the total practice population:

- SM07 'The percentage of patients aged 15 years and over whose notes record smoking status in the preceding 27 months'
- SM08 'The percentage of patients aged 15 years and over who are recorded as current smokers who have a record of an offer of support and treatment within the preceding 27 months'

These can be summarized as follows:

SMOKING STATUS INDICATOR (SM07) =

No. of patients who have their smoking status recorded

No.of eligible patients in the practice

SMOKING CESSATION INDICATOR (SM08) =

No. of patients who have a record of cessation support

<sup>/</sup>No.of patients recorded as current smokers

The denominator of the SMOKING STATUS INDICATOR (SM07) provides an estimate of the sample of the practice population whose smoking status should be recorded. This includes the whole practice population aged over 15, with the exception of people who have joined the practice in the three months prior to the data extraction point and patients who refuse to provide their smoking status. The denominator of the SMOKING CESSATION INDICATOR (SM08) provides an estimate of those who are recorded as current smokers. In addition indicators of a similar nature were included but applying to those with any, or any combination, of a range of QOF specified chronic conditions (SM05 and SM06). population whose smoking status should be recorded. This includes the whole practice population aged over 15, with 

SMOKING PREVALENC	E ESTIMATE =
No.of p	patients recorded as current smokers / /No.of eligible patients in the practice
	_
	– Denominator of SM08 <sub>/</sub>
	Denominator of SM07
denominator for SM08 smoking prevalence ca method was used to e	ce A the denominator for SM07 is 3721 – the number of eligible patients in the practice. The is 1129 - indicating that there are 1129 registered patients recorded as current smokers. Hence n be estimated as 1129/3721 or 30.3%. Table 2 gives worked examples for five practices. This stimate smoking prevalence for the total practice population in 2013/14 and, using appropriate ith chronic conditions from 2006/07 to 2013/14 (SM05 and SMO06 in 2013/14).
	ntage of the practice population with a chronic condition was determined using the denominator of the practice population and the denominator of SM05 as a measure of the practice population on.
and then confirmed by local authority districts smoking status has be are included in Table 3	re linked to local authority districts using the National Statistics Postcode Directory (NSPD) [23] visual check of addresses. Practice level data were aggregated, to estimate smoking prevalence in s. Details of the estimated population of each district, the aggregated population for which en determined, the number of practices in each district and the sample size for the IHS 2011/12 s. compared to estimates of smoking prevalence in local authority districts based on data from the
smoking prevalence w various population and premature CHD deaths the same explanatory QOF 2006/07. Service	ortance of being able to estimate smoking prevalence in practice populations, the estimate of as included in a model to determine the associations of premature CHD (under 75) mortality with d service characteristics; the methods are described by Honeyford et al.[10] Here, counts of s (between April 2006 and March 2009) were modelled using negative binomial regression, using variables but including estimated smoking prevalence for those with chronic conditions based on and population characteristics derived from QOF registers from 2006/07 were originally selected dy but an estimate of smoking prevalence for the general population was not available for this

### RESULTS

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# **Estimates using QOF data**

Estimation of overall smoking prevalence using QOF smoking indicators 2012/13

The median underlying achievement for the recording of smoking status in the total practice population was 88.1% in 2012/13 (IQR: (83.7, 91.0)). The median estimate of smoking prevalence in practice populations was 19.2%, ranging from 5.8% to 43.0% (IQR: (15.1%, 22.9%)).

# Estimates of smoking prevalence in those with chronic conditions using QOF smoking indicators 2012/13

The underlying achievement for recording smoking status in those with chronic conditions was higher than for the total practices population (96.6% IQR (95.0, 97.7)). The median practice based estimate for those with any or any

10 combination of a specific list of chronic conditions was 15.4% (IQR: 12.6% to 19.4%), ranging from 7.1% to 51.5%. 11 The estimates of smoking prevalence in those with chronic conditions have been consistent since 2006/07, with the 12 13 median varying slightly during that time. Concordance was high between estimates for all years; Lin's concordance 14 coefficient [25] was greater than 0.92 and mean difference was less than one in all cases (Table S1 in Appendix for more 15 details). 16

### 17 Comparisons with local area estimates

18 Estimates of smoking prevalence were in line with estimates derived from the IHS. Aggregating over the total area, 19 smoking prevalence was 19.5%, compared to 19.3% when IHS district level data were aggregated over the same area. 20 21 When practice data were combined to give estimates of smoking for local authority districts there was a strong positive 22 correlation (Rp=0.86, p<0.0001) and good agreement (mean difference: 0.39%; 95% limits of agreement (-3.77, 4.55)) 23 between estimates based on QOF registers and IHS estimates (Fig. 1).[26]

24 When the estimates of prevalence for those with chronic conditions were aggregated into local authority districts, 25 estimates were lower than IHS estimates for the majority of areas. 26

### 27 Associations between measures 28

29 Association between smoking prevalence in the general practice population and those with chronic conditions.

- 30 Smoking prevalence in those with chronic conditions was lower than in the general practice population. The mean 31 difference between the two estimates was -3.05% (95% limits of agreement: (-8.65, 1.56)). The Bland-Altman plot does 32 not suggest a strong pattern, despite some evidence that the difference increases as the average increases (Fig. 2). 33 There was a strong positive correlation ( $R_p$ =0.92, p<0.0001) between the overall estimate of smoking prevalence within 34 a practice population and in those with chronic conditions. A regression model was developed to predict smoking 35 prevalence in the general population based on the prevalence in those with chronic conditions; removal of outliers 36 37 improved model fit.
- 38 Associations between recording of smoking status and prevalence
- 39 There was a strong positive correlation between recording of smoking status in the general population and in those with 40
- chronic conditions (underlying achievement for SM07 and SM05 respectively) ( $R_0$ =0.74, p<0.0001). There was no 41
- evidence of an association between smoking prevalence in the general population and recording of smoking status (R<sub>p</sub>= 42 0.07, p=0.28) or the percentage with a chronic condition ( $R_p$ =0.03, p=0.67). 43

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- **Including smoking prevalence estimates in models of mortality** Table 4 shows incident rate ratios, 95% CIs and associated *p* values for the original and modified models. Inclusion of the a 45 46 smoking prevalence variable in the model reduced the strength of the associations between deprivation and premature 47
- mortality, and percentage white and premature mortality. Sensitivity analysis considering the impact of exception 48
- reporting indicates no impact on interpretation (see Doran [27] for details of exception reporting). 49

### DISCUSSION 50

### **Principal findings** 51

52 These results show how the QOF registers required as part of the general practice pay for performance scheme in 53 England can be used to estimate smoking prevalence in practice populations and that these estimates are useful when 54 analysing patterns of mortality. Practice based estimates can be aggregated to provide estimates of smoking prevalence 55 in local areas. 56

57 When smoking prevalence is estimated in the general population using QOF indicators there is good agreement with 58 59 estimates of IHS smoking prevalence for similar geographical areas. 60

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### **BMJ Open**

QOF data can also be used to estimate smoking prevalence in those with chronic conditions, which is generally lower than smoking prevalence in the general population. There is good agreement between the estimates in successive years. The correlation between estimates of smoking prevalence in the general population in 2012/13 and those with chronic conditions is strong. These strong correlations suggest that the estimates based on previous years can be used in place of smoking prevalence in the general population for some purposes. Regression analysis suggests that smoking prevalence in those with chronic conditions can be used to predict smoking prevalence in the general practice population, for practices with a typical patient list.

9 When an estimate of smoking prevalence in those with chronic conditions was used in a study of the association 10 between premature CHD mortality and various population and service characteristics an important positive association 11 between CHD mortality and smoking prevalence was shown. 12

### 14 Strengths and weaknesses

Protected by copyright, including 15 The agreement between IHS based area estimates of smoking prevalence and estimates based on combining QOF data 16 provides evidence to suggest that manipulating QOF data results is a useful measure of smoking prevalence within 17 practice populations when compared to other available measures. This is supported by the work of Szatkowski et al [17] 18 which found good agreement between national smoking prevalence predicted by patient records and the General 19 Household Survey. In addition, practice based QOF data can be aggregated to provide local area estimates of smoking 20 21 prevalence based on a much larger sample size than other surveys.

22 When comparing practices and analysing patterns across practices, it is important that the estimate is consistent across 23 practices. The percentage of patients who do not have their smoking status recorded varies from 40% to less than 1%, 24 but the characteristics of these patients are not known. Recording of smoking status has been shown to vary between 25 groups [18-19, 28]; women, older people and those with chronic conditions were more likely to have their smoking 26 status recorded. National surveys suggest that smoking rates are lower in these groups and therefore smoking 27 prevalence from QOF may underestimate actual smoking prevalence. The implications of this will vary between 28 29 practices, dependent on the proportion of these groups within their practice populations. Our analysis did not find an association between the percentage with a chronic condition and the recording of smoking status in the total population 30 31 or the estimate of smoking prevalence. 32

QOF data are based on self-reported smoking status, which has been shown to be reliable in the general population, [28] 33 but to underestimate smoking prevalence in pregnant women. [29] In addition, practices are only asked to record 34 smoking status in the preceding 27 months, meaning the estimates may be useful in assessing need and analysing 35 36 associations, but will have disadvantages in assessing the effectiveness of interventions, unless practices commit to 37 more regular recording.

38 Practice level smoking data have been aggregated to local authority districts based on practice postcode rather than 39 patient postcodes. General practice catchments are not constrained by local authority boundaries, however studies 40 have shown that 80% of patients live within a 10 minute car journey of their practice [30], suggesting that patients 41 choose practices close to where they live. It is relatively common for practice postcodes to be used as a proxy for 42 patient postcodes; however, when used to estimate deprivation this has been found to underestimate relationships 43 44 between deprivation and health outcomes.[31-32]

45 Further work using individual patient records is necessary to analyse the frequency of recording of smoking status and 46 the characteristics of patients for whom no smoking status is recorded or have been excluded on the basis of exception 47 reporting. In this analysis practice level data have been aggregated to estimate smoking prevalence in local authority 48 districts. Analysis of patient level postcode information, not available for this study, would allow estimates of smoking 49 prevalence for smaller geographical areas to be made. These could then be compared to modelled estimates or locally 50 commissioned surveys, where they exist. 51 52

### 53 Implications

54 Manipulating QOF data is an easy and cost effective method of estimating smoking prevalence in both practice 55 populations and local areas, although further work is necessary to determine the validity of using aggregated practice 56 level data for local area estimation. Both local area and practice based estimates are important to those tasked with 57 reducing smoking rates and improving the nation's health. CCGs and public health departments in local authorities need 58 59 them to target smoking cessation and other additional resources. Understanding more about the patient populations 60

would enable similar practices to be compared when considering differences in health outcomes and the apparent effectiveness of interventions.[33]

Current estimates of smoking prevalence in local areas are based on the Integrated Household Study. The IHS is currently in an experimental phase since the weighting methodology needs to be assessed and potentially revised.[34] Aggregated practice level data includes the majority of the resident adult population in local areas and could therefore be a more useful measure of local area smoking prevalence, at district level and at smaller local areas than are currently available through the IHS. Analysis of patient level geographical data is necessary to determine the potential utility of simple and more complex aggregation methods.

Protected by copyright, including When estimates of smoking prevalence are included in the analysis of the associations between premature CHD mortality and practice population and service characteristics, there are reductions in the magnitude of the incident rate ratios (IRRs) for both deprivation and percentage white. This suggests that these may be acting as surrogate markers of other lifestyle factors, such as smoking prevalence. Hence, the lack of reliable smoking information may be leading to relative over emphasis being placed on socio-economic deprivation, often described using an index of multiple factors. Reliable measures of smoking prevalence will improve our understanding of the relative importance of deprivation and other characteristics in explaining inequalities in a variety of health outcomes.

Smoking prevalence in those with chronic conditions is typically lower than in the general population. This may be due for to diagnosis increasing motivation to guit smoking, [35] the increase in smoking cessation advice and support [36] or the uses age and gender profile of those with chronic conditions. Smoking prevalence in those with chronic conditions has not reduced over the seven year period covered in this analysis, possibly suggesting that smoking cessation advice has limited effect, but this may be due to the turnover of patients with chronic conditions as a result of both premature mortality and new diagnoses. A wide range of smoking cessation advice and support has recently been reviewed by Zwar õ et al;[37] consideration of how these impact on those with chronic conditions is recommended as a result of this finding. 

QOF smoking indicators have changed since 2004 and continue to change. The introduction, in 2012/13, of an indicator which allows estimates of the smoking prevalence within the general population is useful for researchers as well as CCGs and public health officials. The removal of the indicator that covers the recording of smoking status in the total population from QOF in 2014/15 will impact on the methodology described in this paper, although the number of patients who are recorded as current smokers will continue to be available. The population of the practice will need to Вu be used as the denominator in the calculation of smoking prevalence. It will be important to determine if the smoking 

be used as the denominator in the calculation of smoking prevalence. It will be important to determine if the smoking status declines after the removal of the indicator; a recent study suggests that removal of indicators does not lead to a decline in clinical activities.[38] Conclusion Data published through QOF allow useful estimations of smoking prevalence within practice populations and in those with chronic conditions to be made. These estimates are important in developing our understanding of differences in health outcomes between practices, and are useful to both individual practices and CCGs when comparing practice level health outcomes, to assess need and to inform targeting. Aggregating practice level data may also be useful to allow estimates of smoking prevalence in local areas to be made. Revisions to QOF means that researchers will need to update methodology as indicators change. 

# Table 1 Summary of smoking indicators for which underlying achievement is published

	Patient group				
General form of the indicator	Patients with any, or any combination of the following conditions: coronary heart disease, stroke or TIA, hypertension, diabetes, COPD or asthma <sup>1</sup> .	All patients aged 15 years+			
% of patients whose notes record	SM01: 2006/07 & 2007/08	Records 22: 2006/07 & 2007/08			
smoking status <sup>2</sup>	SM03: 2008/09 – 2011/12	Records 23: 2008/09 – 2011/12			
	SM05: 2012/13	SM07: 2012/13			
	SMOK002: 2013/14 – 2014/15	SMOK001: 2013/14 – retired in 2014/15			
% of patients who are recorded as	SM02: 2006/07 & 2007/08	SM08: 2012/13			
current smokers whose notes	SM02: 2008/09 – 2011/12	SMOK004: 2013/14 – 2014/15			
contain a record that smoking	SM06: 2012/13				
cessation advice or referral to a	SMOK005: 2013/14 – 2014/15				
specialist service, where available,					
has been offered within the					
previous 15 months <sup>3</sup>					
The practice supports smokers in		Information 5: 2006/07-2011/12			
stopping smoking by a strategy		SMOK003: 2012/13 – 2014/15			
which includes providing literature and offering appropriate therapy.					
	affective disorder or other psychoses were added to thus the been made in the past 15 months, reduced to				
was added. <sup>2</sup> For those with chronic conditions, the record me 27 months, reduced to 24 months in 2013/14.	ust have been made in the past 15 months, reduced to of an offer of support and treatment within the precedir	12 months in 2013/14, for all patients the p			
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# Table 2 Example of QOF data from 2012/13, showing how it can be used to calculate smoking prevalence for individual practices.

		Example practices				
QOF lescription	Interpretation for purposes of calculating smoking prevalence	A	В	C	D	E
M07 Points	smoking prevalence	11	10.5	10.8	9.6	11
M07 lumerator	Patients <sup>1</sup> whose notes contain a record of smoking status	3450	1319	6276	31948	11 6504 7212 90.20% 12
M07 Denominator	Patients who are eligible to be included in this indicator <sup>2</sup>	3721	1497	7033	37654	7212
M07 UA		92.70%	88.10%	89.20%	84.80%	90.20%
M08 Points		12	9.9	12	8.9	12 0
M08 lumerator	Patients who are recorded as current smokers and have a record of an offer of support etc	1024	325	1578	8439	2165
M08 Denominator	Patients who are recorded as current smokers	1129	401	1586	10931	2373
M08 UA		90.70%	81.00%	99.50%	77.20%	91.20%
	Calculation to determine percentage who are smokers SM08 den/ SM07 den	1129/3721	401/1497	1586/7033	10931/37654	2373/7212
	Estimate of smoking prevalence	30.30%	26.80%	22.60%	29.00%	32.90%
<sup>1</sup> Patients aged ov For example patie	nts who are newly registered with th	e practices (less th	an three months;	are excluded from	n the indicator	ļ

data.				
	Population aged 15		Number of	
	and over (2011	Population included in QOF	general	IHS sample size
Local authority	Census) <sup>1</sup>	indicator SM07 <sup>2</sup>	practices <sup>3</sup>	2011/12 <sup>4</sup>
Leicestershire				
Blaby	77600	67895	9	30
Charnwood	139800	152533	24	39
Harborough	70200	69168	8	23
Hinckley and Bosworth	87800	84159	12	30
Melton	41900	34912	2	13
North West				
Leicestershire	77000	78331	14	24
Oadby and Wigston	47100	48054	9	16
Northamptonshire				
Corby	49400	57112	5	13
Daventry	64100	71902	8	22
East Northamptonshire	70900	55279	8	21
Kettering	75900	87059	9	18
Northampton	171600	184370	27	44
South Northamptonshire	69700	60391	8	20
Wellingborough	61300	61013	9	44 20 17
Unitary Authorities				
Leicester	264600	293156	59	147
Rutland	31300	29628	4	147 41
Totals	1400200	1434962	215	524

Table 3: Comparison of the population of each district based on the 2011 Census and aggregation QOF based practice

Data based on 2011 Census available from ONS [21] 

<sup>2</sup> Based on QOF registers accessed from [22] 

<sup>3</sup> Practices are matched to local authority districts based on the postcode of the practice [23]. 

<sup>4</sup> Based on IHS data 2011/12 [24] 

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	<b>withou</b> variabl	<b>it</b> smoking pro le	evalence	<b>with</b> sn variabl	noking preval e	prevalence	
Explanatory variable	IRR	95% CI	p value	IRR	95% CI	p val	
Percentage white patients	1.007	(1.003,	0.002	1.001	(0.995,	0.65	
		1.012)			1.007)		
Deprivation score (IMD 2007)	1.017	(1.011,	< 0.0001	1.005	(0.995,	0.34	
		1.024)			1.015)		
Prevalence of diabetes (QOF	1.108	(1.020,	0.015	1.095	(1.008,	0.03	
2006/07)		1.203)			1.187)		
Percentage over 65	1.060	(1.038,	< 0.0001	1.067	(1.044,	<0.0	
		1.083)			1.091)		
Percentage male patients	1.073	(1.035,	< 0.0001	1.058	(1.021,	0.00	
		1.111)			1.097)		
Number of GPs per 1000 patients	1.209	(0.894,	0.218	1.113	(0.821,	0.49	
		1.637)			1.508)		

(0.955,

1.014)

(0.996,

1.016)

(0.980,

0.999)

(0.986,

1.029)

(0.990,

1.000)

0.300

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0.989

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0.995

$egin{array}{c} 6 & 7 & 8 & 9 & 1011213141516171819221223242522728293313233435637839401424344546474849551223445567882334556778894014243445467784955122345567787878787878787878787878787878787878$	<sup>1</sup> IRR mor
50 51	

59 60 Hypertension detection 2006/07

% patients offered smoking

cessation advice (SM02 - QOF

% serum cholesterol (CHD08 - QOF

% aspirin (CHD09 - QOF 2006/07)

perception of being able to see

% of patients with recalled

preferred GP (QOF 2006/07) %smoking prevalence – estimated

(QOF 2006/07)

2006/07)

2006/07)

(QOF 2006/07)

5

<sup>1</sup>IRR, 95% confidence intervals and associated p values as a result of negative binomial model of count of premature mortality caused by CHD.



(0.959,

1.018)

(1.000,

1.021)

(0.983,

1.002)

(0.982,

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(0.990,

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(1.012,

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0.988

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0.992

1.003

0.995

1.031

0.416

0.057

0.109

0.777

0.061

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Applied Health Research and Care) based at LNR. RB is in receipt of an NIHR Senior Investigator award. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. The funders had no role in the study design, data collection and analysis, decision to publish or preparation of the

manuscript.

# **Competing Interests**

KH had financial support from CLAHRC in the form of funding for PhD fees. RB is in receipt of an NIHR Senior Investigator award. No financial relationships with any organisations that might have an interest in the submitted work in the previous five years; no other relationships or activities that could appear to have influenced the submitted work. 

#### Authors' contributions

#### **Contributor Statement**

The study was conceived by KH, RB, JB and DJ. KH designed the study, carried out the analysis and drafted the initial manuscript. JB and DJ contributed to the statistical analysis. RB, JB and DJ contributed to drafting and editing the final manuscript and interpreting and reviewing the results of the analysis.

#### **Ethical committee approval**

NRES advised that NHS ethics committee was not required. 

#### **Data sharing**

No additional data is available

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Figure Legend	<ul> <li>1 Relationship between aggregated QOF estimates and IHS estimates for local authority districts         Fig 1a Association between estimates (dashed line: estimates are equal)         Fig 1b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed         lines: 95% limits of agreement)         QOF estimates based on 2012/13 data; IHS estimates based on 2011/12 survey.     </li> </ul>
Figure Legend	2 Relationship between QOF estimates for the general population and those with chronic conditions (2012/13) Fig 2a Association between estimates (dashed line: estimates are equal; solid line: fitted line) Fig 2b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement) SMO7 and SM08 (2012/13) used for QOF estimates for the general population; SM05 and SM06 (2012/13) used for QOF estimates for those with chronic conditions.

TITLE Estimating smoking provalence in a	general practices: an evaluation of QOF (Quality and Outcomes Framework) d
	general practice using data from the Quality and Outcomes Framework (QOF)
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#### **Objectives**

To determine to what extent underlying data published as part of QOF can be used to estimate smoking prevalence within practice populations and local areas and to explore the usefulness of these estimates.

#### **Design**

Cross-sectional, observational study of QOF smoking data. Smoking prevalence in general practice populations and among patients with chronic conditions was estimated by simple manipulation of QOF indicator data. Agreement between estimates from the integrated household survey (IHS) and aggregated QOF-based estimates were calculated. The impact of including smoking estimates in negative binomial regression models of counts of premature CHD deaths was assessed.

### Setting

Primary care in the East Midlands.

### **Participants**

All general practices in the area of study were eligible for inclusion (230). 14 practices were excluded due to incomplete QOF data for the period of study (2006/07 - 2012/13). One practice was excluded as it served a restricted practice list.

#### **Measurements**

Estimates of smoking prevalence in general practice populations and among patients with chronic conditions.

### Results

Median smoking prevalence in the practice populations for 2012/13 was 19.2% (range 5.8% - 43.0%). There was good agreement (mean difference: 0.39%; 95% limits of agreement (-3.77, 4.55)) between IHS estimates for local authority districts and aggregated QOF register estimates. Smoking prevalence estimates in those with chronic conditions were lower than for the general population (mean difference -3.05%), but strongly correlated ( $R_p$ =0.74, p<0.0001). An important positive association between premature CHD mortality and smoking prevalence was shown when smoking prevalence was added to other population and service characteristics.

**Conclusions** Published QOF data allow useful estimation of smoking prevalence within practice populations and in those with chronic conditions; the latter estimates may sometimes be useful in place of the former. It may also provide useful estimates of and similar technologies. smoking prevalence in local areas by aggregating practice based data.



#### Strengths and limitations of this study

- This paper clearly demonstrates that useful estimations of smoking prevalence within practice populations can be calculated from routine data published through the Quality and Outcomes Framework (QOF).
- Our analysis shows that estimates of smoking prevalence in those with chronic conditions can be used • in some situations in place of an estimate for the general population, if this is not available.
- Comparisons with local area estimates suggest QOF-based estimates are useful for estimating smoking prevalence in both practice populations and in local areas.
- QOF data rely on self-reported smoking status, recorded in the previous 27 months, which may underestimate smoking status or the effectiveness of interventions.
- Protected by copyright, including for uses related ve a.. This study does not have access to individual patient data limiting our understanding of patients who do not have smoking status recorded and the possible impact of missing data on estimates of smoking prevalence.

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	im to explore to what extent underlying data published as part of QOF can be used to estimate
	ce within practice populations and to evaluate the usefulness of such estimates.
	im to explore to what extent underlying data published as part of QOF can be used to estimate
	<u>ce within practice populations. The usefulness of these estimates are explored by (i) comparing</u> vith local area estimates from other sources and (ii) including practice level estimates in a model of
CHD mortality.	
<u>ine mortantyi</u>	

	METHOD Sample
	All practices within three primary care trusts (PCTs), the organizational unit for administering general practices in
·	England, (2006/07 to 2011/12) in the East Midlands were eligible for inclusion in the study. 215 practices with QOF data
	available for the seven financial years were included in the analysis. 14 practices were excluded because they lacked
-	data for all seven years. One practice was excluded from the study as it served a restricted practice list; another practice
	was excluded from the study as 2012/13 QOF data strongly suggested an error.
; 2	was excluded from the study as 2012/15 Qor data strongly suggested an error.
	Manipulation of QOF data
	QOF data can be downloaded from the Health and Social Care Information Centre website containing information for all practices in a region; [22] Table 2 illustrates the type of data available. Iwo key QOF indicators are used in the calculations of smoking prevalence in the total practice population:
-	Two key QOF indicators are used in the calculations of smoking prevalence in the total practice population:
4	
5	27 months'
6	<ul> <li><u>SM07 'The percentage of patients aged 15 years and over whose notes record smoking status in the preceding 27 months'</u></li> <li><u>SM08 'The percentage of patients aged 15 years and over who are recorded as current smokers who have a record of an offer of support and treatment within the preceding 27 months'</u></li> <li>These can be summarized as follows:</li> </ul>
7	record of an offer of support and treatment within the preceding 27 months'
8 9	
0	These can be summarized as follows:
1	
2	B
3	SMOKING STATUS INDICATOR (SM07) =
4	
5 6	No.of patients who have their smoking status recorded / No.of eligible patients in the practice
7	/No. of eligible patients in the practice
8	ted to the second se
9	
0	SMOKING CESSATION INDICATOR (SM08) =
1	No. of patients who have a record of cessation support $_{I}$
2 3	No. of patients who have a record of cessation support, No. of patients recorded as current smokers
4	
5	
6	
	The denominator of the SMOKING STATUS INDICATOR (SM07) provides an estimate of the sample of the practice
	population whose smoking status should be recorded. This includes the whole practice population aged over 15, with
9 <u>1</u> 0 ,	the exception of people who have joined the practice in the three months prior to the data extraction point and patients who refuse to provide their smoking status. The denominator of the SMOKING CESSATION INDICATOR (SM08) provides an estimate of those who are recorded as
1	who refuse to provide their smoking status.
2 -	۵
3	current smokers. n addition indicators of a similar nature were included but applying to those with any, or any combination, of a range of 읰
	n addition indicators of a similar nature were included but applying to those with any, or any combination, of a range of QOF specified chronic conditions (SM05 and SM06).
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1	Using the data given for these indicators, it is possible to estimate the smoking prevalence in a practice population,
2	summarised below.
3 4	
5	SMOKING PREVALENCE ESTIMATE =
6	
7	No. of patients recorded as current smokers / No. of eligible patients in the practice
8	/No.of eligible patients in the practice
9 10	=
11	Denominator of SM08/ Denominator of SM07
12	Denominator of SM07
13	
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17	For example, for practice A the denominator for SM07 is 3721 – the number of eligible patients in the practice. The
18	denominator for SM08 is 1129 - indicating that there are 1129 registered patients recorded as current smokers. Hence
19	smoking prevalence can be estimated as 1129/3721 or 30.3%. Table 2 gives worked examples for five practices. This
20	method was used to estimate smoking prevalence for the total practice population in 2013/14 and, using appropriate
21 22	indicators, for those with chronic conditions from 2006/07 to 2013/14 (SM05 and SM006 in 2013/14).
22	
24	In addition, the percentage of the practice population with a chronic condition was determined using the denominator
25	of SM07 as a measure of the practice population and the denominator of SM05 as a measure of the practice population
26	with a chronic condition.
27 28	
20 29	Comparisons with local area estimates
30	Practice postcodes were linked to local authority districts using the National Statistics Postcode Directory (NSPD) [23]
31	and then confirmed by visual check of addresses. Practice level data were aggregated, to estimate smoking prevalence in
32	local authority districts. Details of the estimated population of each district, the aggregated population for which
33 34	smoking status has been determined, the number of practices in each district and the sample size for the IHS 2011/12
35	are included in Table 3.
36	These estimates were compared to estimates of smoking prevalence in local authority districts based on data from the
37	Integrated Household Survey.[24]
38	Medelling
39 40	Modelling To determine the importance of being able to estimate smoking prevalence in practice populations, the estimate of
41	smoking prevalence was included in a model to determine the associations of premature CHD (under 75) mortality with
42	various population and service characteristics; the methods are described by Honeyford et al.[10] Here, counts of
43	premature CHD deaths (between April 2006 and March 2009) were modelled using negative binomial regression, using
44 45	the same explanatory variables but including estimated smoking prevalence for those with chronic conditions based on
46	QOF 2006/07. Service and population characteristics derived from QOF registers from 2006/07 were originally selected
47	for inclusion in the study but an estimate of smoking prevalence for the general population was not available for this
48	year.
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# RESULTS

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# **Estimates using QOF data**

Estimation of overall smoking prevalence using QOF smoking indicators 2012/13

The median underlying achievement for the recording of smoking status in the total practice population was 88.1% in 2012/13 (IQR: (83.7, 91.0)). The median estimate of smoking prevalence in practice populations was 19.2%, ranging from 5.8% to 43.0% (IQR: (15.1%, 22.9%)).

Estimates of smoking prevalence in those with chronic conditions using QOF smoking indicators 2012/13

The underlying achievement for recording smoking status in those with chronic conditions was higher than for the total practices population (96.6% IQR (95.0, 97.7)). The median practice based estimate for those with any or any

combination of a specific list of chronic conditions was 15.4% (IQR: 12.6% to 19.4%), ranging from 7.1% to 51.5%.

The estimates of smoking prevalence in those with chronic conditions have been consistent since 2006/07, with the

Protected by copyright, including for uses related to text and data mining, median varying slightly during that time. Concordance was high between estimates for all years; Lin's concordance coefficient [25] was greater than 0.92 and mean difference was less than one in all cases (Table S1 in Appendix for more details).

# **Comparisons with local area estimates**

Estimates of smoking prevalence were in line with estimates derived from the IHS. Aggregating over the total area, smoking prevalence was 19.5%, compared to 19.3% when IHS district level data were aggregated over the same area. When practice data were combined to give estimates of smoking for local authority districts there was a strong positive correlation (Rp=0.86, p<0.0001) and good agreement (mean difference: 0.39%; 95% limits of agreement (-3.77, 4.55)) between estimates based on QOF registers and IHS estimates (Fig. 1).[26]

When the estimates of prevalence for those with chronic conditions were aggregated into local authority districts, estimates were lower than IHS estimates for the majority of areas.

# **Associations between measures**

28 29 Association between smoking prevalence in the general practice population and those with chronic conditions. 30 Smoking prevalence in those with chronic conditions is-was lower than in the general practice population. The mean 31 difference between the two estimates was -3.05% (95% limits of agreement: (-8.65, 1.56)). The Bland-Altman plot does 32 not suggest a strong pattern, despite some evidence that the difference increases as the average increases (Fig. 2). 33 There was a strong positive correlation ( $R_p$ =0.92, p<0.0001) between the overall estimate of smoking prevalence within 34 a practice population and in those with chronic conditions. A regression model was developed to predict smoking 35 36 prevalence in the general population based on the prevalence in those with chronic conditions; removal of outliers 37 improved model fit.

38 Associations between recording of smoking status and prevalence

, Al training, and similar technologies. 39 There was a strong positive correlation between recording of smoking status in the general population and in those with 40 chronic conditions (underlying achievement for SM07 and SM05 respectively) ( $R_0$ =0.74, p<0.0001). There was no 41 evidence of an association between smoking prevalence in the general population and recording of smoking status (R<sub>p</sub>= 42

0.07, p=0.28) or the percentage with a chronic condition ( $R_p$ =0.03, p=0.67). 43

#### 44 QOF smoking indicators 2006/07-2012/13

45 The estimates of smoking prevalence in those with chronic conditions have been consistent since 2006/07, with the 46 median varying slightly during that time. Concordance was high between estimates for all years; Lin's concordance 47 coefficient 3] was greater than 0.92 and mean difference was less than one in all cases (Table S1 in Appendix for more 48 details). 49

#### Including smoking prevalence estimates in models of mortality 50

Table 43 shows incident rate ratios, 95% CIs and associated p values for the original and modified models. Inclusion of 51 52 the smoking prevalence variable in the model reduced the strength of the associations between deprivation and 53 premature mortality, and percentage white and premature mortality. A one unit increase in smoking prevalence was 54 associated with an increase of 3.2% in expected premature CHD mortality count. If a practice with a moderately high 55 smoking prevalence (75<sup>th</sup> percentile: 18.86%) is compared to one with a median level of smoking prevalence (15.09%), a 56 difference of 11.69% in premature CHD mortality count can be expected, after adjusting for the other variables in the 57 model. 58

59 Sensitivity analysis considering the impact of exception reporting indicates no impact on interpretation (see Doran [27] 60 for details of exception reporting).

	Discussion
1	Principal findings
2	These results show how the QOF registers required as part of the general practice pay for performance scheme in
3	England can be used to estimate smoking prevalence in practice populations and that these estimates are useful when
4 5	analysing patterns of mortality. Practice based estimates can be aggregated to provide estimates of smoking prevalence
6	in local areas.
7	These results show how QOF registers can be used to estimate smoking prevalence in practice populations and that
8	these estimates are useful when analysing patterns of mortality.
9	these estimates are useful when analysing patterns of mortality.
10	
11	When smoking prevalence is estimated in the general population using QOF indicators there is good agreement with
12	estimates of IHS smoking prevalence for similar geographical areas.
13	QOF data can also be used to estimate smoking prevalence in those with chronic conditions, which is generally lower
14	than smoking prevalence in the general population. There is good agreement between the estimates in successive years.
15 16	The correlation between estimates of smoking prevalence in the general population in 2012/13 and those with chronic
17	conditions is strong. These strong correlations suggest that the estimates based on previous years can be used in place
18	of smoking prevalence in the general population for some purposes. Regression analysis suggests that smoking
19	prevalence in those with chronic conditions can be used to predict smoking prevalence in the general practice
20	population, for practices with a typical patient list.
21	
22	When an estimate of smoking prevalence in those with chronic conditions was used in a study of the association
23	between premature CHD mortality and various population and service characteristics an important positive association
24	between CHD mortality and smoking prevalence was shown.
25	between end mortainty and smoking prevalence was shown.
26 27	Strengths and weaknesses
27 28	The agreement between IHS based area estimates of smoking prevalence and estimates based on combining QOF data
20 29	provides evidence to suggest that manipulating QOF data results is a useful measure of smoking prevalence within
30	
31	practice populations when compared to other available measures. This is supported by the work of Szatkowski et al [17]
32	which found good agreement between national smoking prevalence predicted by patient records and the General
33	Household Survey. In addition, practice based QOF data can be aggregated to provide local area estimates of smoking
34	prevalence based on a much larger sample size than other surveys.
35	When comparing practices and analysing patterns across practices, it is important that the estimate is consistent across
36	practices. The percentage of patients who do not have their smoking status recorded varies from 40% to less than 1%,
37	but the characteristics of these patients are not known. Recording of smoking status has been shown to vary between
38	groups [18-19, 28]; women, older people and those with chronic conditions were more likely to have their smoking
39 40	status recorded. National surveys suggest that smoking rates are lower in these groups and therefore smoking
40 41	prevalence from QOF may underestimate actual smoking prevalence. The implications of this will vary between
42	practices, dependent on the proportion of these groups within their practice populations. Our analysis did not find an
43	association between the percentage with a chronic condition and the recording of smoking status in the total population
44	or the estimate of smoking prevalence.
45	QOF data are based on self-reported smoking status, which has been shown to be reliable in the general population, [28]
46	but to underestimate smoking prevalence in pregnant women.[29] In addition, practices are only asked to record
47	smoking status in the preceding 27 months, meaning the estimates may be useful in assessing need and analysing
48	associations, but will have disadvantages in assessing the effectiveness of interventions, unless practices commit to
49	more regular recording.
50 51	Practice level data have been aggregated to local authority districts based on practice postcode rather than patient
51 52	
53	postcodes; it is relatively common for practice postcodes to be used as a proxy for patient postcodes but when used to
54	estimate deprivation has been found to underestimate relationships between deprivation and health outcomes.
55	Further work using individual patient records is necessary to analyse the frequency of recording of smoking status and
56	the characteristics of patients for whom no smoking status is recorded or have been excluded on the basis of exception
57	reporting.
58	Practice level smoking data have been aggregated to local authority districts based on practice postcode rather than
59	patient postcodes. General practice catchments are not constrained by local authority boundaries, however studies
60	have shown that 80% of patients live within a 10 minute car journey of their practice [30], suggesting that patients

<text><text><text><text><text><text><text>

Reliable measures of smoking prevalence will improve our understanding of the relative importance of deprivation and other characteristics in explaining inequalities in a variety of health outcomes.

Similarly, it was found that social class was not linked to hospital admissions for stroke and CHD when rates were adjusted for various factors including smoking.[27] However, even with smoking prevalence included in the models, Brettell et al [29] found that increased deprivation was associated with higher heart failure admission rates, and Purdy et al [6] found that higher deprivation was associated with increased emergency admissions for myocardial infarction and angina. Unless we have reliable measures of smoking prevalence it is difficult to determine the relative importance of deprivation and other characteristics in explaining inequalities in a variety of health outcomes.

I training, and similar technologies Smoking prevalence in those with chronic conditions is typically lower than in the general population. This may be due to diagnosis increasing motivation to guit smoking, [35] the increase in smoking cessation advice and support [36] or the age and gender profile of those with chronic conditions. Smoking prevalence in those with chronic conditions has not reduced over the seven year period covered in this analysis, possibly suggesting that smoking cessation advice has limited effect, but this may be due to the turnover of patients with chronic conditions as a result of both premature mortality and new diagnoses. A wide range of smoking cessation advice and support has recently been reviewed by Zwar et al;[37] consideration of how these impact on those with chronic conditions is recommended as a result of this finding.

QOF smoking indicators have changed since 2004 and continue to change. The introduction, in 2012/13, of an indicator which allows estimates of the smoking prevalence within the general population is useful for researchers as well as CCGs and public health officials. The removal of the indicator that covers the recording of smoking status in the total population from QOF in 2014/15 will impact on the methodology described in this paper, although the number of

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patients who are recorded as current smokers will continue to be available. The population of the practice will need to be used as the denominator in the calculation of smoking prevalence. It will be important to determine if the smoking status declines after the removal of the indicator; a recent study suggests that removal of indicators does not lead to a decline in clinical activities.[38]

#### Conclusion

stimutions is see stimutes are is due useful to both to inform targeting. Agent to local areas to be made. Revise review for the state of the state of the state of the state review for the state of the state Data published through QOF allow useful estimations of smoking prevalence within practice populations and in those with chronic conditions to be made. These estimates are important in developing our understanding of differences in health outcomes between practices, and are useful to both individual practices and CCGs when comparing practice level health outcomes, to assess need and to inform targeting. Aggregating practice level data may also be useful to allow estimates of smoking prevalence in local areas to be made. Revisions to QOF means that researchers will need to update methodology as indicators change. health outcomes between practices, and are useful to both individual practices and CCGs when comparing practice level

#### Table 1 Summary of smoking indicators for which underlying achievement is published

	Patient group					
General form of the indicator	Patients with any, or any combination of the following conditions: coronary heart disease, stroke or TIA, hypertension, diabetes, COPD or asthma <sup>1</sup> .	All patients aged 15 years+				
% of patients whose notes record smoking status <sup>2</sup>	SM01: 2006/07 & 2007/08 SM03: 2008/09 – 2011/12	Records 22: 2006/07 & 2007/08				
	SM05: 2008/09 - 2011/12 SM05: 2012/13 SMOK002: 2013/14 - 2014/15	Records 23: 2008/09 – 2011/12 SM07: 2012/13 SMOK001: 2013/14 – retired in 2014/15				
% of patients who are recorded as	SM02: 2006/07 & 2007/08	SM08: 2012/13				
current smokers whose notes	SM04: 2008/09 - 2011/12	SMOK004: 2013/14 – 2014/15				
contain a record that smoking	SM06: 2012/13					
cessation advice or referral to a	SMOK005: 2013/14 – 2014/15					
specialist service, where available,						
has been offered within the						
previous 15 months <sup>3</sup>						
The practice supports smokers in		Information 5: 2006/07-2011/12				
stopping smoking by a strategy		SMOK003: 2012/13 – 2014/15				
which includes providing literature						
and offering appropriate therapy.	affective disorder or other psychoses were added to t					
	of an offer of support and treatment within the precedi	we to we attack the new and is 27 we anthe few al				
patients, reduced to 12 months and 24 months r		ng 15 months , the period is 27 months for a				

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		Example practices					
QOF description	Interpretation for purposes of calculating smoking prevalence	A	В	С	D	E	
SM07 Points		11	10.5	10.8	9.6	11	
SM07 Numerator	Patients <sup>1</sup> whose notes contain a record of smoking status	3450	1319	6276	31948	6504	
SM07 Denominator	Patients who are eligible to be included in this indicator <sup>2</sup>	3721	1497	7033	37654	7212	
SM07 UA		92.70%	88.10%	89.20%	84.80%	90.20%	
SM08 Points		12	9.9	12	8.9	12	
SM08 Numerator	Patients who are recorded as current smokers and have a record of an offer of support etc	1024	325	1578	8439	2165	
SM08 Denominator	Patients who are recorded as current smokers	1129	401	1586	10931	2373	
SM08 UA		90.70%	81.00%	99.50%	77.20%	91.20%	
	Calculation to determine percentage who are smokers SM08 den/ SM07 den	1129/3721	401/1497	1586/7033	10931/37654	2373/72	
	Estimate of smoking prevalence	30.30%	26.80%	22.60%	29.00%	32.90%	

# Table 2 Example of QOF data from 2012/13, showing how it can be used to calculate smoking prevalence for individual practices.

1<sup>1</sup>Patients aged over 15

<sup>2</sup>For example patients who are newly registered with the practices (less than three months) are excluded from the indicator

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<u>ocal authority</u>	Population aged 15 and over (2011 Census) <sup>1</sup>	Population included in QOF indicator SM07 <sup>2</sup>	<u>Number of</u> general practices <sup>3</sup>	<u>IHS sample size</u> 2011/12 <sup>4</sup>
<u>eicestershire</u>				
<u>Blaby</u>	<u>77600</u>	<u>67895</u>	<u>9</u>	<u>301</u>
<u>Charnwood</u>	<u>139800</u>	<u>152533</u>	<u>24</u>	<u>396</u>
<u>Iarborough</u>	<u>70200</u>	<u>69168</u>	<u>8</u>	<u>234</u>
linckley and Bosworth	<u>87800</u>	<u>84159</u>	<u>12</u>	<u>305</u>
<u>/lelton</u>	<u>41900</u>	<u>34912</u>	<u>2</u>	<u>130</u>
<u>Iorth West</u>				29
<u>eicestershire</u>	<u>77000</u>	<u>78331</u>	<u>14</u>	<u>242</u>
Dadby and Wigston	<u>47100</u>	<u>48054</u>	<u>9</u>	<u>167</u>
<u>Iorthamptonshire</u>				
<u>Corby</u>	<u>49400</u>	<u>57112</u>	<u>5</u>	<u>131</u>
Daventry	<u>64100</u>	<u>71902</u>	<u>8</u>	<u>223</u>
ast Northamptonshire	<u>70900</u>	<u>55279</u>	<u>8</u>	<u>217</u>
<u>Cettering</u>	75900	<u>87059</u>	<u>9</u>	<u>180</u>
<u>Iorthampton</u>	<u>171600</u>	<u>184370</u>	<u>27</u>	<u>446</u>
outh Northamptonshire	<u>69700</u>	<u>60391</u>	<u>8</u>	<u>205</u>
<u>Vellingborough</u>	<u>61300</u>	<u>61013</u>	<u>9</u>	<u>172</u>
<b>Jnitary Authorities</b>				2
<u>eicester</u>	<u>264600</u>	<u>293156</u>	<u>59</u>	<u>1475</u>
Rutland	<u>31300</u>	<u>29628</u>	<u>4</u>	<u>416</u>
<u>otals</u>	<u>1400200</u> us available from ONS [21]	<u>1434962</u>	<u>215</u>	<u>5240</u>
Based on QOF registers ad Practices are matched to I Based on IHS data 2011/1	ocal authority districts bas	ed on the postcode of the pra	<u>ctice</u> [23] <u>.</u>	

Table **34** Estimated incident rate ratios (IRRs) for premature (U75) CHD mortality count (n=215)<sup>1</sup>.

	<b>withou</b> variabl	I <b>t</b> smoking prev e	valence		with smoking prevalence variable		
Explanatory variable	le IRR 95% CI p value		p value	IRR	IRR 95% CI p		
Percentage white patients	1.007	(1.003 <i>,</i> 1.012)	0.002	1.001	(0.995 <i>,</i> 1.007)	0.657	
Deprivation score (IMD 2007)	1.017	(1.011 <i>,</i> 1.024)	<0.0001	1.005	(0.995 <i>,</i> 1.015)	0.348	
Prevalence of diabetes (QOF 2006/07)	1.108	(1.020, 1.203)	0.015	1.095	(1.008, 1.187)	0.031	
Percentage over 65	1.060	(1.038, 1.083)	<0.0001	1.067	(1.044 <i>,</i> 1.091)	<0.000	
Percentage male patients	1.073	(1.035 <i>,</i> 1.111)	<0.0001	1.058	(1.021 <i>,</i> 1.097)	0.002	
Number of GPs per 1000 patients	1.209	(0.894 <i>,</i> 1.637)	0.218	1.113	(0.821, 1.508)	0.491	
Hypertension detection 2006/07 (QOF 2006/07)	0.984	(0.955 <i>,</i> 1.014)	0.300	0.988	(0.959 <i>,</i> 1.018)	0.416	
% patients offered smoking cessation advice (SM02 - QOF 2006/07)	1.006	(0.996, 1.016)	0.271	1.010	(1.000, 1.021)	0.057	
% serum cholesterol (CHD08 - QOF 2006/07)	0.989	(0.980, 0.999)	0.028	0.992	(0.983 <i>,</i> 1.002)	0.109	
% aspirin (CHD09 - QOF 2006/07)	1.007	(0.986, 1.029)	0.514	1.003	(0.982 <i>,</i> 1.025)	0.777	
% of patients with recalled perception of being able to see preferred GP (QOF 2006/07)	0.995	(0.990, 1.000)	0.069	0.995	(0.990, 1.000)	0.061	
%smoking prevalence – estimated (QOF 2006/07)				1.031	(1.012 <i>,</i> 1.052)	0.002	

<sup>1</sup>IRR, 95% confidence intervals and associated p values as a result of negative binomial model of count of premature mortality caused by CHD.

#### **Competing Interests**

KH had financial support from CLAHRC in the form of funding for PhD fees. RB is in receipt of an NIHR Senior Investigator award. No financial relationships with any organisations that might have an interest in the submitted work in the previous five years; no other relationships or activities that could appear to have influenced the submitted work.

#### Authors' contributions

#### **Contributor Statement**

The study was conceived by KH, RB, JB and DJ. KH designed the study, carried out the analysis and drafted the initial manuscript. JB and DJ contributed to the statistical analysis. RB, JB and DJ contributed to drafting and editing the final manuscript and interpreting and reviewing the results of the statistical analysis.

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#### Ethical committee approval

NRES advised that NHS ethics committee was not required.

#### Data sharing

No additional data is available

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56 57 58 59 60	

<ul> <li>Figure 1 Relationship between aggregated QOF estimates and IHS estimates for local authority districts</li> <li>Legend Fig 1a Association between estimates (dashed line: estimates are equal)</li> <li>Fig 1b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement)</li> <li>QOF estimates based on 2012/13 data; IHS estimates based on 2011/12 survey.</li> </ul>	BMJ Open: first published
lines: 95% limits of agreement) QOF estimates based on 2012/13 data; IHS estimates based on 2011/12 survey. Figure 2 Relationship between QOF estimates for the general population and those with chronic conditions (2012/13) Legend Fig 2a Association between estimates (dashed line: estimates are equal; solid line: fitted line) Fig 2b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement) SMO7 and SMO8 (2012/13) used for QOF estimates for the general population; SMO5 and SMO6 (2012/13) used for QOF estimates for those with chronic conditions.	as 10.1136/bmjopen-2014-005217 on 16 July 2014. Downloaded from http://b Enseignement Superieur (ABES).
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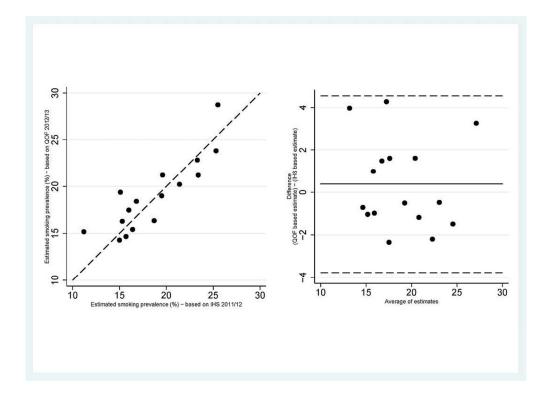


Figure 1 Relationship between aggregated QOF estimates and IHS estimates for local authority districts Legend Fig 1a Association between estimates (dashed line: estimates are equal) BMJ Open: first published as 10.1136/bmjopen-2014-005217 on 16 July 2014. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Fig 1b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement) QOF estimates based on 2012/13 data; IHS estimates based on 2011/12 survey.

90x65mm (300 x 300 DPI)

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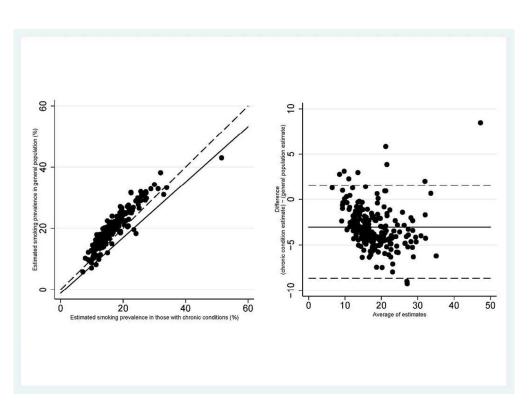


Figure 2 Relationship between QOF estimates for the general population and those with chronic conditions (2012/13)

Legend Fig 2a Association between estimates (dashed line: estimates are equal; solid line: fitted line) Fig 2b Bland-Altman plot showing relationship between difference in estimates and mean difference (solid line: mean difference; dashed lines: 95% limits of agreement)

SM07 and SM08 (2012/13) used for QOF estimates for the general population;

SM05 and SM06 (2012/13) used for QOF estimates for those with chronic conditions.

90x65mm (300 x 300 DPI)

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Table S1 Concordance between estimates of smoking prevalence in those with chronic conditions 2006/07
to 2012/13

Year	2012/13	2011/12	2010/11	2009/10	2008/09	2007/08
2011/12	0.97					
	-0.15 <sup>1</sup> (-2.4, 2.7) <sup>2</sup>					
2010/11	0.97	0.97				
	-0.12 (-2.8, 2.6)	0.04 (-2.6, 2.7)				
2009/10	0.96	0.96	0.99			
	-0.12 (-3.3, 3.0)	-0.03 (-3.2, 3.2)	0.00 (-2.0, 2.0)			
2008/09	0.95	0.95)	0.97	0.98		
	0.06 (-3.5, 3.7)	0.22 (-3.4, 3.8)	0.18 (-2.5, 2.9)	0.19 (-1.9, 2.3)		
2007/08	0.93	0.93	0.95	0.96	0.97	
	0.71 (-3.0, 4.6)	0.87 (-3.0, 4.8)	0.83 (-2.4, 4.0)	0.84 (-1.8, 3.5)	0.65 (-1.74, 3.0)	
2006/07	0.93	0.92	0.94	0.94	0.95	0.97
	0.64 (-3.6, 4.6)	0.79 (-3.4, 5.0)	0.76 (-2.8, 4.4)	0.76 (-2.6, 4.1)	0.57 (-2.9, 4.1)	-0.08 (-2.6, 2.5

*Lin's concordance coefficients p*<0.001 for all coefficients

Mean difference<sup>1</sup> and 95% Limits of Agreement<sup>2</sup> are given in italics

#### STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	ltem #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	3 - abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3 - abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4 - background
Objectives	3	State specific objectives, including any prespecified hypotheses	3 - abstract 4 - background
Methods			
Study design	4	Present key elements of study design early in the paper	3 -abstract
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 – methods – 'sample'
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5 – methods – 'sample'
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5 - methods
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5 - methods
Bias	9	Describe any efforts to address potential sources of bias	5 – methods & 6 – results
			(recording of smoking status and prevalence)
Study size	10	Explain how the study size was arrived at	5 – methods – 'sample'
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5 - methods

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Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5 – methods
		(b) Describe any methods used to examine subgroups and interactions	5 – methods
		(c) Explain how missing data were addressed	5 – methods
		(d) If applicable, describe analytical methods taking account of sampling strategy	5 – methods
		(e) Describe any sensitivity analyses	6 - results
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 - methods
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5 - methods
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6 - results
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence	
		interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5 – methods 6 - results
Discussion			
Key results	18	Summarise key results with reference to study objectives	7 – discussion – principal findings
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7 – discussion – strengths and weaknesses
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7 - discussion
Generalisability	21	Discuss the generalisability (external validity) of the study results	7 - discussion
Other information			

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on	11 – competing
		which the present article is based	interests

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

.d, if applicable, ft. .st item and gives methodological ba .alable on the Web sites of PLoS Medicine at . .eepidem.com/). Information on the STROBE Initiative. Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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