QualityWatch

Focus On: Antidepressant prescribing

Trends in the prescribing of antidepressants in primary care

Ruth Spence, Adam Roberts, Cono Ariti and Martin Bardsley

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About this report

This QualityWatch Focus On report examines trends in antidepressant prescribing in England during the recent economic recession.

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Glossary

Lower Super Output Area	A geographical area created for the 2001 Census, each containing an average of 1,500 residents.
Mean	A value that represents the most likely value in a sample, calculated by dividing the sum of all observations in the sample by the number of observations.
Parameter estimate	The estimated increase in the dependant variable associated with an increase of one unit of a predictor variable.
***p* value**	The estimated probability of rejecting the null hypothesis of a study question when that hypothesis is true.
Residual	The difference between the observed value of a quantity and the value predicted by a statistical model.
Standard error	The standard deviation of the distribution of the parameter estimate. This is a measure of the precision of the parameter estimate with smaller values indicating a more reliable estimate.
Standardised residual	The observed value of the residual is transformed to conform to a distribution of residuals having a mean of zero and a standard deviation of one. This aids in identifying outlying values.
***t* value**	The parameter estimate divided by the standard error. It is a measure of the strength of association between the dependant variable and a predictor variable. Larger positive or negative values of the *t* value indicate a stronger association.

Summary

Antidepressant medication is an intervention of proven value in treating depression (NICE, 2009) and good-quality care should ensure that drugs are prescribed appropriately to those who will benefit most. However, overuse of antidepressants can have a negative impact on patient health and create dependencies, representing an inefficient use of health care resources. Therefore, it is important that health services seek to minimise instances of over-, or under-, prescribing of these important drugs. Yet, there are reports of a rising use of antidepressants in primary care and the reasons behind this are not clear.

One explanation may lie in the recent economic recession. There are strong links between socioeconomic disadvantage and deprivation, and poor mental health. Therefore, it is likely that the recent growth of unemployment, poverty and inequality caused by the economic recession will lead to an increase in mental health problems, and a subsequent demand for health services. In the first instance, such problems are most likely to be seen through management in primary care. In this analysis, we explore antidepressant prescribing patterns and investigate whether economic indicators are linked to general practitioner (GP) prescribing.

Using routinely available datasets, we looked at trends in antidepressant prescribing between 1998 and 2012, and the variation in levels of prescribing across England between 2010 and 2013. In order to explore variation in prescribing at practice level, we developed a statistical model to assess which factors are associated with the total number of antidepressants prescribed per registered patient at GP practice level.

165%

increase in the prescribing of antidepressant drugs in England between 1998 and 2012

Key findings

- There was a 165 per cent increase in the prescribing of antidepressant drugs in England between 1998 and 2012 (an average of 7.2 per cent a year). This increase does not seem to be an artefact of changes in packaging or average doses but represents a greater consumption of prescribed antidepressants.
- Although there has been a recent increase in the prevalence of depression recorded by GPs, this change cannot fully account for the increased dispensing of antidepressants.
- There is some evidence that the rate of increase has not been stable and there have been periods where the increase has accelerated, including a period from 2008 to 2012 in line with the financial recession.
- There are large geographical variations in the rates of prescribing. During the period between October and December 2012/13, rates varied from 71 items per 1,000 people in NHS Brent, to 331 items per 1,000 people in NHS Blackpool. Generally, there were lower levels of prescribing in London and higher rates in the North East.

The detailed model to explain variation at practice level showed that:

- GP practices that prescribed more antidepressants had a greater percentage of patients aged 65 and over, female and white.

- The quantity of antidepressants prescribed was associated with GP practice characteristics such as the number of GPs per 10,000 patients and the number of antibiotics prescribed, which we used as an indicator of overall prescribing behaviour.
- Socioeconomic factors were less influential, although GP practices in areas with better health prescribed more antidepressants, whereas GP practices in areas with better housing prescribed fewer antidepressants.
- Improving Access to Psychological Therapies (IAPT) was not significantly associated with the extent of GP prescribing of antidepressants.

A model we developed to explain variation at primary care trust (PCT) level showed that:

- PCTs that were prescribing outside of what was predicted tended to prescribe at a greater, rather than a lower, level than expected.
- There does not appear to be a geographic pattern to over-prescribing at PCT level.

Antidepressant prescribing in England has been increasing since 1998. Our analysis of PCT-level data from 2008 to 2012 suggests that the rise is not based on a corresponding increase in depression or a change in the way antidepressants are administered but instead reflects genuine changes in prescribing practice. This suggests that other factors are behind this trend.

Our original notion that the recent economic climate may be driving patterns of mental health and therefore prescribing of antidepressants was partially borne out. Our analysis showed that some socioeconomic factors, such as housing, were important predictors and that an increase in unemployment was associated with an additional increase in prescribing levels. Therefore, we can estimate what impact changes in indicators of social wellbeing and disadvantage, such as unemployment rates, will have on greater prescribing (and, by implication, need) for mental health care in general practice.

We used the level of antibiotic prescribing as a proxy for the propensity of GPs to prescribe and found that this variable was significantly associated with higher use of antidepressants. The implication was that GP practices that prescribed more antibiotics per population, also prescribed more antidepressants per registered person – even when standardising for the range of other factors in the model that describe need. Moreover, we observed that within a PCT, practices exhibited some commonality in terms of prescribing behaviour – even accounting for other factors. We assume that these patterns were a product of the different ways that PCTs sought to influence prescribing in their area.

Finally, we had hoped to see an inverse relationship between primary care prescribing of antidepressants and uptake of IAPT. In fact, we found no significant relationship but this may change as more data are collected on IAPT over a longer period.

We used the models to determine whether GP practices and PCTs were prescribing antidepressants at a rate over or under that predicted given their geographic and patient characteristics – although clinical commissioning groups have now replaced PCTs, these methods would still apply.

These analyses suggest that there is a complex interaction of factors driving the ever-increasing prescribing of antidepressants – acting at individual level, practice level and across broader society. For GP practices and commissioners, the models we have developed may help them to better understand practice within their own area and prompt further analysis of local drivers. Most importantly, these models can help to provide a focus on the most likely areas where need and supply are not being matched, to improve patient care and reduce waste.

1 Introduction

Social disadvantage and inequality are both linked with poorer health – as the socioeconomic characteristics of a neighbourhood lower so does the overall health of its inhabitants. More specifically, the relationship between socioeconomic disadvantage and higher psychiatric morbidity is well documented (Ford and others, 2010; Madianos and others, 2011; Paul and Moser, 2009). Those from a lower socioeconomic status face more disabilities and a poorer prognosis, even when considering problem severity (Lorant and others, 2003). At an individual level, a number of studies have shown that there is a strong link between depression and unemployment (Payne and others, 1993) and that this relationship is bi-directional whereby those who are unemployed are more likely to suffer from depression, while depression can create a greater risk of becoming unemployed (Jefferis and others, 2011). The recent recession has had widespread economic implications for the population of the United Kingdom (UK). Unemployment rates have risen: from roughly 5.5 per cent in 2007 to 7.7 per cent in 2012 (ONS, 2014). Additionally, inflation has increased more than wages, leading to a rising cost of living. Such changes could have an impact on the prevalence of mental health problems and require changes in the services delivered.

A general population study (N = 950) by Huber (2010) found that 53 per cent of adults had experienced depressive symptoms – four to five times higher than levels recorded among the general population before the recession. Of those who had lost their jobs in the previous 12 months, 71 per cent had experienced depressive symptoms. There was a 50 per cent increase in the number of calls made to Mind's Infoline in 2012/13 compared with 2011/12, and people were getting in touch with more acute and complex problems, many stemming from financial worries. The recession had led to high levels of anxiety among men; 45 per cent were worried about their finances and 27 per cent were worried about job security (Mind, 2009). Additionally, researchers found evidence of an association between increased suicide rates in men and levels of unemployment following the 2008 financial crisis (Chang and others, 2013). Even before the recession, a quarter of GP consultations were related to mental health problems (Department of Health, 2000) and depression was the third most common reason for GP consultations in the UK (Gilbody and others, 2002; Plummer and Gray, 2000).

10%

increase a year in the number of antidepressants prescribed

We would expect this increase in reported need to be met with a corresponding increase in service provision. Indeed, there have been a number of recent reports concerning the increase in prescribing of antidepressants; however, it seems that this has been a longstanding trend. Using the number of antidepressants prescribed in 1998 as a baseline, Ilyas and Moncrieff (2012) found that the number of antidepressants prescribed in England between 1998 and 2010 rose by an average of approximately 10 per cent a year. More recent studies suggest that the rate of increase in the number of antidepressants prescribed is actually slowing down; the Health and Social Care Information Centre found an increase of roughly 9.0 per cent between 2010 and 2011 and 7.5 per cent between 2011 and 2012 (Health and Social Care Information Centre, 2012).

Nevertheless, there continues to be an upward trend in prescribing, which is similar to the pattern of prescribing found in other countries such as Iceland, Canada and the United States (Helgason and others, 2004; Hemels and others, 2002; Olfson and others, 2002). This is despite evidence that suggests that rates of depression are not changing substantially (Munoz-Arroyo and others, 2006). Although some of this trend is due to a rise in the number of patients receiving long-term treatment and an increase in treatment length (Moore and others, 2009), the factors behind the rise remain poorly understood.

Furthermore, antidepressant prescribing has continued to grow despite investment in alternative treatments. Most recently, the government created the Improving Access to Psychological Therapies (IAPT) programme to offer a first-line treatment for people suffering from depression and anxiety. The service has been running since 2006, and has been open to adults of all ages since 2010. However, a recent time-series analysis using PCT-level data found that IAPT had no significant effect on antidepressant prescribing (Sreeharan and others, 2013).

Thus, there remains the question as to whether primary care is responding appropriately to mental health problems. Previous studies have demonstrated that depression is often under-recognised and under-treated in primary care (Ballenger and others, 2001). A study of 15 international sites for the World Health Organization (WHO) by Sartorius and others (1996) indicated that in primary care, clinicians were only correctly identifying half of the cases of depression. This could lead to under-prescribing and cases of depression escalating in severity as they go untreated. Conversely, the *Los Angeles Times* (Ulene, 2009) reported that in 2002, more than 70 per cent of the 700 adults surveyed who had received a prescription for antidepressants had no medical need for antidepressant treatment. Over-prescribing such as this exposes depressed patients to an increased risk of suffering side effects, such as increased suicidal behaviour (Gotzsche, 2014) and dependency, and represents a waste of resources.

The question of how primary care is able to respond to common mental health problems could be considered more pertinent than ever given the current economic climate and the corresponding increase in need. A first step towards ensuring that primary care is prescribing appropriately is to explore how patterns of antidepressant prescribing are changing over time and what factors are driving the change. Additionally, it is important to explore the factors that are associated with prescribing, as understanding these influences can help commissioners of health services to improve and plan service provision accordingly. Furthermore, it can help to evaluate the appropriateness of current services.

The present study used data collected across England at PCT and GP levels. The aims of the study were to look at what indicators influence antidepressant prescribing and more specifically to consider the following:

- How has prescribing of antidepressants changed over time and to what extent is it linked with the recession?
- Are there geographic differences in the level of prescribing and changes over time?
- What factors are associated with high levels of prescribing at GP practice level?

We decided to create a model including the variables that could influence the level of prescribing observed in any one practice; these could operate at different levels. They include:

- the characteristics of patients on the GP practice's list, for example the prevalence of depression, age and gender
- the characteristics of the GP practice itself, for example the number of doctors and their propensity to prescribe
- the area-level characteristics, for example local levels of deprivation and unemployment.

This model used variables at all three of these levels.

We used the model to:

- help us identify any practices where the level of prescribing differed from what would be expected
- determine which PCTs had rates of prescribing that differed from what would be expected
- investigate how trends in prescribing differed at PCT level across 2010/11.

Although throughout the report we refer to prescribing, our data are based on the number of antidepressants dispensed as recorded in Prescription Cost Analysis data. While there may be some discrepancies between the number of antidepressants prescribed and the number dispensed, we assume that dispensing rates are indicative of prescribing rates and patterns in one will reflect the other.

2 Methods

Initially we looked at trends in antidepressant prescribing in England from 1998 to 2012. We identified antidepressant drugs using section 4.3 (Antidepressant drugs) of Chapter 4 (Central nervous system) of the *British national formulary* (Royal Pharmaceutical Society, 2014). However, following advice from experts, we excluded amitriptyline from all our analyses as this is now more commonly used to treat pain rather than depression. The analysis included studies of trends at national level, differences at PCT level and separate multivariate analysis at practice and PCT levels.

National rates of antidepressant prescribing were identified using Prescription Cost Analysis data for England from the national archives (1998 to 2003). Data from 2004 onwards were obtained from the Health and Social Care Information Centre (HSCIC). National prescribing rates were calculated using the total number of items prescribed (that is, the number of items prescribed on a prescription form) across England each year.

Data at individual practice level were obtained from HSCIC; the GP practice prescribing presentation-level datasets were used to attain the total quantity and number of items prescribed for antidepressants and antibiotics on a monthly basis and covered the period from August 2010 to March 2013.

GP practices with an unknown list size, or a list size of less than 1,000 (n = 365), were excluded from the analysis, leaving 7,935 practices included in the analyses. There were more practices with available data in 2012; nevertheless, all three years showed similar numbers of males, females and those aged 65 and over per practice.

We used two models to identify the variables most strongly associated with levels of prescribing at GP practice level:

- A cross-sectional model sought to explain differences between practices at one point in time. This was used to assess the effect of a range of predictor variables, including IAPT and a range of GP variables only available for 2012, on the total number of antidepressants prescribed per registered patient at GP practice level in 2012/13.
- A longitudinal model was used to try to explain differences in the changes in prescribing. This was a mixed-effects repeated-measures[1] regression model to assess the strength of a range of predictor variables on the total number of antidepressants prescribed monthly per registered patient at GP practice level from 2010/11 to 2011/12.[2]

1. Technical details of the longitudinal model are described in Appendix 2.

2. From April 2012, the depression prevalence calculation used in the Quality and Outcomes Framework (QOF) changed to only include patients with a diagnosis of depression from 1 April 2006 onwards, therefore removing those with longer-term depression. As this influences the meaning of the depression prevalence estimates, a model using data from all three years could not be run.

Dependent variable: our dependent variable for both models was tablets per registered person at GP practice level. We calculated this by dividing the total quantity of tablets dispensed each month by each GP practice by the number of people registered at each GP practice.

Note: When we refer to 'tablets' in this report, we are referring to the number of dose units dispensed, which may be tablets or capsules and so on. We use 'tablets' here for simplicity.

We used a range of predictor variables drawn from information about the practice list population, about the local area and about the practice itself; these are summarised in Table 2.1 and described in detail following this.

Table 2.1: Data used to model factors influencing antidepressant prescribing

Variable	Description	2010/11	2011/12	2012/13
List size	Number of registered patients from Public Health England	X	X	X
Depression	Per cent prevalence from QOF	X	X	X
Age	Per cent aged 65 and over from Public Health England	X	X	X
Gender	Per cent female from Public Health England	X	X	X
Satisfaction	Per cent who would recommend GP from patient satisfaction questionnaire	X	X	X
Antibiotics	Number of antibiotics prescribed from HSCIC	X	X	X
Unemployment	Per cent unemployed from Nomis	X	X	X
Number of GPs	Number of GPs per practice from HSCIC	X	X	X
IAPT	Per cent of people entering IAPT as a proportion of people with depression or anxiety from HSCIC		X	X
Index of Multiple Deprivation (IMD) domains	Score on each IMD domain from GOV.UK	X		
Ethnicity	Per cent classed as white from 2011 Census		X	
GP gender	Per cent of GPs at practice who are female from HSCIC NHS staff workforce census data			X
GP country of qualification	Per cent of GPs at practice who qualified in the UK from HSCIC NHS staff workforce census data			X
GP age	Per cent of GPs at practice who are aged 55 or over from HSCIC NHS staff workforce census data			X

Basic information about patient-level needs at practice level

The prevalence of depression at each GP practice as described in QOF for the years 2010/11 to 2012/13 was included to indicate clinical need for antidepressants. Age and sex distributions were also obtained as these are both known to predict patterns of service use (Bebbington and others, 2000; Vegda and others, 2009), which may relate to levels of prescribing. These data were obtained at GP level from Public Health England's practice profiles for the years 2010/11 to 2012/13. Additionally, to adjust for practice size, the number of registered patients was calculated using the number of males and females at each practice. We added ethnicity to the model because being from a minority ethnic group is also associated with greater use of primary health care services (Nazroo and others, 2009). These figures were from the 2011 Census at Lower Super Output Area (LSOA)[1] level and translated into GP-level distributions. The ethnicity distribution was not assumed to change over time and was therefore used for 2010/11 and 2012/13 as well.

Indicators of socioeconomic position

We measured area-level deprivation and social inequality using the Index of Multiple Deprivation (IMD) and unemployment rates. The IMD consists of estimates from seven domains: income, health, education, housing, crime, living environment and employment. These domains, excluding employment, were included in the model. The IMD domain figures were obtained at LSOA level from GOV.UK for 2010 and translated into corresponding rates at GP level. The unemployment figures were taken from the official labour market statistics provided by Nomis from 2010/11 until 2012/13. These were given at local authority area level and were translated into the corresponding rates at GP level. For both models, we assumed that the IMD domain scores did not change over this time, thus the data from 2010/11 and 2011/12, respectively, were carried over.

Characteristics of the practices

Evidence suggests that solo practices prescribe fewer antidepressants (Morrison and others, 2009). Therefore, the number of GPs per practice was taken from HSCIC for 2010 and 2011 and NHS staff workforce census data for 2012. To look at the number of GPs per 10,000 people, the number of GPs was divided by the practice size and then multiplied by 10,000.

Patient satisfaction was included to explore whether higher levels of prescribing were associated with greater levels of satisfaction, possibly indicating that patients want medication. Patient satisfaction was measured by the question 'Would you recommend your GP surgery to someone who has moved to the area' in the patient satisfaction questionnaire. We used the percentage of people answering 'yes' to each question as an index of satisfaction. Any practice with less than 50 people answering the GP satisfaction questionnaire had their responses to the satisfaction questionnaire excluded.

We also used the rates of antibiotic prescribing as a measure of each practice's overall propensity to prescribe. Antibiotics were chosen as these can be a reflection of discretionary prescribing behaviour (Harris, 2013; Nathwani and Davey, 1999). These data were available from HSCIC from August 2010 until March 2013.

1. A small area defined in the Census with a population of about 1,500.

GP characteristics such as sex, country of birth and age have all been shown to influence prescribing behaviour (Morrison and others, 2009). Therefore, GP attributes were taken from the NHS staff workforce census for 2012 provided by HSCIC; this included the number of female GPs at the practice, the number of GPs who qualified in the UK and the number of GPs aged 55 or over. As these data were only available for 2012, they were entered along with the other predictors into a cross-sectional model for the year 2012/13.

Information about local provision

We also tested whether the level of non-GP mental health provision was a factor. Data from IAPT were available at PCT level for 2012/13. Therefore, the percentage of people entering IAPT services as a proportion of people with anxiety or depression was included in the cross-sectional model.

3 Results

The summary statistics for the practices included in the analysis are shown in Table 3.1.

Table 3.1: Number of GP practices and registered patients a year by gender and patients aged 65 and over

	GP practices	Total registered	% female per practice	% aged 65 and over per practice
2010/11	7,730	53,656,662	49.76	15.54
2011/12	7,907	54,210,973	49.79	15.36
2012/13	7,934	54,582,249	49.84	15.53

Recorded rates of depression in QOF for adults aged 18 and over were 11.2 per cent in 2010/11 and 11.7 per cent in 2011/12. In 2012/13, the methodology for recording depression in QOF was changed and became more conservative (British Medical Association and NHS Employers, 2012). Because of this, the depression prevalence for 2012/13 was estimated to be much lower, at 5.8 per cent. This change is consistent across all practices, so has little impact on the results of the model. Figures taken from Public Health England's National General Practice Profiles showed that the average IMD in 2010 was 24.10, 23.89 in 2011 and 22.59 in 2012.

Information on other services shows that in 2011/12, 533,733 people entered treatment using the IAPT mental health service. In 2012/13, this increased by 12 per cent to 599,873, accounting for 8.73 per cent and 9.81 per cent of all those in England suffering from anxiety or depression in each year, respectively.

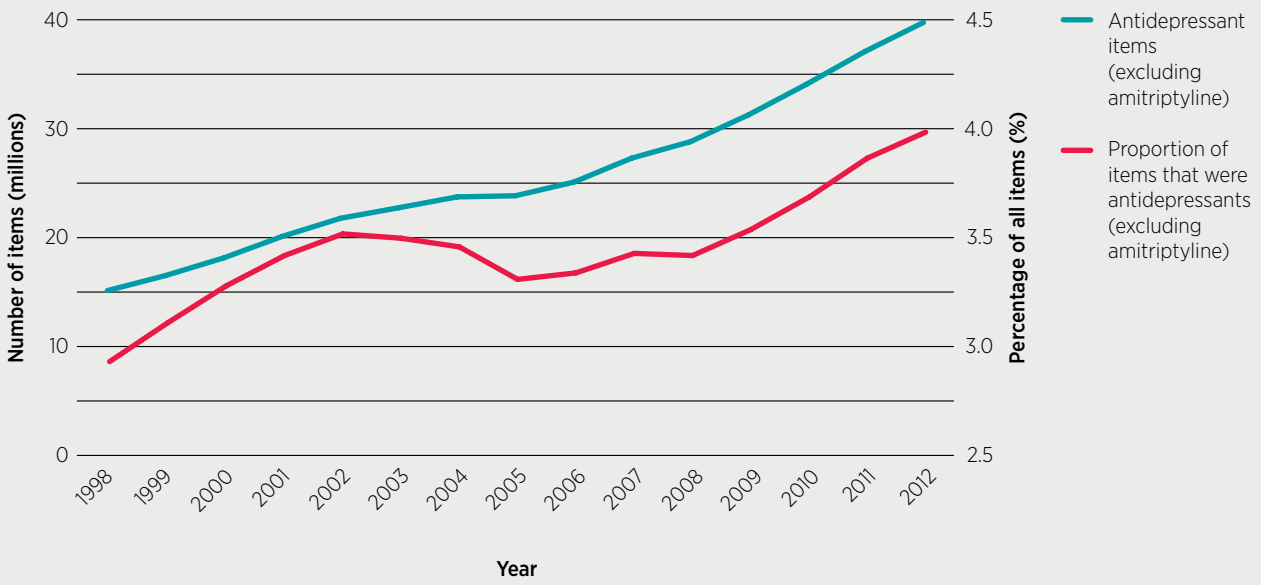
How are levels of prescribing in England changing?

The national-level data show the general pattern for prescribing in England from 1998 to 2012 (Figure 3.1). Overall, the number of antidepressants prescribed in England rose by 165 per cent from 14,999,000 in 1998 to 39,722,700 in 2012, an average increase in items prescribed of 7.2 per cent a year.[1] Between 1998 and 2008, antidepressant prescriptions rose by roughly 6.7 per cent a year; however, this increased to 8.5 per cent a year between 2008 and 2012. Therefore, the rate of increase in prescribing of antidepressants was higher in the years from the start of the 2008 recession than in the years beforehand.

Using the change point method formulated by Spiegelhalter (1996), we were able to confirm that the most significant change in the rate of prescribing occurred in the period around 2008 ($p < 0.001$). This has meant that our subset of antidepressants prescribed rose from 2.9 per cent of all prescriptions in 1998 to 4.0 per cent in 2012. Over this time, the average number of antidepressants prescribed per 1,000 people in England rose from 307 items a year in 1998, to 743

1. Although we used the same data as Ilyas and Moncreiff (2012), our annual increase was lower than their reported value of 10 per cent. This is because theirs compares the average annual increase to the 1998 baseline, and ours accounts for the compound inflation in the rate of prescribing. Therefore our value is closer to what would have been observed year on year.

Figure 3.1: Trend in prescribing of antidepressants in England, expressed as a total count, and as a proportion of all items prescribed, 1998 to 2012

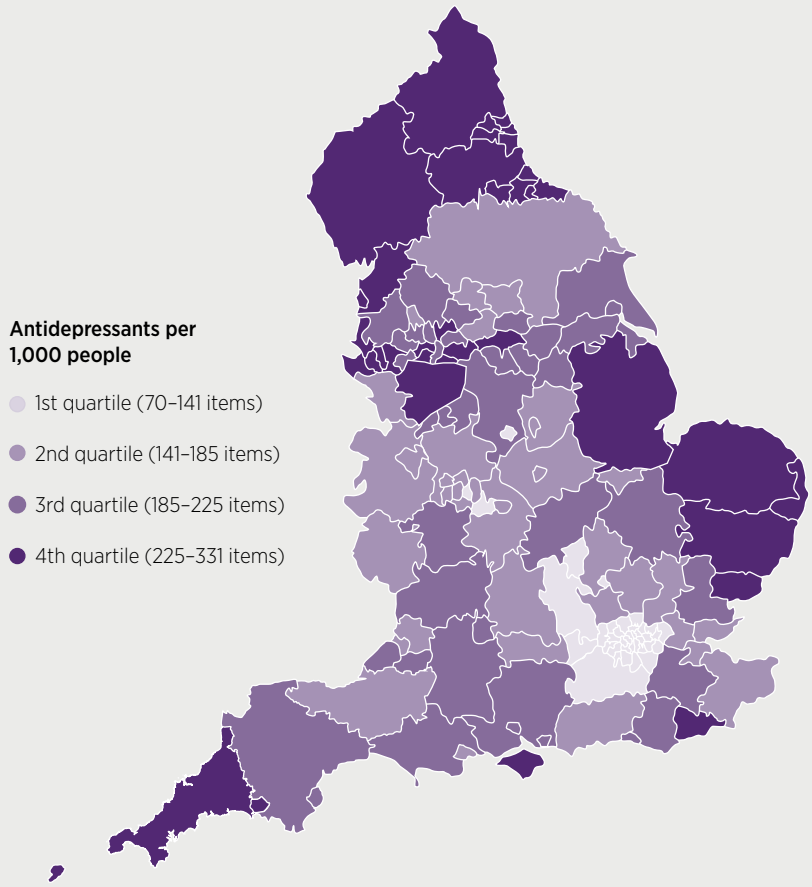


items a year in 2012. Thus, on top of a background increase there seems to have been a slight acceleration in prescribing. This could be a reflection that primary care is responding to an increase in mental health problems.

The rate of antidepressant prescriptions per person varied widely across different PCTs. In quarter 3 of 2012/13, 15 PCTs prescribed between 50 and 100 items per 1,000 people, whereas 20 PCTs prescribed over 250 items per 1,000 people. One PCT (NHS Blackpool) prescribed 331 items per 1,000 people. A cross-sectional analysis, mapping PCT rates of prescribing, was better able to illustrate current regional variations in antidepressant prescribing. Figure 3.2 shows that PCTs with the lowest rate per person in 2012/13 were almost all located in and around London[1] while the PCTs in the upper quartile were largely in the north (27 of the 36 PCTs).

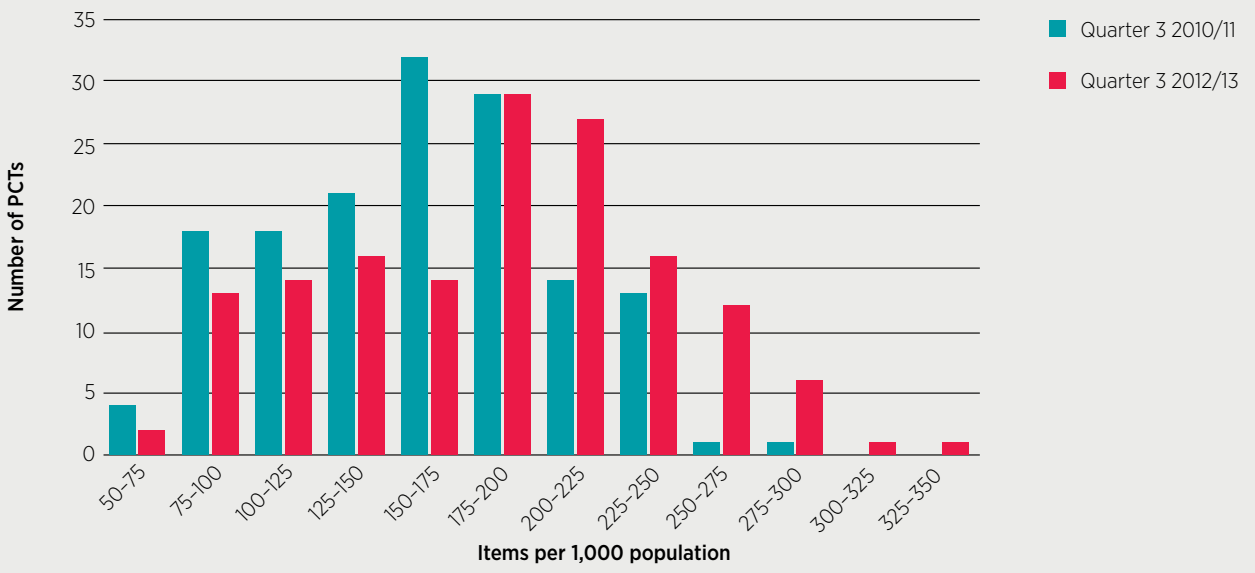
1. Only eight of the 38 PCTs were located outside of the M25, while all of the PCTs within the M25 were in the lowest quartile.

Figure 3.2: Amount of antidepressant drugs prescribed by PCTs in England in quarter 3 of 2012/13 (not age-adjusted)



The change in levels of prescribing at PCT level showed that the distribution shifted from between 50 and 300 items per 1,000 people in quarter 3 of 2010/11, to between 50 and 350 items in quarter 3 of 2012/13 (Figure 3.3). All except one of the PCTs saw an increase in the number of items per person. The only decrease was NHS Lewisham, which fell by 6 per cent (from 93 items to 87 items per 1,000 people). The largest relative increase was for NHS Tower Hamlets, which rose by 30 per cent (from 94 items to 122 items per 1,000 people).

Figure 3.3: Distribution of antidepressant drugs prescribed per person by PCTs in England, 2010/11 and 2012/13



These trends are based on the total number of items prescribed, rather than the quantity of medication prescribed. It is possible that an increased number of items is linked to a decrease in the quantity per item; for example, one prescription for a three-month supply being replaced by three prescriptions, each for a one month's supply. However, the analysis in Appendix 1 shows that this was not the cause of the increase.

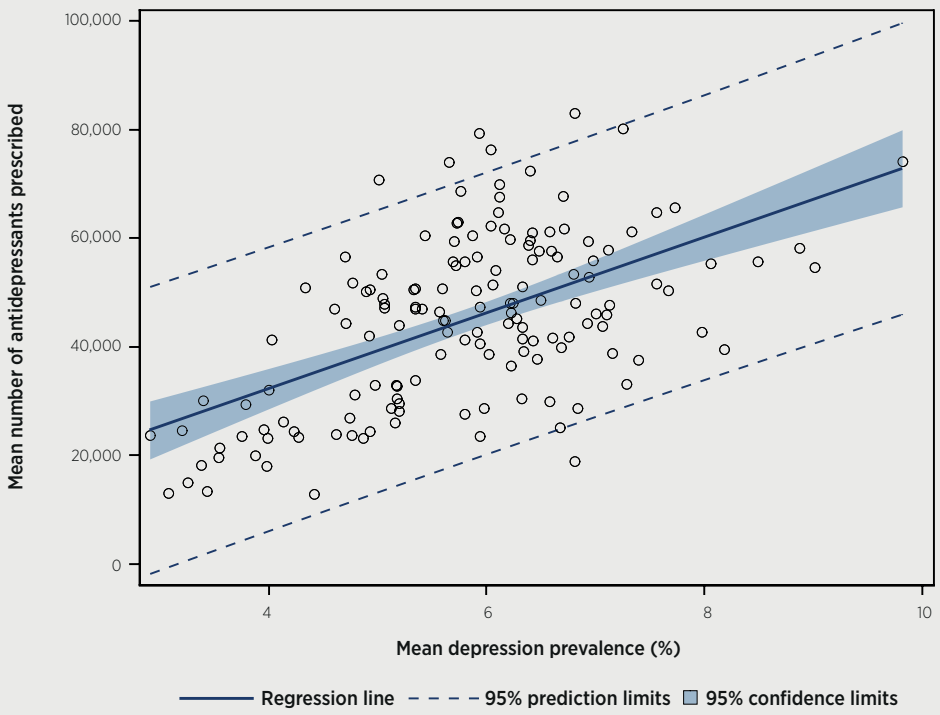
What factors are associated with high levels of prescribing?

Our first hypothesis was that the rise in antidepressant prescribing might be related to a rise in depression. We noted that QOF reports that the prevalence of depression recorded by GPs increased from 10.9 per cent in 2009/10 to 11.7 per cent in 2011/12 – a rise of 3.6 per cent a year. However, antidepressant prescribing has increased by 8.7 per cent a year since the end of 2008/09.[1]

Nevertheless, this is not to say that the prevalence of depression does not relate to antidepressant prescribing. By plotting the mean level of antidepressants prescribed at PCT level against depression prevalence for quarter 1 of 2012/13, we found that as the prevalence of depression at PCT level increases, so do PCT antidepressant prescribing rates (Figure 3.4), with depression prevalence explaining 31 per cent of the variance in PCT levels of antidepressant prescribing. There were nine PCTs whose mean quantity of prescribed antidepressants was less than 20,000 (from 12,738 to 19,935); these PCTs all had a mean depression prevalence of under 7 per cent (from 3.1 per cent to 6.8 per cent), and all but one were in London. Therefore, levels of depression go some way towards explaining the regional differences illustrated in Figure 3.4. However, the points are scattered around the regression line, implying there are a number of factors other than the local level of depression that influence the level of antidepressant prescribing.

1. This figure differs slightly from that quoted previously in the report as these data are in financial years rather than calendar years.

Figure 3.4: Mean quantity of antidepressants prescribed plotted against mean depression prevalence (%) at PCT level



Which variables explain prescribing levels at one point in time? Cross-sectional analysis (2012/13)

The cross-sectional regression model sought to look at predictors of the number of antidepressants prescribed per registered person at practice level. The explanatory variables tested included:

- prevalence of depression
- age
- gender
- ethnicity
- number of GPs per 10,000 patients
- the IMD domains, excluding the employment domain
- rates of unemployment
- patient satisfaction
- rates of antibiotics prescribed per registered person.

Additionally, this model included IAPT data and GP-level predictors that were only available for 2012/13.[1] To factor in geographical differences, the model clustered GP practices within PCTs.

1. Specifically: the percentage of people entering IAPT services as a proportion of people with anxiety or depression; the percentage of GPs who were female per practice; the percentage of GPs who were aged 55 years or over per practice; and the percentage of GPs who had qualified in the UK per practice.

Overall, the model explained approximately 71 per cent of the variance in antidepressants prescribed per registered person at GP practice level. The parameter estimates in Table 3.2 demonstrate the effect of each predictor on the amount of antidepressants prescribed per registered person. The t-values indicate the strength of the association between the predictor and the amount of antidepressants prescribed per registered person. So, for example, the t-values demonstrated that depression prevalence was one of the variables most strongly related to prescribing and the parameters showed that a 1 per cent change in depression prevalence would result in the greatest change in the number of tablets prescribed per registered person (0.353 tablets per registered person).

Table 3.2: Regression parameters for factors that predict GP-level antidepressant prescribing, 2012/13

Predictor	Parameter estimate	Standard error	*t* value	*p* value
Depression prevalence since 2006 (%)	0.353	0.023	15.5	<.0001
Aged 65 and over (%)	0.306	0.015	19.94	<.0001
Female (%)	0.261	0.037	7.02	<.0001
Ethnicity: white (%)	0.164	0.007	22.68	<.0001
GPs per 10,000 patients	0.216	0.025	8.53	<.0001
Income domain (1–100)[1]	0.016	0.013	1.22	0.2213
Health domain (1–100)	0.200	0.012	17.25	<.0001
Education domain (1–100)	0.015	0.010	1.55	0.1223
Housing domain (1–100)	-0.042	0.006	-6.61	<.0001
Crime domain (1–100)	-0.001	0.008	-0.08	0.9353
Living environment domain (1–100)	-0.013	0.007	-1.95	0.0514
Unemployment rate (%)	-0.109	0.060	-1.81	0.0696
Patient satisfaction (%)	0.023	0.006	3.77	0.0002
Antibiotics (items per registered person)	0.261	0.010	26.9	<.0001
IAPT	0.127	0.206	0.62	0.5366
GP gender (% female)	0.005	0.003	1.83	0.0667
Qualified in the UK (%)	0.022	0.002	9.41	<.0001
GP aged 55 or over (%)	-0.015	0.003	-6.13	<.0001

Impact of practice list characteristics

Patient demographics were among the most significant factors associated with GP prescribing. GP practices with a greater proportion of patients who were aged 65 and over, female and white prescribed more antidepressants. Indeed, as the percentage of patients aged 65 and over at the practice increased, the number of tablets prescribed per registered person increased by 0.306.

Impact of practice characteristics

The number of antibiotics prescribed per registered person was the most strongly practice characteristic-related predictor of antidepressant prescribing. As the number of antibiotics prescribed per registered person increased, the number of

1. As the Index of Multiple Deprivation (IMD) values increase, the deprivation associated with that domain decreases.

antidepressants prescribed per registered person increased by 0.261 tablets per registered person. This suggests that some GP practices have a higher propensity to prescribe than others.

The other GP practice characteristics were also positively associated with prescribing. As patient satisfaction and number of GPs per 10,000 patients increased, so too did the amount of antidepressant tablets prescribed per registered person. Two of the GP characteristics were significant predictors of antidepressant prescribing. As the percentage of GPs at the practice qualifying in the UK increased, the number of antidepressants prescribed per registered person increased by 0.022. In addition, as the percentage of GPs aged 55 or over at the practice increased, the number of tablets prescribed per registered person decreased by 0.015.

Area-level socioeconomic variables

The IMD domains indicated that when controlling for the other variables, areas with higher levels of health had greater rates of antidepressant prescribing per registered person, whereas areas with better housing had lower levels of antidepressant prescribing per registered person. Indices of income, education, crime and living environment were not significantly associated with antidepressant prescribing. Unexpectedly, the rate of unemployment was also not significantly associated with antidepressant prescribing rate.

Other forms of local mental health care

IAPT was not significantly related to prescribing patterns. However, this may be due to the lack of variation in the level of uptake at PCT level (interquartile range from 1.55 per cent to 2.97 per cent). As more granular GP-level data become available over a longer period, this relationship may become significant.

Which variables best explain the change in prescribing levels over time? Longitudinal analysis (2010/11 to 2011/12)

The longitudinal regression model sought to look at the variables that relate to the trend in prescribing over time as measured in terms of the number of tablets per registered person a month at practice level. Similar to before, the explanatory variables tested included:

- prevalence of depression
- age
- gender
- ethnicity
- number of GPs per 10,000 patients
- the IMD domains, excluding the employment domain
- rates of unemployment
- patient satisfaction
- rates of antibiotic prescribing per registered person
- time.

To factor in geographical differences, the model clustered GP practices within PCTs.

Overall, the model explained approximately 60 per cent of the variance in the change in antidepressants prescribed per registered person a month at GP practice level. The parameter estimates and t-values for each predictor are presented in Table A2.2 in Appendix 2. The model demonstrated that the number of antibiotics prescribed was the most important predictor of antidepressant prescribing over time.

Impact of practice list characteristics

The model showed that when all the other variables were accounted for, every month there was an increase in prescribing of 0.010 tablets per registered person (0.12 tablets per registered person a year). This may be reflecting the cumulative effect of more patients receiving longer-term treatment (Moore and others, 2009). As expected, as depression prevalence increased, so did prescribing; for every one percentage point rise in the prevalence of depression, prescribing increased by 0.019 tablets per registered person a month.

As in the cross-sectional model, increased prescribing of antidepressants was associated with patient characteristics. Prescribing was higher in practices with more patients aged 65 and over, female or in the white ethnic group. As the proportion of patients who were aged 65 and over increased, the number of antidepressants prescribed increased by 0.025 tablets per registered person a month.

Impact of practice characteristics

Similar to the cross-sectional model, the number of antibiotics prescribed per registered person a month was the most strongly related predictor of antidepressant prescribing over time. As the number of antibiotics prescribed per registered person a month increased, so did the expected number of antidepressants prescribed per registered person a month.

The other practice characteristics did not tend to be as important as the practice list characteristics. Changes in the number of GPs per 10,000 patients were associated with a change of 0.014 antidepressant tablets per registered person a month. Although patient satisfaction was significant, it was not strongly associated with antidepressant prescribing and changes in patient satisfaction did not appear to have much of an impact on the number of tablets prescribed per registered person a month.

Area-level socioeconomic variables

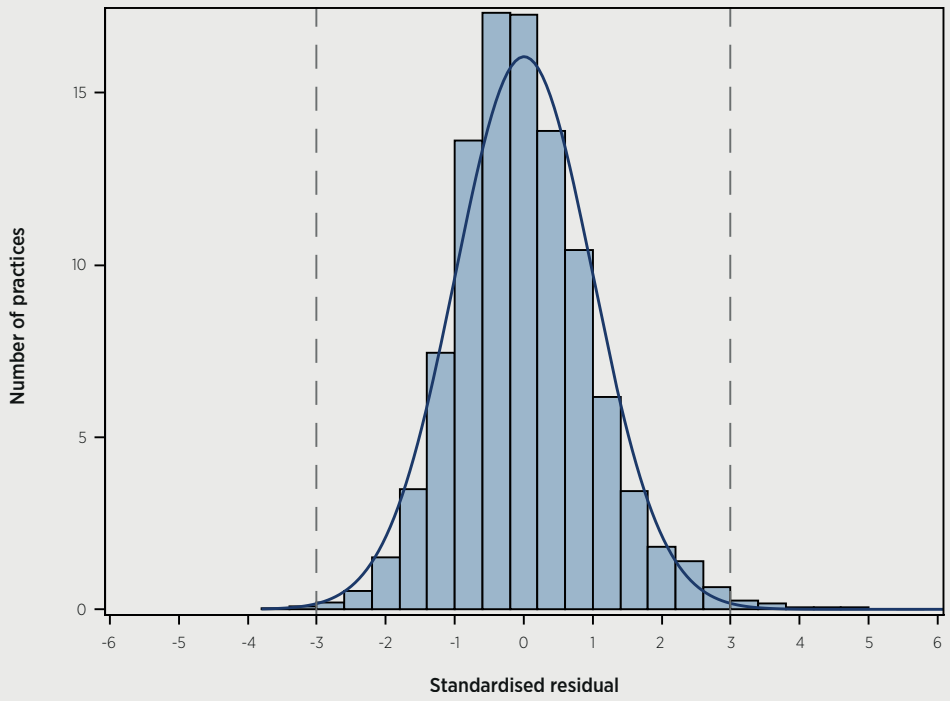
In this model, the rate of unemployment was positively associated with antidepressant prescribing rates and a 1 per cent change in unemployment resulted in a change in prescribing of 0.013 tablets per registered person a month. The majority of the relationships between the IMD domains and antidepressant prescribing did not change in the longitudinal model. However, the relationship between prescribing and living environment was now significant. This suggests that GP practices in areas with better living environments prescribed less.

Applying the model to understand GP over- and under-prescribing

We explored whether any GP practices were outliers and prescribing a much greater or lower level of antidepressants than might be expected based on local prevalence of depression and other factors in our cross-sectional model. We calculated the difference between the expected and observed rate of prescribing

(the residual) for each GP practice during 2012/13, taking into account all of the model's predictors. Figure 3.5 shows the distribution of the practice residuals. The dotted lines indicate where practices were prescribing either at more or less than three standard deviations away from what would be expected – this would arise by chance in about 1 in 1,000 practices. Given the characteristics in the model, there were 48 practices prescribing at more than three standard deviations away from what was expected, 40 were prescribing more than expected and eight were prescribing less than expected. These extreme practices were not associated with any one particular PCT or area.

Figure 3.5: GP practice antidepressant prescribing standardised residuals



Applying the model to understand PCT-level trends

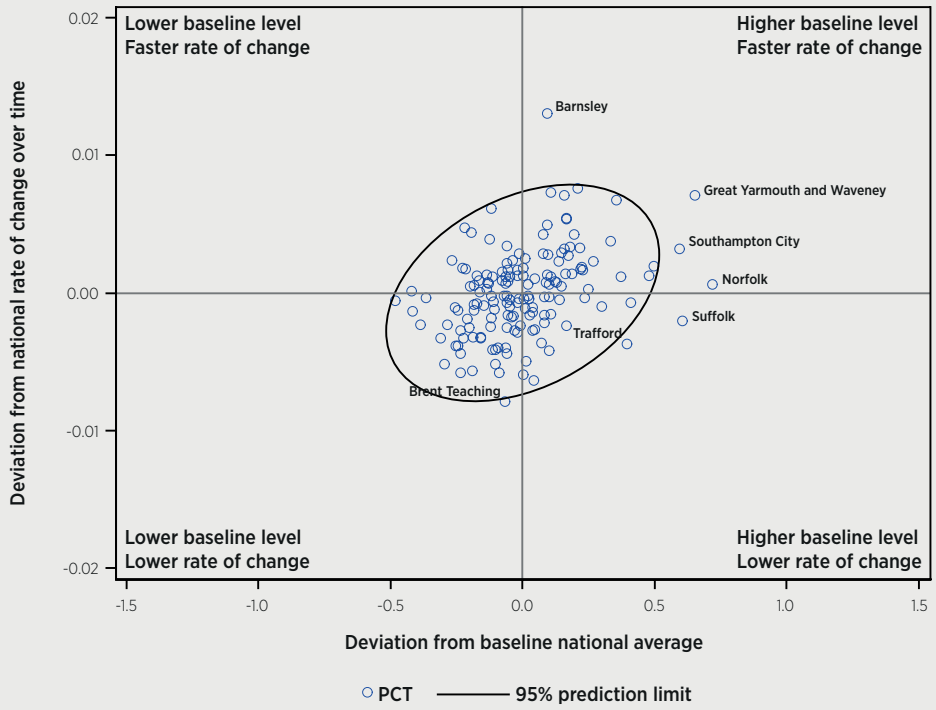
One potential factor influencing levels of prescribing at GP practice level is the effects of the PCT itself – either because of the way the PCT works with its constituent practices to influence prescribing levels or due to some other factor in the local area – not covered by other explanatory variables. We therefore applied our model to look at the variability across PCTs by looking at the difference between observed and expected levels of prescribing in August 2010. Expected values were derived from the longitudinal model described earlier. Additionally, we looked at the relative rate of change in prescribing at PCT level from August 2010 to March 2012 in order to determine whether certain areas were increasing their prescribing faster or slower than expected given the national average increase in prescribing.

Our approach (Appendix 2) resulted in estimates for each PCT of residuals, which are a measure of the amount each PCT differs from the typical national population-level model (in other words, national average level of prescribing and rate of change). The results for individual PCTs are shown in Figure 3.6. As expected, the 95 per cent prediction interval was large, which reflected the amount of unexplained variability at the PCT level. We would expect around eight

PCTs to be outside the limits by chance alone, so the existence of these seven is not surprising. However, it was notable that they were clustered in the quadrants of higher initial levels of prescribing. For example, Great Yarmouth and Waveney PCT had a higher than expected initial level of prescribing in August 2010 and had a faster increase rate of prescribing than expected. This was also true of Barnsley PCT, Southampton City and to a lesser extent Norfolk PCT.

In contrast, after starting the study period at a higher level than expected, Suffolk and Trafford PCTs showed a decreasing trend in prescribing relative to that expected. Only Brent Teaching PCT showed evidence of a slower than expected increase after starting the period below the expected baseline level.

Figure 3.6: Scatter plot of PCT-level residuals from the population-level model, August 2010 to March 2012



Each PCT was then categorised into simple groups with characteristic behaviours relative to national averages and in changes over time. By way of example, if a PCT's prescribing behaviour was in line with the estimated population model then we would expect the residuals for the PCT-level random (latent) intercept and slope to be close to zero. Using this logic we categorised the PCTs as shown in Appendix 2, Table A2.1.

Alternatively, the PCTs can be classified according to the categories shown in Table 3.3. As expected, the majority of PCTs (68 per cent) prescribed at the expected level and followed the national population trend. Of the remaining PCTs, 36 (23.6 per cent) increased prescribing at the same rate as the population trend; 16 (10.5 per cent) of these started at a higher level of prescribing than expected, which meant they had a higher prescribing level than expected at the end of the period. There were 20 PCTs (13.1 per cent) where the starting level was lower than expected, and after following the population trend their prescribing level was lower than expected at the end of the period. Only a minority of PCTs (2.6 per cent) showed a significant difference from the population trend rate of increase.

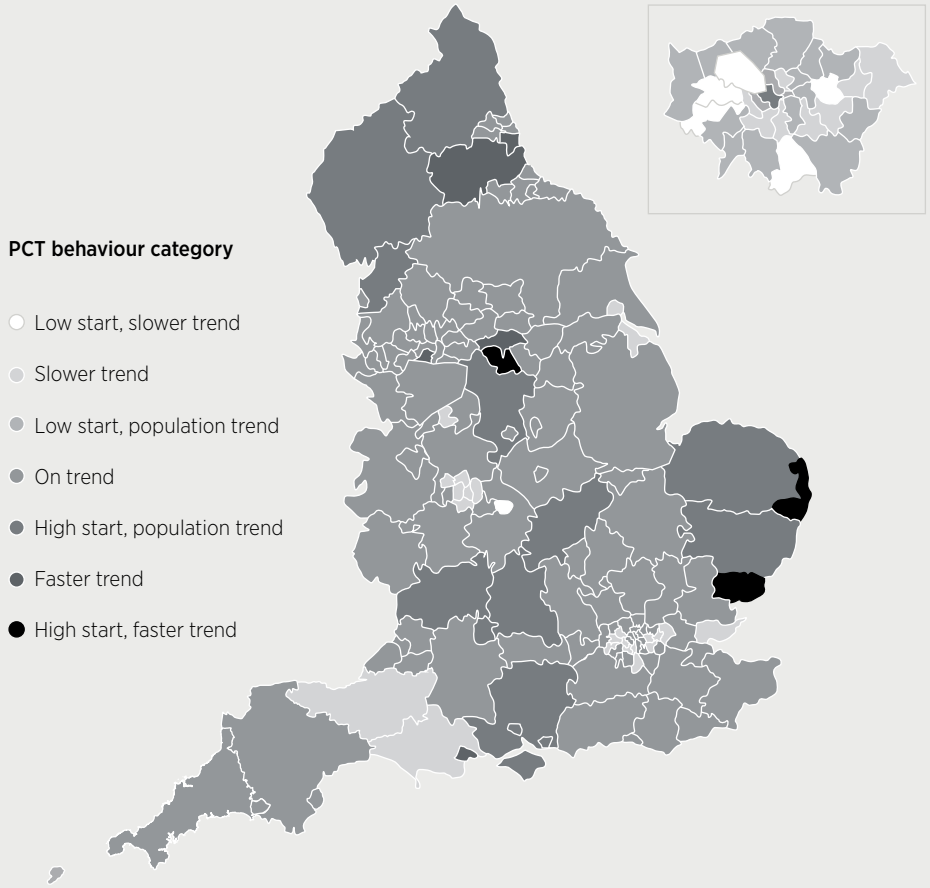
In three cases, the PCTs had higher than expected initial prescribing levels, which grew faster than the population trend over this period.

Table 3.3: Alternative classification of PCT trends

PCT behaviour	Number of PCTs	%
Followed national population trend	104	68.0
Initial level low and increased at same rate as population trend rate	20	13.1
Initial level high and increased at same rate as population trend rate	16	10.5
Initial level at population level and increased at slower rate than population trend	5	3.3
Initial level at population level and increased at faster rate than population trend	4	2.6
Initial level lower than population level and increased at slower rate than population trend	1	0.6
Initial level higher than population level and increased at faster rate than population trend	3	2.0

To see whether obvious geographical patterns emerged, Figure 3.7 shows the PCT results on a map. As can be seen, no clear picture emerges of a concentration of geographic over-prescribing. The London data show a pattern of slower growth of prescribing in some areas, with other areas conforming to the population trend. Some pockets in the North East and East Coast showed increased prescribing over and above what was expected even after allowing for geographic and GP practice-level characteristics. Although the majority of PCTs showed little statistical deviation from what was expected, there was still a relatively large degree of variability among the PCTs. This is interesting as the PCT-level results were averaged over the GP practices contained in each PCT. So even after allowing for the smoothing of trends at the GP practice level, PCTs exhibited differential behaviour.

Figure 3.7: Map of PCT prescribing behaviour category for England, August 2010 to March 2012 (London inset)



4 Discussion

In this analysis, we looked at how antidepressant prescribing trends have changed since 1998 and what factors might be associated with these trends. Our findings agree with other studies and show that antidepressant prescribing has been increasing since 1998. Additionally, we found that since the recession in 2008 the rate of increase has grown slightly. Moreover, our analysis of changes in dosage and packaging suggests that these increases are related to higher consumption and are not explained by an obvious artefact of the way the drugs are prescribed.

The trend analysis revealed that although prescribing is rising, it is not doing so uniformly. The prescribing levels vary widely among PCTs, with lower levels of prescribing in London and higher levels in the North East. To some extent, our analysis was able to explain what factors are behind some of this geographical variation. For example, London has a younger and more ethnically diverse population; however, the North East has high rates of unemployment (ONS, 2011). London also has some areas with relatively high levels of list inflation – that is, when the numbers of people on GP lists exceed the total population as seen in Census or Office for National Statistics estimates. This issue arises where populations are mobile and GPs' administrative lists include patients who have died or moved away. The problem is not unique to London but is typically greatest in a number of inner-city areas. The implications are that our estimates therefore include a denominator that is larger than the true population – over 10 per cent in some cases. However, sensitivity analysis suggested that this did not change the pattern of results observed.

By using multivariate models we can look at expected levels of prescribing – given the characteristics of an area. The models also demonstrated that even when accounting for all of our predictors, there would be an increase in prescribing of 0.010 tablets per registered person a month – an increase that indicates changes in prescribing practices. This increase could be due to increasing numbers of individuals receiving long-term treatment (Moore and others, 2009).

'there may still be a lack of commitment to tackle gender inequality in primary care'

The analysis indicated that patient characteristics were important in influencing levels of prescribing seen at practice level. After controlling for the other variables, including depression prevalence, antidepressant prescribing increased as the proportion of patients who were aged 65 and over, female and white increased. We know that women are more likely to report, consult for and be diagnosed with depression (Bebbington and others, 2000; Men's Health Forum, 2008). Women are also more likely to consult repeatedly for psychiatric problems (ten Have and others, 2001). This potentially increases the likelihood of any mental health problems being recognised and receiving a diagnosis. A report by Mind (2009) found that health services are not always responding to men's needs and suggested that mental health services are 'feminised'. It recommended both male friendly environments and male focused promotion strategies. Therefore, these results demonstrate that there may still be a lack of commitment to tackle gender inequality in primary care.

Older adults often have comorbid conditions and tend to visit their GP more often than younger adults (Benzeval and Judge, 1996; Vegda and others, 2009).

Additionally, they are more likely to exhibit positive help-seeking attitudes and favourable intentions to seek help (MacKenzie and others, 2006; 2008). Therefore, similar to females, this may increase their likelihood of obtaining a diagnosis and thus a prescription.

Our models indicated that as the percentage of white individuals in a practice increases, so does the number of antidepressants prescribed. One explanation for this may be a Western cultural bias in primary care (Ahmed and Bhugra, 2007) whereby doctors are less likely to recognise and identify depression among people from minority ethnic groups (Bhui and others, 2001; Gillam and others, 1980). This can particularly be a problem if the doctor is of a different race from the patient (Borowsky and others, 2000).

Sartorius and others (1996) indicated that there were marked variations in prescribing between practices. Indeed, our analysis shows that the greatest predictor of antidepressant prescribing is antibiotic prescribing; this implies that GP practices with a greater propensity to prescribe are more likely to recommend antidepressant medication. Additionally, the cross-sectional model demonstrated that having a greater proportion of GPs who qualified in the UK was associated with higher prescribing and a greater proportion of GPs aged 55 or over was associated with lower prescribing. These findings are supported by previous research (Morrison and others, 2009).

In considering the wider socioeconomic environment and the potential impacts of the recession, our cross-sectional model found that there was not a significant association between unemployment and antidepressant prescribing at practice level. However, the longitudinal model did show some evidence that higher rates of unemployment and areas with worse living environments were associated with an increase in prescribing, despite controlling for the prevalence of depression. This was only for a 19-month period; longer time series data are needed to fully understand this relationship. In addition, the relationships may have altered due to the change in how depression prevalence is now measured. In 2012, QOF measures of depression prevalence excluded cases of depression that occurred before 2006, therefore excluding long-term cases of depression. Those with long-term depression are more often unemployed than those who have episodic (non-chronic) major depression, potentially explaining why this relationship weakened (Angst and others, 2009).

However, although several IMD domains indicating social disadvantage tended to be associated with higher levels of antidepressant prescribing, the scale of this effect was less than for other variables. Furthermore, the relationship between deprivation and prescribing was mixed. As might be expected, GP practices in areas with better housing and living environments prescribed less antidepressants. However, GP practices in areas with a greater proportion of people who have worse general health also prescribed less. This was an unexpected finding and difficult to explain; it may be that GPs are not recognising depression in populations who present with greater health problems.

Similar to the study by Sreeharan and others (2013), our analysis demonstrated that the proportion of people entering IAPT in the local area was not associated with antidepressant prescribing. However, the data were aggregated at PCT level and the level of variation between the different PCTs was small. Therefore, it is possible that data at a GP level would have shown a significant relationship with prescribing.

When controlling for other variables, only a minority of practices were prescribing outside of the level that would be expected. Taking into consideration the models'

predictors also explained much geographic variation; most GP surgeries were prescribing within three standard deviations of what was expected. Those that were prescribing more or less than expected did not cluster within PCTs but instead were dependent on characteristics local to the practice.

Similarly, despite the substantial variability in prescribing at the PCT level, after controlling for the predictors in the longitudinal model the majority of PCTs prescribed at the expected level. That is, our model variables accounted for most of the variation. Moreover, for those PCT areas that were atypical, there did not appear to be any wider geographic clustering. The exceptions to this were: a suggestion that London PCTs exhibited behaviours that led to lower trends in prescribing over time; and in some urban areas there was evidence that prescribing had been maintained at lower levels and/or was increasing at a lower level than expected. Additionally, some PCTs in the North East and East Coast showed a faster than average increase in prescribing from an already high baseline level of prescribing.

To understand more about the implications of the variability at PCT level (or clinical commissioning group level now) we would require more detailed longitudinal information at both the PCT level and individual GP practice level. In addition, a programme of qualitative research could help to better understand the reasons why a particular PCT's behaviour is deviating from the population model. For example, if a PCT has a significantly higher initial level of antidepressant prescribing and a faster growth trend, does this mean that it is systematically over-prescribing or are there other indicators of unmet need not identified in our current models? Is a PCT with a lower growth rate inappropriately discouraging prescribing or encouraging alternative treatment models?

While our analysis provides an insightful approach to national variations of prescribing, there are some limitations. First, the current study is limited in that it only accounts for the total number of antidepressants prescribed and not the reasons behind the prescription. Some medications have multiple indications and treat complaints other than depression. Indeed, GPs frequently prescribe antidepressants for non-psychiatric health conditions regularly treated in primary care (Mercier and others, 2013). Additionally, the conclusions made at an individual GP level are limited because the data in the model were aggregated over GP practices. Additionally, the longitudinal element is limited in terms of duration (19 months) and the number of attributes available on a time series rather than an annual basis. In this case it was not possible to estimate the effect of variables on the time trend but simply as adjustments to the overall level at each time point, so it was not possible to include variable interactions with time. The models contain few GP practice-level variables and so considerable variation exists unexplained at that level of the data, which could explain some of the prescribing behaviours. Finally, the definitions of key variables are changing from year to year and it is, therefore, not possible to create a truly harmonised set of time series data. Importantly the definition of depression prevalence changed in 2012/13 in a way that meant it could not be included in the longitudinal analysis.

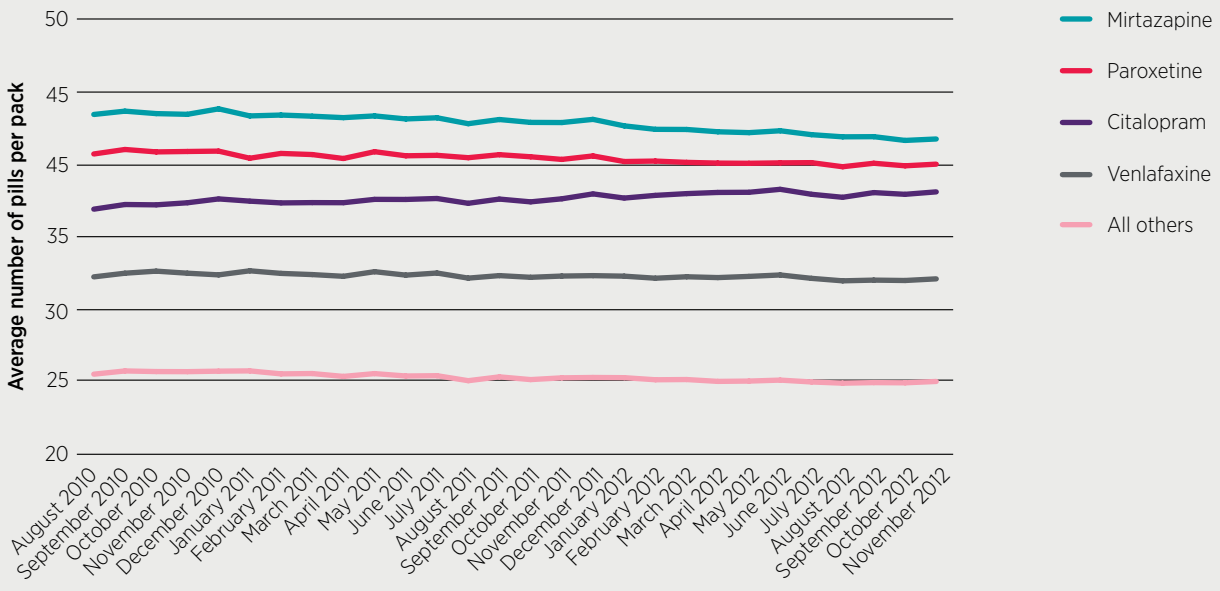
The results show the importance of patient and surgery characteristics as influences on GP prescribing of antidepressants. The likelihood of receiving antidepressants will change depending on the characteristics of the GP practice, such as their propensity to prescribe, and demographic features of the patient such as gender and ethnicity. Thus, our results suggest that primary care may still not be responding appropriately to those presenting with mental health problems. Policies surrounding mental health and prescribing need to ensure equality and encourage GPs to review their prescribing practices.

Our analysis did not show that some factors that might be associated with the recession, such as levels of deprivation, had a large effect on prescribing. However, unemployment rates (when measured across time) do seem to impact on increases in prescribing. These results indicate that some of the increasing need for antidepressants associated with the recession are possibly contributing to the increase in prescribing. Generally, our analysis was able to explain GP practice prescribing behaviour and very few practices were prescribing more or less than would be expected given these characteristics. This means that commissioners can use the model to predict expected levels of prescribing and identify GP practices that appear to be over- or under-prescribing relative to their expected behaviour. Additionally, this analysis presents a way to understand geographic variation at the commissioning level for both initial prescribing levels and trajectories across time.

Appendix 1: Are changes in prescribing due to changes in pack size or dose?

Our observed increases in the number of antidepressants dispensed in the community are based on the total number of items. We cannot determine whether these trends are based on the same people receiving more medication, or whether they reflect an increase in the number of people receiving antidepressants. It may also be that these trends are the result of changes in the dosage of drugs or their packaging. Recently, there has been a move towards using 28-day prescription durations so that smaller rather than larger quantities of medications are prescribed, in other words providing enough for one month rather than three (Brighton and Hove LINk, 2010; York Health Economics Consortium and School of Pharmacy, University of London, 2010). This is intended to ensure that patients are seen more regularly and reduce waste due to unused medication. We therefore looked at whether the average pack size had changed over time by measuring the total quantity (tablets) of each drug prescribed and dividing it by the total number of items (prescriptions) prescribed. This was done separately for the top four most prescribed antidepressants – citalopram, mirtazapine, paroxetine and venlafaxine – and any other antidepressant medication was grouped together into the category 'all others'. The average pack size has remained relatively stable since August 2010, with only very slight decreases over time for: paroxetine, mirtazapine and 'all others'. Thus, it is unlikely that decreasing pack sizes account for the rise in antidepressant prescribing (Figure A1.1).

Figure A1.1: Antidepressant average pack size over time, August 2010 to November 2012



Alternatively, it may be that the increase in prescriptions is the result of prescribing lower doses. If this were true, we would expect to see an increase in the amount of smaller doses prescribed and a decrease in larger doses. The four most frequently prescribed antidepressant drugs account for 55 per cent of all antidepressants prescribed in England (excluding amitriptyline). Therefore, the percentage change was calculated for these top four. With a few exceptions, the quantity and amount of items prescribed increased regardless of dose (Table A1.1). This suggests that the overall rise in antidepressant prescribing is not accounted for by the larger doses being substituted by an increased number of smaller doses.

Table A1.1: Percentage change in quantity and items by dose, 2010 to 2012

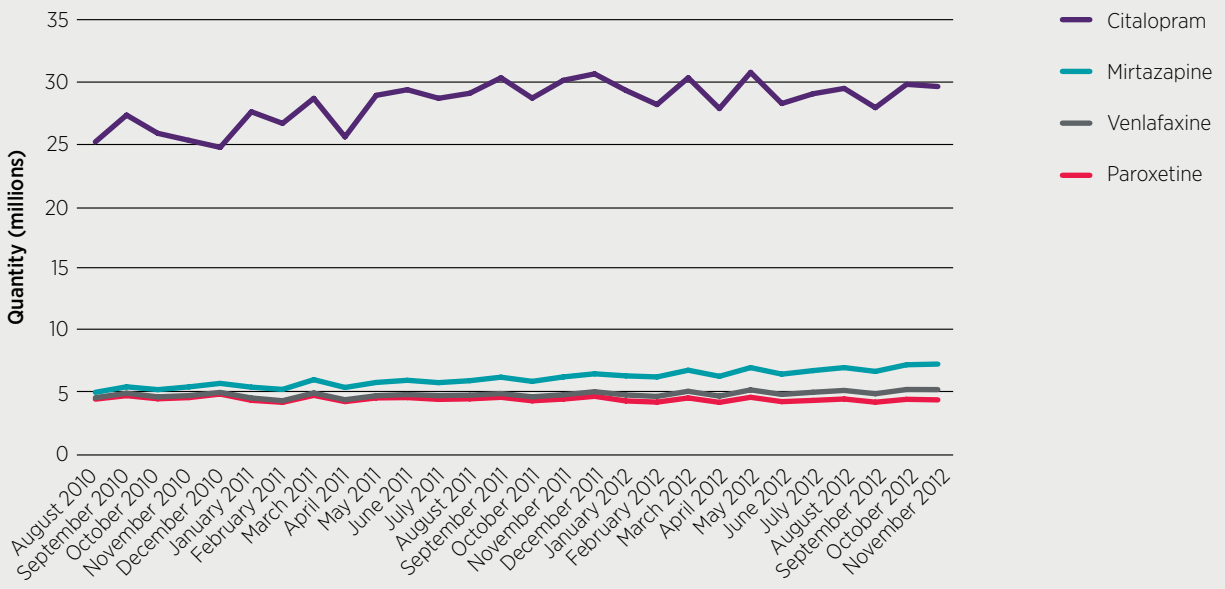
	Dose	Items (%)	Quantity (%)
Venlafaxine	37.5 mg	35.69	35.38
	75 mg	6.34	13.35
	150 mg	-0.87	1.135
	225 mg	238.17	228.01
Citalopram	10 mg	23.57	24.37
	20 mg	19.11	17.78
	40 mg	11.32	11.96
Paroxetine	10 mg	16.85	-3.68
	20 mg	-2.03	-1.24
	30 mg	5.64	5.28
Mirtazapine	15 mg	55.85	53.72
	30 mg	42.59	39.93
	45 mg	62.23	58.47

Indeed, the increase is still visible when the doses are standardised using the defined daily dose.[1] We calculated the daily dose equivalent for the top four most frequently prescribed antidepressants. The quantity of tablets prescribed at each dose was divided into the standard daily dose amount to create an equivalent daily dose amount for each medication (for example, the daily dose of citalopram is 20 mg, therefore dividing the total quantity of citalopram prescribed at 10 mg by two would provide the 'daily dose amount' prescribed).

After standardising, citalopram was shown to be the most prescribed medication, with the number of daily doses prescribed increasing by approximately 4,500,000 (18 per cent) over the period. Mirtazapine showed the greatest percentage increase as the number of daily doses increased by nearly 2,300,000 (46.3 per cent) and venlafaxine demonstrated increases of approximately 650,000 (14.5 per cent). Indeed, only paroxetine showed any decrease in prescribing over time, with reductions of roughly 60,700 (1.4 per cent) (Figure A1.2).

1. A metric used to standardise the comparison of drug usage between different drugs, indicating the average maintenance dose a day for a drug.

Figure A1.2: Daily doses for the top four most prescribed antidepressants over time, August 2010 to November 2012



During the same period, the total quantity of antidepressants prescribed increased by approximately 8.3 per cent a year; the quantity of citalopram and venlafaxine increased by approximately the same amount (8.4 per cent and 8.2 per cent a year, respectively). However, the quantity of mirtazapine increased to a greater extent (21.3 per cent a year). The quantity of paroxetine prescribed decreased by approximately 0.78 per cent a year.

This analysis rules out the increase in prescribing as being due to changes in pack size or a substitution of larger for smaller doses.

Appendix 2: PCT-level prescribing analysis methodology

In more detail, our analysis assumed that each GP practice and PCT came from a (hypothesised) population of GP practices and PCTs. The models assume that these populations are on a normal distribution with an overall mean of zero and an estimated variance that reflects the unexplained variability at each level. By employing these models the analysis accounts for clustering of GP practices within the PCT and the fact that the individual monthly prescribing data are correlated within each GP practice.

We further refined the models to incorporate for each GP practice and each PCT a random (latent) effect to describe their initial prescribing level at August 2010 (model intercept) and another random (latent) effect to describe the trajectory from August 2010 until March 2012 (model slope). These are assumed to come from a multivariate normal distribution with mean zero and a variance-covariance structure that describes the correlation between monthly time points and between GP practices clustered within an individual PCT. In general, this structure is used to obtain a better fit to the data so that parameters in the fixed part of the model – those that describe the population-level associations – are more precisely estimated, having accounted for the clustered longitudinal structure of the data.

In some cases, the random (latent) effects are of interest as they can be considered 'residuals' at each level of the data. In our case, we describe geographic variation by estimating the random intercepts and slopes for each PCT in the model (see Table A2.1 and Figure A2.1 for a full description of the patterns of geographic variation). This differs slightly from the traditional use of residuals as we are not so much interested in 'observed versus expected' but in deriving information about the deviations from the population-level model's intercept and slope (that is, the population model estimates the national level of prescribing and its trajectory over time).

Table A2.1: PCT-level prescribing trends over time

PCT prescribing behaviour scenario	Size and direction of baseline difference from expected	Size and direction of the change above expected	Interpretation
1	Equal to zero	Equal to zero	The PCT is following the typical national pattern in both its initial level of prescribing and subsequent trajectory over time.
2	Less than zero	Less than zero	The initial level of the PCT was lower than the average and has increased at a slower rate than the average. So at the end of the period the PCT level of prescribing would be lower than what is predicted by the model.
3	Equal to zero	Less than zero	The initial level of the PCT was the same as the average and has increased at a slower rate than the average. So at the end of the period the PCT level of prescribing would be lower than what is predicted by the model.
4	Less than zero	Equal to zero	The initial level of the PCT was lower than the average and it has increased at the same rate as the average. So at the end of the period the PCT level of prescribing would still be lower than what is predicted by the model.
5	Less than zero	Greater than zero	The initial level of the PCT was lower than the average and has increased at a faster rate than the average. So at the end of the period the PCT level of prescribing may be higher or lower than what is predicted by the model, depending on the rate of increase.
6	Greater than zero	Less than zero	The initial level of the PCT was higher than the average and has increased at a slower rate than the average. So at the end of the period the PCT level of prescribing may be higher or lower than what is predicted by the model, depending on the rate of increase.
7	Greater than zero	Equal to zero	The initial level of the PCT was higher than the average but it has increased at the same rate as the average. So at the end of the period the PCT level of prescribing would be higher than what is predicted by the model.
8	Equal to zero	Greater than zero	The initial level of the PCT was the same as the average and has increased at a faster rate than the average. So at the end of the period the PCT level of prescribing would be higher than what is predicted by the model.
9	Greater than zero	Greater than zero	The initial level of the PCT was higher than the average and has increased at a faster rate than the average. So at the end of the period the PCT level of prescribing would be higher than what is predicted by the model.

Figure A2.1: Examples of PCT behaviour scenarios defined in Table A2.1

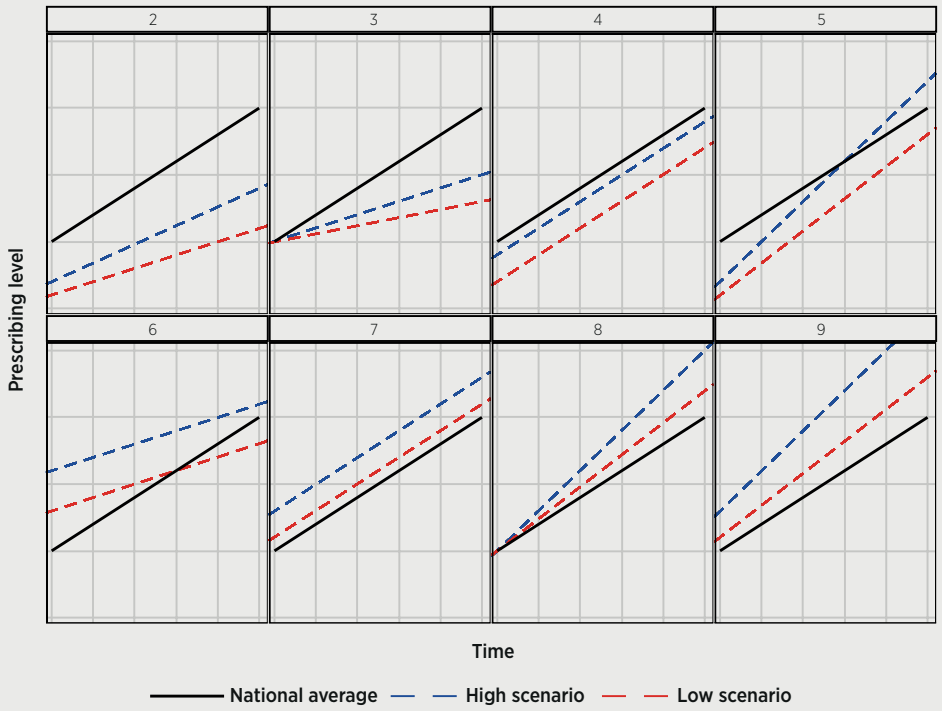


Table A2.2: Regression parameters for factors that predict monthly GP-level antidepressant prescribing, 2010/11 to 2011/12

Predictor	Parameter estimate	Standard error	t-value	*p* value
Intercept	-1.999	0.107	-18.78	<.0001
Time (month)	0.010	0.000	29.14	<.0001
Depression prevalence (%)	0.019	0.001	26.31	<.0001
Aged 65 and over (%)	0.025	0.001	22.58	<.0001
Female (%)	0.031	0.002	15.85	<.0001
Ethnicity: white (%)	0.012	0.001	22.63	<.0001
GPs per 10,000 patients	0.014	0.001	14.95	<.0001
Income domain (1–100)[1]	0.000	0.001	-0.3	0.7676
Health domain (1–100)	0.016	0.001	18.24	<.0001
Education domain (1–100)	0.001	0.001	1.61	0.1072
Housing domain (1–100)	-0.002	0.000	-3.42	0.0006
Crime domain (1–100)	0.000	0.001	-0.61	0.5433
Living environment domain (1–100)	-0.002	0.000	-3.81	0.0001
Unemployment rate (%)	0.013	0.002	8.18	<.0001
Patient satisfaction (%)	0.001	0.000	4.92	<.0001
Antibiotics (items per registered person)	0.072	0.001	73.82	<.0001

1. As the Index of Multiple Deprivation (IMD) values increase, the deprivation associated with that domain decreases.

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About the authors

Ruth Spence was a Research Analyst at the Nuffield Trust from April 2013 to March 2014, after completing her PhD in developmental psychiatry at the University of Cambridge. Ruth's research involved using a mixed methods approach to investigate how personality and temperament influence mental health service use in adolescents.

Prior to beginning her PhD she worked as a researcher at the Institute of Psychiatry. She was involved in a study assessing the impact of functional family therapy on adolescent antisocial behaviour and an evaluation of medium secure services for personality disordered offenders.

Adam Roberts is a Senior Research Analyst at the Nuffield Trust. He joined the Trust in November 2010 from Humana Europe, where he led a team analysing costed acute data to identify potential issues for NHS commissioners. During his time at Humana he developed a strong understanding in commissioning of secondary care services, NHS Acute Data, National PbR Tariffs and PbR Rules for Acute Contracting and Invoice Validation.

Prior to Humana, Adam was responsible for the production of risk estimates of NHS organisations for the Care Quality Commission (and the former Healthcare Commission) to support the programme of targeted inspections. These estimates were generated by applying cutting-edge methods to all relevant and available data sources, both quantitative and qualitative, to identify areas of possible concern for the commission to follow up.

Cono Ariti is a Senior Research Analyst at the Nuffield Trust. He previously worked at the London School of Hygiene and Tropical Medicine (LSHTM) where he was a Lecturer in Medical Statistics. His research interests at the Trust include the evaluation of complex community interventions using large administrative datasets in areas such as telehealth and predictive risk modelling.

At LSHTM Cono worked on the planning, design and analysis of randomised clinical trials and observational studies in the areas of cardiovascular disease, malaria and tuberculosis. He was responsible for developing predictive risk models for cardiovascular disease utilising data from an international consortium of pooled studies.

He also taught on the postgraduate programmes in Epidemiology, Public Health and Medical Statistics. Prior to joining LSHTM, Cono was Vice President of Statistics at Capital One Bank Europe where he led the development and application of risk modelling tools for the UK business. Cono is currently an Honorary Lecturer in Medical Statistics at LSHTM.

Martin Bardsley is Director of Research at the Nuffield Trust. He leads a specialist team undertaking a range of quantitative research projects, most of which aim to exploit existing information systems in the NHS.

Martin has over 20 years' experience in health services research and analysis. Before joining the Trust he worked in healthcare regulation. He was Assistant Director at the Commission for Health Improvement before moving to the Healthcare Commission, where he led its work on new ways to use information to target regulatory activity. This included ground-breaking work on the use of multiple indicators and time series analyses for surveillance.

Martin is a Fellow of the Faculty of Public Health and in the 1990s he established a London-wide resource on public health information. This work led to a number of reports on health in London, including the first Public Health Report for Greater London in 1998.

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The Health Foundation
90 Long Acre
London WC2E 9RA

020 7257 8000
info@health.org.uk

www.health.org.uk

Nuffield Trust
59 New Cavendish Street
London W1G 7LP

020 7631 8450
info@nuffieldtrust.org.uk

www.nuffieldtrust.org.uk