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Measuring change in health care equity using small area administrative data – evidence from the English NHS 2001-8

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Richard Cookson[1] Mauro Laudicella[2] Paolo Li Donni[3]

[1] Centre for Health Economics, University of York, England
[2] Imperial College Business School, London, England
[3] Department of Economics, Finance and Business, University of Palermo, Italy

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Corresponding author:
Dr Richard Cookson, Centre for Health Economics, University of York, York YO10 5DD, Tel: 01904 321412, Fax: 01904 321402, Email: richard.cookson@york.ac.uk

ABSTRACT

Background. This study develops a method for measuring change in socio-economic equity in health care utilisation using small area administrative data, which contains more detailed information on utilisation than survey data but only examines socio-economic differences between neighbourhoods rather than individuals. The context is the English NHS from 2001 to 2008, a period of accelerated expenditure growth and pro-competition reform.

Methods. Hospital records for all adults receiving non-emergency hospital care in the English NHS from 2001 to 2008 were aggregated to 32,482 English small areas with mean population about 1,500 and combined with small area data. Regression models of utilisation were used to examine year-on-year change in the small area association between deprivation and utilisation, allowing for population size, age-sex composition and disease prevalence including (from 2003-8) cancer, chronic kidney disease, coronary heart disease, diabetes, epilepsy, hypertension, hypothyroidism, stroke, transient ischaemic attack and (from 2006-8) atrial fibrillation, chronic obstructive pulmonary disease, obesity and heart failure.

Results. There was no substantial change in small area associations between deprivation and utilisation for outpatient visits, hip replacement, senile cataract, gastroscopy or coronary revascularisation, though overall non-emergency inpatient admissions rose slightly faster in more deprived areas than elsewhere. Associations between deprivation and disease prevalence changed little during the period, indicating that observed need did not grow faster in more deprived areas than elsewhere.

Conclusion. There was no substantial deterioration in socio-economic equity in health care utilisation in the English NHS from 2001 to 2008, and if anything, there may have been a slight improvement.

WHAT IS ALREADY KNOWN

Methods for measuring change in individual level socio-economic equity in health care utilisation using sample survey data are limited by small numbers of sample members using specific procedures and potentially unrepresentative samples of disadvantaged populations.

There is cross sectional evidence suggestive of both individual level and neighbourhood level socio-economic inequity in health care utilisation in the English NHS in the early 2000s.

WHAT THIS STUDY ADDS

This study develops a method for measuring change in neighbourhood level socio-economic equity in health care utilisation, using administrative data on utilisation of a battery of general and procedure-specific forms of specialist care.

There was no substantial deterioration in socio-economic equity in health care utilisation in the English NHS between 2001 and 2008, and if anything there may have been a slight improvement.

Equity in health care is topic of ongoing importance in all health systems [1, 2]. Evidence of socio-economic inequity in the utilisation of non-emergency specialist care relative to need has been found even in high income countries with universal and comprehensive health programmes like the English National Health Service (NHS) [3-5]. This is often interpreted as an important indicator of broader socio-economic inequity of access to health care, since utilisation of non-emergency specialist care is potentially sensitive to all of the important financial and non-financial access barriers that people may face in navigating their way through the health system.

Much of this evidence is cross sectional, and much methodological development has centred on improving the accuracy and cross country comparability of equity measures [2, 4]. However, health service policy makers and managers need better methods for detecting change in health care equity (equity "movies") as well as better methods for measuring levels of health care equity (equity "snapshots").

Most research on equity in health care utilisation uses survey data rather than administrative data [2]. The main advantage of survey data is that it allows conclusions to be drawn about inequity in utilisation between individuals, and not just inequity in utilisation between small area populations (or "neighbourhoods", for short). This is because survey data contains information about the health needs and socio-economic characteristics of individuals who have not used health care, as well as those who have used health care. However, survey data has at least two important disadvantages [6]. First, surveys only include small numbers of sample members using specific procedures, so equity analyses are typically restricted to general utilisation indicators such as the probability of receiving any form of specialist care. Second, surveys have difficulty selecting representative samples of the most disadvantaged and most advantaged population subgroups. By contrast, administrative data can include large numbers using specific procedures and can provide information on the whole population.

So in this study we develop methods for measuring change in health care equity using small area administrative data, as a complement to conventional methods using individual level survey data. Our main challenge is to allow convincingly for change in small area health care need, in order to distinguish change in equity from appropriate change in health care utilisation due to change in need [7] We do this by using primary care data to construct time varying small area indicators of disease prevalence including (from 2003-8) cancer, chronic kidney disease, coronary heart disease, diabetes, epilepsy, hypertension, hypothyroidism, stroke, transient ischaemic attack and (from 2006-8) atrial fibrillation, chronic obstructive pulmonary disease, obesity and heart failure. We use this data to allow for need in regression models of the utilisation of specialist care, and to check whether there was any systematic tendency for health care need to grow more rapidly (or more slowly) in deprived neighbourhoods than elsewhere. We cannot measure severity of disease, and so probably under-estimate need for specialist health care in deprived areas. This means our method does not allow us accurately to measure the level of health care equity in cross section data. However, it does allow us to measure change in health care equity in time series data, on the reasonable assumption that trends in unobserved need run parallel between population subgroups. Our discussion section provides arguments and evidence to support this key assumption of parallel trends in need.

The context of our study is the English NHS from financial years 2001/2 to 2008/9 (in England, the financial year runs from April to March). This was a period of accelerated public expenditure growth on health care throughout and pro-competition reform from 2006. Real annual NHS expenditure growth averaged 6.56% from 1999/00 to 2010/11 compared with 3.48% from 1950/51 to 1999/00 [8]. Reforms include a sustained target-driven reduction in hospital waiting times from 2001 [9, 10], a pay for performance scheme in primary care from 2004 [11] and increased hospital choice and competition from 2006 [12]. When Prime Minister Tony Blair was promoting his NHS reforms in the early 2000s, he claimed that the resulting increase in capacity and choice would enhance equity for poorer patients [12, 13]. This claim was supported by Julian Le Grand, Tony Blair's senior policy adviser from 2003-5, who highlighted evidence that socio-economic inequities in specialist care existed prior to the reforms [3, 14]. In contrast, critics argued that the new emphasis on choice, competition and independent sector provision of publicly funded hospital care would undermine socio-economic equity [15-18]. Our methods only measure change in equity, and do not allow us to identify which elements of reform caused which changes in equity. Nevertheless, it is of considerable policy interest to find out what actually happened to socio-economic equity in the utilisation of hospital care in the English NHS during this period: did things get better (as Prime Minister Blair predicted) or worse (as his critics predicted) or stay about the same?

METHODS

Our research question was whether there was any change between 2001 and 2008 in small area socio-economic equity in the utilisation of specialist care relative to need in the English NHS. Our small areas are 32,382 English Lower Layer Super Output Areas (LSOAs) with mean population 1,500. These are stable, similar sized and residentially homogenous geographical units designed by the Neighbourhood Statistics Service, which supports UK government policy on social exclusion and neighbourhood renewal [19]. We examine change in the association between small area deprivation and utilisation of non-emergency outpatient and inpatient hospital care, allowing for observable change in need.

Outcome variables – non-emergency outpatient and inpatient hospital utilisation

Neighbourhood utilisation counts were extracted from Hospital Episode Statistics for England [20]. Our data includes all NHS funded hospital care, including care provided by independent sector hospitals. We do not examine privately funded care, which makes up about 20% of total health expenditure in the UK – falling slightly during the 2000s from 20.7% in 2001 to 17.6% in 2008 [21]. Our indicator of overall inpatient utilisation counts the number of continuous inpatient spells for adults age 18 or over admitted for non-emergency inpatient acute hospital care in the English NHS in financial years 2001/2 to 2008/9. Our indicator of overall outpatient utilisation counts the number of individuals age 18 or over attending outpatient visits in financial years 2004/5 to 2008/9, including visits in community settings as well as hospital settings and including visits to professions allied to medicine as well as medical specialists. We also examine four specific non-emergency inpatient procedures: primary hip replacement, senile cataract surgery, gastroscopy (diagnostic endoscopic examination of the upper gastrointestinal tract) and coronary revascularisation (including both coronary artery bypass grafting and percutaneous coronary intervention). For gastrosopy we include all adults age 18 or over, whereas for the other procedures we focus on adults age 45 or over as younger patients are rare and atypical. Our basket of specific inpatient procedures represents a broad spectrum of hospital care – including high and low cost care, day case and residential care, secondary and tertiary care, diagnostic and therapeutic care – across four different clinical specialities (orthopaedics, ophthalmology, gastroenterology and cardiothoracic surgery). Hip replacement [22-25] and coronary revascularisation [26] are commonly used as indicators of health care equity, and both were cited by Prime Minister Blair's adviser Julian Le Grand [27] during the reform period as significant examples of health care inequity in the NHS. Hip replacement, senile cataract and coronary revascularisation were all important targets of the NHS reforms, with initially high waiting times that fell substantially during the reform period [10, 28]. Examining gastroscopy allows us to check whether equity trends differ for a low cost diagnostic procedure, as opposed to relatively high cost treatments. Finally, all four indicators are high volume procedures with tens of thousands performed each year – hundreds of thousands in the case of gastroscopy – making it possible to detect statistically significant change over time.

Neighbourhood deprivation variables

Neighbourhood deprivation is measured using the time-varying income deprivation domain of the English Economic Deprivation Index (EDI) 2008, which indicates the proportion of individuals aged 0 to 60 living in households receiving low income benefits [29]. This index provides the most up-to-date picture of neighbourhood deprivation in the light of changing economic circumstances, does not include any health variables that might introduce circularity into the modelling, and is easy to interpret. We use other time-fixed deprivation indices in sensitivity analysis.

Need variables

Annual estimates of neighbourhood population size and age-sex composition are obtained from the Office for National Statistics [30]. We also estimate neighbourhood disease prevalence using administrative data from the UK's primary care pay-for-performance scheme, the "Quality and Outcomes Framework" [11, 31]. We attribute family practice data to neighbourhoods using the Attribution Data Set [32], which contains information on the number of patients in each family practice resident in each neighbourhood. Most of the prevalence data starts from 2003/4 onwards and refers to all age populations (see appendix table SA1).

Supply variables

We use two sets of supply variables: indicators of urbanization from the Office for National Statistics, and indicators of NHS administrative area for resource allocation purposes (152 Primary Care Trusts fixed at 2006 boundaries).

Graphical analysis of equity trends by deprivation group

To illustrate year-by-year trends in socio-economic utilisation patterns, we present time series charts showing need standardised utilisation rates per 100,000 general population by interval deprivation group and year. To illustrate change between the first and last year, we present social gradient charts comparing the two years using need standardised utilisation ratios – which share a common scale independent of growth in average utilisation rates – by deprivation group. This deprivation group approach provides a clearer picture of change over time than concentration curves summarizing the entire socio-economic distribution, since concentration curves for different years appear close together and are hard to tell apart.

We use four interval deprivation groups with an increasing proportion of individuals living in households receiving low income benefits: (1) 0-10%, (2) 10-20%, (3) 20%-30% and (4) 30% or above. Since the distribution of the EDI score is left-skewed, this generates unequally sized groups comprising about 57%, 22%, 12% and 9% of small areas respectively – though the size and composition of these groups varies slightly from year to year due to changing national and local economic circumstances (see appendix table SA2). Our two most deprived groups therefore approximately correspond to the two most deprived tenths of neighbourhoods in England. In sensitivity analysis we also split our deprivation indices into quantile groups.

We standardise utilisation for observed demographic and disease prevalence need variables using the regression-based indirect standardization methods developed by the ECuity group [2]. These methods allow appropriately for correlation between “need” and “non-need” variables such as deprivation and supply variables. We compute standardised utilisation ratios as observed utilisation divided by need expected utilisation, and standardised utilisation rates as the standardised utilisation ratio times the national mean utilisation rate. We use linear regression models for standardization, since predictions from non-linear models are influenced by the value fixed for the “non-need” variables [2]. The linear regression standard errors may be biased due to the non-normal distribution of the procedure-specific counts, so we compute confidence intervals around standardised utilisation ratios using stratified bootstrap simulation of both numerator and denominator with 1,000 replications.

Formal statistical tests for change in equity

We test for change in the neighbourhood association between utilisation and income deprivation using regression models of utilisation with year-deprivation interactions to measure change from the baseline year. In this analysis we treated income deprivation as a continuous variable on a scale of 0 to 100. This is more general than the categorical approach in our graphical analysis, as it takes account of the full socio-economic distribution and avoids the potential selection biases associated with arbitrarily defined groups. We use linear models for overall indicators and negative binomial count data models for the procedure-specific indicators exhibiting excess zeros and over-dispersion. This is because the purpose of this analysis is to test for change in utilisation patterns over time, rather than to visualise such patterns by producing need standardised predictions. We used three models to examine how results change with the addition of different covariates: a base model with population size and age-sex fractions only; a base/needs model adding disease prevalence variables; and a full model adding supply variables. All models are estimated using Stata 11 and use cluster robust standard errors to allow for correlation within small areas over time.

RESULTS

Graphical analysis of equity trends by deprivation group

Figure 1 shows general equity trends in hospital elective and outpatient admissions. The right hand panels compare all eight years in terms of deprivation gaps, showing standardised utilisation rates per 100,000 by the four deprivation groups. Over time, standardised utilisation appears to change approximately in parallel across all four groups. In cross section, however, standardised utilisation is higher in more deprived groups, suggesting some aspects of need remain unobserved (see discussion section). The left hand panels compare the first and last years in terms of deprivation gradients, showing how standardised utilisation ratios vary by the four deprivation groups. Deprivation is increasing as we move rightwards on the horizontal axis. There is no sign of any change in the social gradient in outpatient visits between 2004/5 and 2008/9. However, for inpatient admissions standardised utilisation ratios in the two most deprived groups appear slightly higher in 2008/9 than 2001/2. In 2001/2, standardised utilisation is respectively 17.2% and 13.8% higher in the two most deprived groups compared with the least deprived group, whereas by 2008/9 standardised utilisation is respectively 22.0% and 16.5% higher. This suggests that the rate of inpatient admissions relative to need grew slightly faster in the two most deprived groups compared with the least deprived group.

Figure 2 shows equity trends in our four specific inpatient procedures. In each case, standardised utilisation rates change approximately in parallel across deprivation groups. In cross section, rates of both observed and need standardised utilisation are higher in deprived areas for cataract surgery, gastroscopy and revascularisation, but lower for hip replacement. Appendix Table SA1 reports the observed utilisation rates.

Statistical tests of change in equity

Table 1 presents modeled associations between income deprivation and utilisation, allowing for need, showing the baseline association in 2001/2 and change between 2001/2 and 2008/9. There is no significant change in the deprivation-utilisation association for hip replacement, gastroscopy or revascularisation in any of the models. There is a small change for outpatient visits in the base model allowing for population size, age and sex only, but this disappears after allowing for disease prevalence. There is also a small change for cataract surgery, but deprivation-year coefficients for previous years are not significant and show no systematic pattern of change during the 2000s (full regression tables available from the authors on request).

There is however a small but significant and systematic increase in the positive deprivation-utilisation association for all non-emergency inpatient admissions, in all three models. Deprivation-year coefficients for previous years are gradually increasing, confirming that this is a systematic change throughout the 2000s rather than a temporary change in 2008/9. To interpret the magnitude of the increase, we can consider the effect of a ten percentage point increase in income deprivation – enough to shift a small area into a higher interval deprivation group (0-10%, 10-20%, 20-30% and 30%+). At baseline in 2001/2, the linear deprivation coefficient of 0.758 in the full model means that a ten percentage point increase in deprivation is associated with an additional 7.58 admissions, or 4.77% of mean neighbourhood admissions in 2001/2 (159). The corresponding deprivation-year coefficient in 2008/9 of 0.530 implies that by 2008/9 the coefficient had risen to 1.288 (0.758 + 0.530). This means that in 2008/9 a ten percentage point increase in deprivation was associated with an additional 12.88 admissions, or 5.03% of mean neighbourhood admissions in 2008/9 (256).

DISCUSSION

Main findings

Allowing for need, we find no substantial change in the neighbourhood level association between income deprivation and hospital utilisation for either general or procedure-specific indicators. Standardised rates of non-emergency inpatient admission rose slightly faster in more deprived areas than elsewhere between 2001/2 and 2008/9. However there was no significant and systematic change in neighbourhood level socio-economic utilisation patterns for outpatient visits (data only available from 2004/5), hip replacement, senile cataract, gastroscopy or revascularisation. Trends in average utilisation are discussed in Appendix SA3.

In cross section, neighbourhood deprivation was generally associated with higher utilisation, except in the case of hip replacement. This suggests our demographic and disease prevalence variables generally under-estimate health care need in deprived neighbourhoods. This may be because unobserved disease severity may be higher in deprived areas, and prevalence may be under-diagnosed. So we cannot accurately measure the level of socio-economic equity relative to need at a point in time.

The assumption of parallel trends in need

We can however draw conclusions about change in socio-economic equity relative to need. We can do so by making the reasonable assumption that unobserved trends in need do not systematically and substantially vary between deprivation groups over the space of a few years. Three main factors influence trends in unobserved need for health care:

1. Change in underlying social determinants of health
2. Change in medical technology
3. Change in utilisation of health care

Underlying social determinants of health may evolve differentially between socio-economic groups over a period of decades, but are unlikely to do so in the short run period of a few years. Similarly, medical innovation is unlikely to drive short run differential socio-economic trends in need within high income countries, even though the global innovation process may be influenced by differential disease patterns between high and low income countries. Finally, non-parallel changes in utilisation of health care could potentially drive non-parallel changes in need for health care in future years. But that is not what we observed: utilisation ran approximately parallel across all deprivation groups.

A challenge to this argument is that possibility that unobserved need may have grown faster in deprived areas, due to a relative worsening in deprived areas in unobserved unhealthy lifestyle behaviour such as poor diet, limited physical exercise and smoking. However, Table 1 offers some evidence to defend our assumption against this challenge. We observe prevalence of a battery of conditions sensitive to unhealthy lifestyle behaviour including (from 2003-8) cancer, chronic kidney disease, coronary heart disease, diabetes, epilepsy, hypertension, hypothyroidism, stroke, transient ischaemic attack and (from 2006-8) atrial fibrillation, chronic obstructive pulmonary disease, obesity and heart failure. The addition of these covariates substantially reduces the deprivation-utilisation association for inpatient admissions and outpatient visits, suggesting as expected that observed need is generally greater in deprived areas. However, the addition of disease prevalence covariates has little impact on the year-deprivation interaction terms indicating change in the deprivation-utilisation association. This lack of sensitivity suggests that the relationship between observed need and deprivation did not change muchis stable over time. So even if there was a relative worsening of unhealthy lifestyle behaviour in deprived neighbourhoods during this period, this did not have a short term effect on increased disease prevalence and need for specialist health care during the period of this study.

Table 2 offers further evidence. It shows associations between disease prevalence and deprivation by year, after allowing for age and sex. Most of the associations are positive, with rate ratios between 1.001 and 1.016, so that a ten percentage point increase in EDI score is associated with a 1% to 16% increase in disease prevalence. However, the associations do not change much substantially over time. This shows that trends in observed disease prevalence were approximately parallel between deprivation groups during this period. We cannot of course directly measure unobserved aspects of need, in particular disease severity. However, if disease severity increased faster in deprived areas than elsewhere during this period, one would expect this also to show up in the disease prevalence figures.

We therefore conclude that there was no substantial deterioration in small area socio-economic equity in health care in the English NHS from 2001 to 2008. Small area equity may even have improved slightly, with slightly faster growth in non-emergency hospital utilisation relative to need in deprived areas.

Strengths and limitations

Strengths our study include (1) the ability to examine change in specific high volume procedures as well as general utilisation of specialist care, (2) the use of data on the entire population of patients using the English NHS rather than a potentially unrepresentative sample, (3) the analysis of year-on-year change in utilisation to check whether changes were systematic or due to selection of atypical endpoint years, and (4) the use of primary care disease prevalence data to measure change in population health need.

Our study also had important limitations. First, this was an ecological study and we can only draw firm conclusions about change in neighbourhood level equity, not individual level equity. In 2005, the mean English small area population was 1,554 and 99% had populations smaller than 2,375; falling to 1,173 and 1,818 respectively if we focus on adults age 20 or over. These are small populations, and English neighbourhoods are segregated by socio-economic status, so if there were a substantial change in individual level equity one would expect this to show up as a change in neighbourhood level equity. Nevertheless, there is considerable individual level heterogeneity in socio-economic status within small areas: not all socio-economically disadvantaged individuals live in low income neighbourhoods, and vice versa. Second, data on privately funded hospital care were not available. Privately funded hospital use made up a small and declining share of total hospital activity in England during the period, due to falling NHS waiting times. This shift in demand may have disproportionately increased NHS utilisation in affluent areas, which other things equal would show up as a worsening of equity on our measure. This reinforces our conclusion that if anything equity was improving during this period. Third, our data contained coding errors which may vary systematically between hospitals with different coding practices. This cannot bias our estimates for general indicators of hospital utilisation, which capture all activity irrespective of coding, though is a potential issue for the procedure-specific indicators. However, any such bias is likely to be small as there is no reason to suppose that change in hospital coding practices is systematically and substantially related to the deprivation mix of hospital patient intake. Fourth, there was substantially incomplete reporting of hospital utilisation data for Independent Sector (IS) providers treating NHS funded patients from 2003/4 to 2005/6. This missing data could in theory obscure disproportionate rises in IS activity in affluent neighbourhoods in those years. However, only a small proportion of total NHS hospital utilisation data was missing (see Appendix SA1 and Table SA3). Furthermore, IS patients were not much more likely to live in affluent areas than other NHS patients: one study found mean area deprivation of IS patients was only 1.56 percentage points lower [33].

Policy implications

Together with the findings of previous studies, our findings suggest there has been little change over the last two decades in socio-economic equity in the delivery of health care in the English NHS. Small area studies of hospital utilisation in the English NHS from 1991 to 2001 found no change in socio-economic equity in coronary revascularisation and a small reduction for hip replacement [25, 34]. Patient level studies of the English NHS from the late 1990s to the mid 2000s using small area deprivation measures found little change in small area socio-economic variations in hospital waiting times [35] or in proportions of patients receiving preferred treatments colorectal, breast and lung cancer [36]. This is despite substantial variations in spending growth between the 1990s and 2000s, and the introduction of major pro-competition health reforms in both decades. This suggests that socio-economic inequity in utilisation of health care in the English NHS may reflect slow changing demand factors relating to patient care-seeking behaviour, rather than supply factors that respond to short term changes in NHS spending growth and reform.

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Competing interests

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that they had financial support from the University of York for the submitted work, no financial relationships with any companies that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

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Table 1: Modeled associations between income deprivation and utilisation, showing baseline association and difference in 2008/9 * † ǂ §

	Base model	Base/Needs model	Full model
All Elective (OLS model)			
Deprivation effect in 2001	1.184 (1.115 to 1.254)	0.625 (0.547 to 0.704)	0.758 (0.684 to 0.831)
Difference in 2008	0.623 (0.516 to 0.731)	0.652 (0.541 to 0.763)	0.530 (0.422 to 0.639)
All Outpatient (OLS model)			
Deprivation effect in 2004	2.536 (2.463 to 2.609)	1.964 (1.885 to 2.043)	1.738 (1.666 to 1.809)
Difference in 2008	0.069 (0.010 to 0.128)	0.032 (-0.031 to 0.095)	-0.026 (-0.088 to 0.035)
Hip replacement (negative binomial model)			
Deprivation effect in 2001 (rate ratio)	0.992 (0.991 to 0.993)	0.994 (0.993 to 0.995)	0.995 (0.994 to 0.997)
Difference in 2008 (rate ratio)	1.002 (1.000 to 1.003)	1.001 (0.999 to 1.003)	1.001 (0.999 to 1.002)
Senile Cataract (negative binomial model)			
Deprivation effect in 2001 (rate ratio)	1.011 (1.009 to 1.012)	1.012 (1.01 to 1.013)	1.010 (1.008 to 1.011)
Difference in 2008 (rate ratio)	0.998 (0.996 to 1.000)	0.997 (0.995 to 0.999)	0.994 (0.993 to 0.996)
Gastroscopy (negative binomial model)			
Deprivation effect in 2001 (rate ratio)	1.014 (1.014 to 1.015)	1.01 (1.009 to 1.010)	1.011 (1.010 to 1.011)
Difference in 2008 (rate ratio)	1.000 (0.999 to 1.001)	1.001 (1.000 to 1.001)	1.000 (1.000 to 1.001)
Revascularisation (negative binomial model)			
Deprivation effect in 2001 (rate ratio)	1.005 (1.004 to 1.007)	1.004 (1.003 to 1.005)	1.003 (1.002 to 1.004)
Difference in 2008 (rate ratio)	1.001 (0.999 to 1.003)	1.001 (1.000 to 1.003)	1.001 (0.999 to 1.003)

Notes to Table 1:

* All coefficients are shown with 95% confidence intervals in brackets.

† In the OLS models of general utilisation, the deprivation effect shows the additional number of admissions or visits associated with a one percentage point increase in income deprivation, and the difference in 2008 shows the difference in 2008 compared with baseline (2001 for inpatient admissions and 2004 for outpatient visits).

ǂ In the negative binomial models of procedure-specific utilisation, the deprivation effect shows the proportionate change in utilisation associated with a one percentage point increase in income deprivation, and the difference in 2008 shows the direction of any difference in this association in 2008 compared with 2001.

§ The base model controls for population, age-sex fractions and year only; the base/needs model adds disease prevalence covariates; and the full model adds supply variables (urbanization and NHS administrative area).

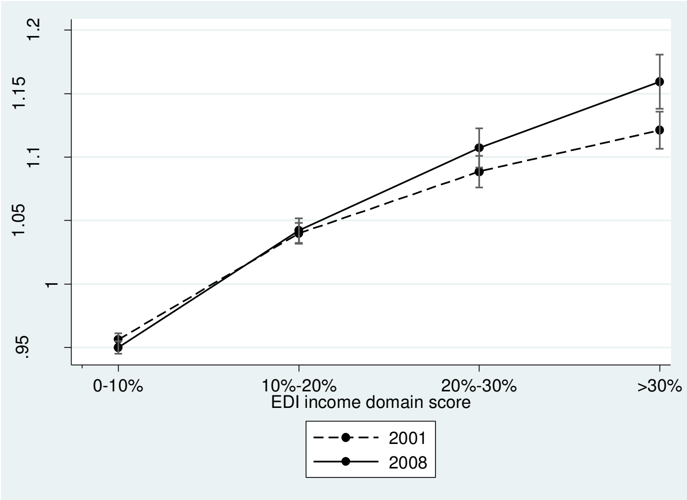
Table 2: Small area associations between disease prevalence and deprivation by year, After allowing for age and sex * † ǂ §

	Atrial fibrillation	Cancer	Chronic kidney disease (*)
2003	N/A	0.996 (0.995 to 0.996)	0.997 (0.996 to 0.997)
2004	N/A	0.995 (0.995 to 0.996)	0.997 (0.996 to 0.997)
2005	N/A	0.995 (0.995 to 0.996)	0.997 (0.997 to 0.998)
2006	0.996 (0.996 to 0.997)	0.995 (0.995 to 0.996)	0.998 (0.997 to 0.998)
2007	0.997 (0.996 to 0.997)	0.996 (0.995 to 0.996)	1.000 (0.999 to 1.000)
2008	0.997 (0.997 to 0.998)	0.996 (0.995 to 0.996)	1.000 (1.000 to 1.001)
	Chronic obstructive pulmonary disease	**Coronary heart disease**	**Diabetes (*)**
2003	N/A	1.006 (1.005 to 1.006)	1.007 (1.006 to 1.007)
2004	N/A	1.005 (1.005 to 1.006)	1.007 (1.007 to 1.007)
2005	N/A	1.005 (1.005 to 1.006)	1.007 (1.007 to 1.007)
2006	1.015 (1.015 to 1.016)	1.006 (1.006 to 1.006)	1.007 (1.007 to 1.007)
2007	1.015 (1.015 to 1.016)	1.006 (1.006 to 1.007)	1.007 (1.007 to 1.008)
2008	1.016 (1.015 to 1.016)	1.006 (1.006 to 1.007)	1.008 (1.007 to 1.008)
	Epilepsy (*)	**Heart failure**	**Hypertension**
2003	1.006 (1.006 to 1.006)	N/A	1.000 (1.000 to 1.001)
2004	1.006 (1.006 to 1.006)	N/A	1.001 (1.000 to 1.001)
2005	1.006 (1.006 to 1.007)	N/A	1.001 (1.001 to 1.001)
2006	1.007 (1.007 to 1.007)	1.004 (1.004 to 1.005)	1.002 (1.002 to 1.002)
2007	1.007 (1.007 to 1.008)	1.005 (1.004 to 1.005)	1.003 (1.003 to 1.003)
2008	1.008 (1.007 to 1.008)	1.005 (1.005 to 1.006)	1.003 (1.003 to 1.003)
	Hypothyroidism	**Obesity (*)**	**Stroke and transient ischaemic attack**
2003	0.997 (0.996 to 0.997)	N/A	1.001 (1.001 to 1.001)
2004	0.996 (0.996 to 0.997)	N/A	1.001 (1.000 to 1.001)
2005	0.997 (0.996 to 0.997)	N/A	1.001 (1.000 to 1.001)
2006	0.998 (0.998 to 0.998)	1.010 (1.010 to 1.010)	1.002 (1.001 to 1.002)
2007	0.998 (0.998 to 0.999)	1.010 (1.010 to 1.011)	1.002 (1.002 to 1.003)
2008	0.999 (0.999 to 0.999)	1.011 (1.011 to 1.011)	1.003 (1.002 to 1.003)

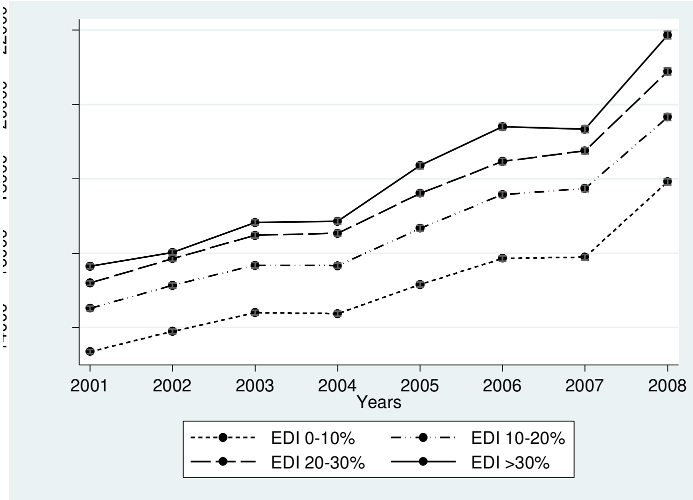
Notes to Table 2:
* Estimated rate ratios with 95% confidence intervals in brackets.
† These rate ratios can be interpreted as the proportionate change in disease prevalence associated with a one percentage point increase in income deprivation.
ǂ Estimates are from separate GLM regression models of disease prevalence in each year, with income deprivation and age-sex fractions as covariates.
§ N/A means data not available for this year.

Figure 1: Overall trends in non-emergency inpatient admissions and outpatient visits

Non-emergency inpatient admissions * † ǂ

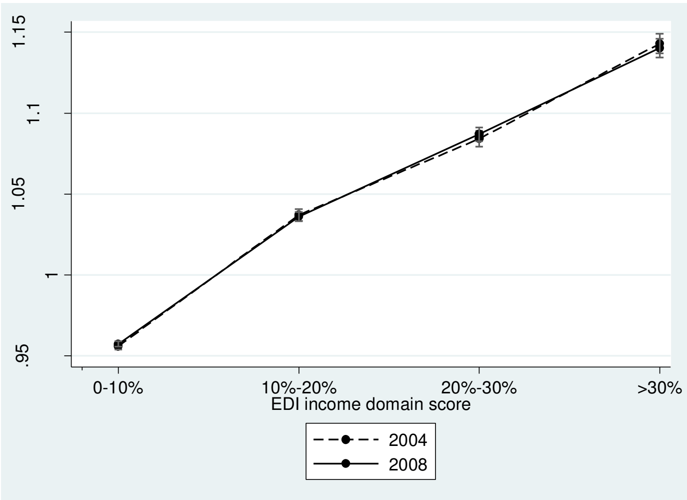


2001 versus 2008

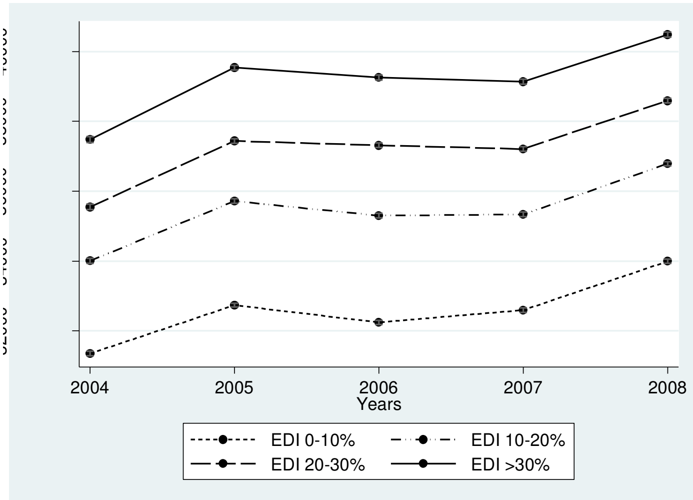


Year-by-year trends
(utilisation rate per 100,000)

Outpatient visits



2004 vs. 2008



Year-by-year trends
(utilisation rate per 100,000)

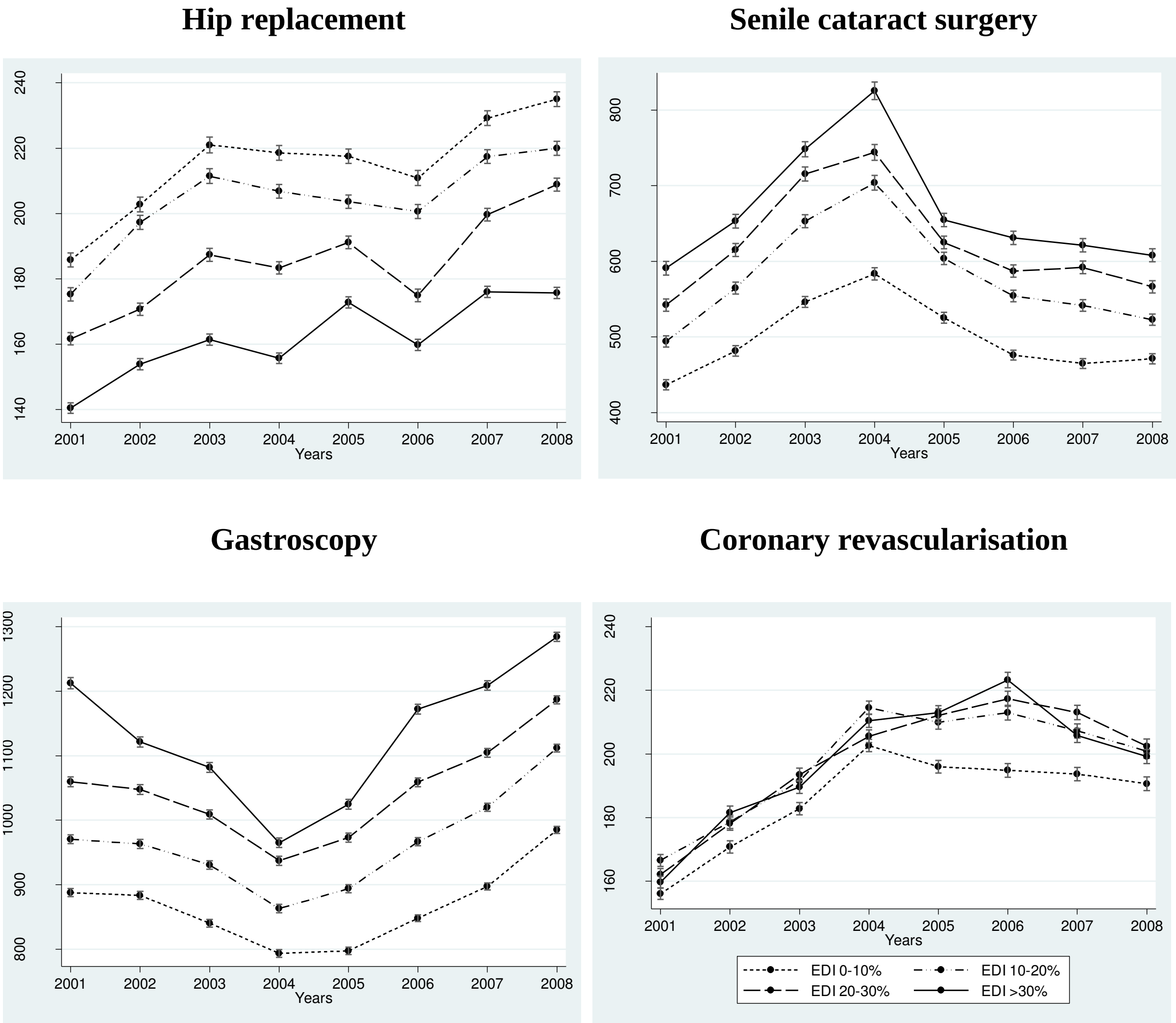
Notes to Figure 1:

***** Year-specific linear regression models are used to standardise utilisation for population size, age-sex fractions and disease prevalence.

† The first year for outpatient visits is 2004, as this is the earliest year for which acceptably complete outpatient data are available in England.

ǂ EDI is the neighbourhood level Economic Deprivation Index indicating the proportion of individuals living in low-income households.

Figure 2: Trends in four specific hospital inpatient procedures (Standardised utilisation rate per 100,000) * †



Notes to Figure 2:

* Year-specific linear regression models are used to indirectly standardise utilisation for population size and age-sex fractions.
† EDI is the neighbourhood level Economic Deprivation Index indicating the proportion of individuals living in low-income households.

Supplementary Appendix

Appendix SA1: Further Details of Data and Coding Procedures

Appendix SA2: Further Details of Estimation Methods

Appendix SA3: Discussion of Average Utilisation Trends

Appendix SA4: Further Discussion of Cross Sectional Results

Table SA1: Observed Utilisation Rates by Year and Deprivation

Table SA2: Small Area Mean Values of Deprivation and Control Variables by Year

Table SA3: Total Inpatient Admissions by Year Comparing NHS and Independent Sector Activity