The determinants of the use of practice nurse services in England

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Abstract

Aims: To investigate the determinants of the use of practice nurse services, and to explore the relationship between practice nurse and GP visits.

Methods: Data for the analysis were taken from two rounds of the Health Survey for England (2001, 2002; n = 38,038). We regressed whether or not each individual had a practice nurse visit in the previous two weeks (yes/no) on a comprehensive set of individual and area covariates using a univariate probit model. We also investigated the relationship between practice nurse and GP visits using a bivariate probit model. We explored potential endogeneity using instrumental variables applied to a recursive bivariate probit model.

Results: Practice nurse use is determined by demographic, morbidity and socio-economic factors including education and economic activity. We found some evidence that the use of GP and practice nurse services are positively correlated, although individuals with more severe acute ill health are more likely to visit only their GP and individuals with chronic sickness are more likely to visit only a practice nurse. Visiting the GP is found to have a positive impact on the probability of having a nurse visit, though the effect is insignificant after controlling for endogeneity.

Conclusions: Our results indicate inequalities in practice nurse use with respect to socio-economic status and show that practice nurse visits can both complement and substitute GP visits.

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Introduction

Most health care services are provided free of charge at the point of delivery in England. Needs for health care are expected to influence whether or not individuals utilise those services and the use of specific health services such as nurses, general practitioner (GPs) or specialists, are expected to be related to morbidity and other indicators of need. However, it has been demonstrated that use of services is determined by 'non-need' variables, such as income, that ought not to affect the use of health care, indicating horizontal inequity (Van Doorslaer et al., 2000; Gravelle, 2001; Morris et al., 2005).

In order to investigate inequity with respect to health service use what is needed is information on the determinants of health service use. This includes whether or not the use of different services is correlated and the extent to which the services are complements or substitutes of each other. We focus on these issues in this study in the context of primary care, and more specifically with respect to the use of practice nurse services and GP services.

The role of practice nurses has expanded in the UK in recent years. The main purpose of nurse practitioners is "to share workload and responsibility with GPs, making best use of clinical skills within the practice, enabling the practice to diverse in the services provided" (Royal College of Nursing, 2007). The term "nurse practitioner" remains ambiguous, but the expectation is that primary care nurses working in extended roles can reduce the demand for doctors by playing a leading role in a wide array of services, at the same time that quality of service is enhanced and direct costs are reduced (Laurant et al., 2007). In addition to acting as substitutes for GPs, at least with respect to some dimensions of primary care activity, practice nurse services may also be complements to GP services, providing follow-up care after an initial GP consultation. In this paper we attempt to identify the factors determining whether practice nurse visits are substitutes or complements to GP visits.

Previous research on the determinants of the use of health services has generally overlooked the services provided by nurses in primary care, usually due to a lack of data. However, there is an extensive literature that looks at the care provided by practice nurses and how this differs from that care provided by GPs in terms of cost and health outcomes. Two recent systematic reviews (Horrocks et al., 2002; Laurant et al., 2007) concluded that appropriate trained nurses can produce high quality care and achieve similar health outcomes

for patients to GPs in primary care. Patients' satisfaction was found to be significantly greater with nurses than with GPs, which may have been related to the significantly longer mean length of practice nurse consultations. Results from studies that allow patients to choose whether to see a GP or a nurse rather than being randomly allocated found that there was a significant difference between the morbidity of problems seen by doctors and nurses, providing evidence that patients self-triage (Myers, 1997; EROS team, 1999).

The aims of our paper are to investigate the determinants of the use of practice nurse services, and to explore the relationship between the use of practice nurse and GP visits. We model the use of practice nurse services using regression analysis with a large set of covariates and use a number of approaches to model the correlation with GP care. To our knowledge, this is the first study to examine these issues, although previous studies have extensively analysed the use of GP services, usually in the context of investigating horizontal inequity in health service use (see, e.g., Abásolo et al. 2001; Van Doorslaer et al., 2000; 2002a; 2002b; Morris et al., 2005).

Data

The analysis is based on pooled data from two rounds (2001 and 2002) of the *Health Survey for England* (HSE). The HSE is a cross-sectional national survey which draws a different sample every year of individuals living in England. Respondents are interviewed on a range of topics including their age and other demographic variables, their socio-economic status, their health and their use of health services. Data are available for 19,640 individuals in 2001 and 18,398 in 2002. We present the summary statistics of the variables included in the analysis in Table 1.

Use of health services

We use data for 2001 and 2002 because in these years there is a question in the HSE about the use of practice nurse and GP services for the whole sample of the survey. Individuals were asked if they had visited a practice nurse at a GP surgery on their own behalf in the past 2 weeks, and if so, how many times. Very few survey respondents had more than one visit to see either the practice nurse or the GP (0.6% and 3% of the sample, respectively) and so we measure practice nurse use and GP use as binary variables reflecting whether or not the

survey respondent visited either professional in the previous two weeks. This approach was also used by Morris et al., 2005.

Health and Psychological indicators

To find the determinants of practice nurse use we use a rich set of morbidity indicators provided in the HSE. These variables include: self-assessed general health measured on a five-point scale from very good to very bad health; whether or not the individual has one of a range of longstanding illnesses by broad disease category; whether or not these longstanding illnesses limit the activity of the respondent in any way; the number of days individuals had to cut down on the activities they usually do in the previous two weeks because of acute illness or injury; the number of longstanding illnesses; and GHQ-12 score (a measure of psycho-social well-being).

Socio-economic variables

We measure socio-economic status in a number of dimensions. Household income is measured in the HSE as a categorical variable with 31 income bands. We use the approach taken by Morris et al. (2005) to compute an estimate of individual income. We first estimated the median level of household income within each band by comparing the number of observations within each band with the number that would be generated by the log normal distribution, which is often used to characterised income distributions (Cowell, 1995; Lambert, 2001). The mean and standard deviation parameters of the log normal distribution were determined by minimising the sum of squared differences between actual and generated numbers in each band. The median income in each band is computed as the value at half the cumulative density within the band. All individuals within each band were allocated the same median value. Then, we computed an estimate of the household income for each respondent allowing for differences in household size and household composition using the McClements scale (McClements, 1977) which is reported in the HSE. We then applied log-transformation to the derived income variable.

We also include a set of variables to capture other dimensions of socio-economic status: social class of the head of the household (measured in seven categories based on the Registrar General's classification), higher educational attainment (seven categories), employment status (nine categories) and ethnicity (eight categories).

Area deprivation and supply

Area deprivation is included using the index of multiple deprivation 2000, which is a composite index of relative deprivation at small area level (electoral wards in England), based on six domains of deprivation: income; employment; geographical access to services; health and disability; education, skills and training; and housing. This index is provided in the 2001 and 2002 rounds of the HSE and is based on quintiles of the distribution allocated to the respondent's electoral ward of residence.

We also used two area-level supply variables: the average number of GPs per 1000 individuals, and the average distance to a GP surgery. Those are based on ward-level areas, and aggregated to Health Authorities (HAs), of which there were 95 in England during the study period. These variables were linked to the respondent's HA of residence. A vector of 95 HA indicators is also included to control for unobserved supply factors (Sutton et al., 2002; Gravelle et al., 2003).

Demographic and other variables

We also control for age, gender, household composition (numbers of infants and children included as linear terms), marital status (5 categories); and also for the degree of urbanisation, housing tenure (5 categories) and for the HSE year.

Analysis

The use of practice nurse services is defined in the analysis as a binary variable taking the value one if the respondent visited a practice nurse in the last 2 weeks and zero otherwise.[1] We use a probit model to analyse the determinants of practice nurse use.

It is possible that the use of practice nurse services is correlated with the use of GP services; we explore the relationship between these services in the first instance by including whether or not the respondent visited a GP in the past two weeks as a covariate in the practice nurse model.

[1] The question included in the HSE was "during the last 2 weeks ending yesterday, did you see a practice nurse at the GP surgery on your own behalf?"

There may be unobservable characteristics that influence whether or not individuals visited the practice nurse and a GP. We account for this correlation using a bivariate probit model. With the two binary equations, four possible outcomes can be observed: the individual had no visits, the individual visited the GP but not the practice nurse; the individual visited the practice nurse but not the GP, and the individual visited both the practice nurse and the GP. We estimate this model and investigate the determinants of each outcome. The correlation coefficient between the two error terms in the bivariate probit model, ρ, provides evidence of whether the equations are independent and can be estimated separately. If ρ is significant the two equations are related and should be estimated simultaneously; the sign of ρ indicates the direction in which unobservable factors that are correlated with seeing a practice nurse are also related to visiting a GP.

The effect of a GP visit is potentially endogenous in the practice nurse equation. The endogeneity may come from three different sources (Wooldridge, 2002):

(i) As a result of an omitted variable if unobservable variables, such as the ability of the nurse to deal with a specific health problem, are correlated with both GP and practice nurse visits;
(ii) As a result of measurement error; in the present analysis this is probably unlikely given the short recall period (2 weeks);
(iii) As a result of reverse causality or simultaneity, e.g., having a nurse visit affects the probability of having a GP contact, or both visits take place in the same appointment.

Instrumental variable (IV) regression provides a general solution to these problems, but the validity of the approach relies on finding an appropriate instrument for GP visits. This requires two properties: it has to be a good predictor of whether the individual visited a GP in the past 2 weeks conditional on the other covariates, and it must be uncorrelated with the error term in the practice nurse equation. Testing the first condition involves conducting a F-test of the instrument variable after we run the model for the probability of visiting a GP; however, the second condition can not be tested directly.

We instrument GP visits using the response to questions in the HSE on whether or not the respondent spoke to a GP or family doctor about being anxious or depressed, or about a

mental, nervous or emotional problem in the last 12 months. Given the types of patient typically seen by GPs and practice nurses, this variable is expected to be a significant predictor of visiting the GP, but given the different time frame is not likely to itself be endogenous. The second condition requires that the variable is not a component of the error term in the practice nurse visit equation, but it is only correlated through its impact on GP consultation. Given that we control for a rich set of covariates, including mental health disorders and GHQ-12 scores, it is unlikely that the effect of the instrument will affect the probability of seeing a nurse other than via the effect of having a GP consultation. To account for the binary nature of both variables we use a recursive bivariate probit model in the IV models.

We report average marginal effects (AMEs) for the effect of each covariate on the likelihood of a practice nurse visit. We used sample weights to account for the fact that different observations have different probabilities of selection for the survey. Since each year of data has their own sample weight, we rescaled them to a common metric by dividing the individual weight in each year by the mean weight in that year (Morris et al., 2005).

Observations within Primary Sampling Units (PSUs) in the HSE are likely to be more homogeneous than observations between them; we therefore adjusted for potential clustering using Huber/White/sandwich robust variance estimators that allow the data to be independent across clusters, but not necessarily independent within clusters.

Missing values are added to the omitted category in all categorical variables, and dummy variables for item non-response are included in the analysis. For the income variable, missing values were imputed by regression of the variable on the other explanatory variables, and also a dummy variable indicating item non-response was included.

We perform a link test to check the specification of the practice nurse model. After the estimation of the model we compute the linear prediction and its squared values, and regress the dependent variable against these. If the model is correctly specified, the square of the linear prediction should be insignificant. All analyses were undertaken using Stata 9.2 version.

Results

Sample-weighted summary statistics are presented in Table 1, reported as the proportion of individuals in each category for the categorical variables, and as sample mean for the continuous variables. We present the result of all the variables included in the models with the exception of the 95 District Health Authority dummies and the item non-response variables.
Around six per cent of the sample reported to have at least one practice nurse visit in the previous 2 weeks; about 15% had at least one GP consultation; and about 2% of the sample visited both the practice nurse and the GP.

The regression models are in Table 2. We present separately the results of the probit model of the probability of visiting the practice nurse; the results of the same model but including whether the individual visited a GP as a covariate; and the results of the bivariate probit model of the probability of the four possible outcomes (no visits, only GP visit, only practice nurse visit, or both visit).

We also include the probit model for the probability of having a GP visit. We report in the table the tests of the join significance of subsets of variables when possible. The coefficients are significant at the 5% level when the absolute value of the z score exceeds 1.9 and at the 10% level when it exceeds 1.6.

Probit model of the probability of visiting a practice nurse (without GP variable)

Age and gender

The highly significant coefficients of age, age-squared, age-cubed and their interaction with gender suggest a non-linear effect of age and gender on the use of practice nurse services. To illustrate the effects we plotted the probability of use against age for both sexes based on the results of the regression model, and holding all other variables constant. For comparison, we also estimated the unconditional effects of age on the probability of use for each gender (see Figure 1). The conditional curve (solid lines) shows the effect of age after controlling for the covariates, the unconditional curve (dashed lines) includes the effect of other variables that affects use and are correlated with age. For instance, the unconditional curves predict a much

higher use of nurse services in the elderly, since morbidity is highly correlated with age; in the conditional model, after controlling for morbidity the predicted probability of visiting a nurse at the older age is much lower.

For men both the conditional and unconditional probabilities first decrease with age, and then start increasing, to finally decrease in old age. For females, the unconditional probability of use increase with age across the entire age range, while the conditional probability decreases until the age of 40 to slightly increase for older individuals. Figure 2 shows similar curves for the use of GP services. The patterns of the curves are similar to those for practice nurses.

Health and psychological indicators

The effect of self-assessed general health is significant and, as expected, individuals reporting worse health have a higher probability of using practice nurse services. The probability of seeing a practice nurse among those reporting "very bad health" is not significantly higher than those reporting very good health; patients reporting very bad health are, however, more likely to see their GP (see below).

The effect of whether the individual has a limiting long-standing illness is positive but insignificant, conditional on the other variables. Some specific longstanding illnesses significantly increase the probability of having a nurse visit, especially those reporting endocrine or metabolic disorders, those with disease of the heart and circulatory system, and those with respiratory problems. Some conditions are negatively correlated with having a nurse visit, such as disorders of the nervous system and infectious diseases.

Individuals who had to cut down normal activities due to illness or injury over the last 2 weeks have a higher probability of visiting the practice nurse, although this effect vanishes after controlling for whether they had a GP consultation (see column 2).

The number of longstanding illnesses and the GHQ-12 score variables are both individually and jointly insignificant.

Socio-economic variables

The effect of income is positive but insignificant. The effect of the social class of the head of the household indicates that those in low social classes have a greater probability of utilisation, although it is generally insignificant and only borderline significant in the lowest group. The education variables are jointly significant, showing some evidence that those with lower education attainment are more likely to see a practice nurse, conditional on morbidity. The employment status of the individual also affects the probability of utilisation: compared with being in paid employment, those who are permanently unable to work because a long-term sickness, and those looking after home or family have a greater probability of visiting a practice nurse.

The ethnicity variables are both jointly and individually insignificant.

Other demographics and personal characteristics

In terms of marital status, being single or widowed decreases the probability of a practice nurse visit. Every additional infant in the household (children under the age of 2) increases the probability of visiting a practice nurse, while the number of children aged 2 to 16 years is insignificant. Compared with living in a rural area, those living in suburban areas are less likely to see a practice nurse, which may be picking up practice nurse supply effects. Tenure has an insignificant impact on practice nurse visits.

Supply, HSE year and item non-response variables

The index of multiple deprivation, the average number of GPs per 1000 patients, and the average distance to a GP surgery were all insignificant.
The year effect suggests that there is an increase over these two years on the probability of using practice nurse services. Finally missing values and HA dummies are jointly significant (individual effects not reported).

The model passes the link test for model specification ($p = 0.559$), which suggests that the probit specification is appropriate. The pseudo-R^2 for the model is about 9%.

Probit model of the probability of visiting a practice nurse (with GP variable)

The effect of having a GP consultation is highly significant and positively correlated with the probability of visiting a practice nurse. Those reporting at least one GP visit over the last two weeks, have a probability 0.07 greater of having visited a practice nurse over the same period.

The effect of the other covariates remains fairly stable after including the GP variable. The size of the average marginal effects change very little, and although the magnitude of the z scores are reduced in all cases, only the variables discussed above (days having to cut down due to illness) become insignificant at 10% level when controlling for whether or not the individual visited a GP.

Bivariate probit model

In the bivariate probit model the correlation coefficient between the error terms in the practice nurse and GP supply equations, ρ, is positive and significant. This means that unobservable factors that are positively correlated with having a practice nurse visit are positively related with having a GP visit. This suggests that nurse visits are more likely to be complements than substitutes for GP visits with respect to unobserved characteristics.

Individuals reporting worse levels of health status have a greater probably of seeing practice nurses and their GP, but the impact is largest for the probability of seeing only the GP. Those with mental disorders, respiratory problems, genitourinary system conditions and skin complaints, have a higher probability of seeing only a GP than seeing both the GP and the nurse, and are not more likely to see only a practice nurse. Nervous system conditions are significantly less likely to be dealt with by a practice nurse. Endocrine and metabolic conditions, as well as heart and circulatory system problems, are significantly more likely to be dealt by either a nurse or a GP alone rather than by both.

Acute illness is positively correlated with visiting the GP and with visiting the GP and the practice nurse, but is not correlated with seeing only the practice nurse. Individuals with high GHQ-12 scores are more likely to be dealt by a GP than a practice nurse.

However, individuals are more likely to have only a practice nurse visit instead of seeing both the GP and the nurse if they are permanently sick. The probability that they see only a GP is negative and insignificant.

IV regression

In Table 3, we present the main results of the IV regression. The instrument is highly correlated with the probability of visiting a GP conditional on the covariates ($F = 136.14$, $p < 0.0001$). The ρ coefficient is positive and significant, which suggests that GP visits are endogenous. Assuming that the instrument is valid, then after controlling for endogeneity the impact of a GP consultation on a practice nurse visit is insignificant.

Discussion

We have found that a number of individual demographic and morbidity factors are correlated with the probability of visiting a practice nurse. In particular, those reporting chronic conditions such as heart and circulatory problems or endocrine and metabolic disorders are more likely to visit a practice nurse. Consistent with the role of practice nurses in treating chronic conditions we find that those who are permanently unable to work because of long-term sickness are more likely to have a practice nurse consultation, and those with acute sickness are more likely to visit the GP than the practice nurse.

In terms of socioeconomic status, we found that other variables not measuring demography or morbidity affect the probability of seeing a practice nurse. These include education, employment status and the degree of urbanisation. This suggests inequalities in the use of practice nurse services with respect to these variables.

Individuals in low employment status groups have been found in previous studies (Morris et al., 2005) to have lower than expected use of GP services. Also the analysis in this paper found that individuals in paid employment have a greater probability of seeing a GP than those in lower employment categories, especially those in full-time education and looking for paid job. Assuming we control fully for need of health care, it have traditionally been argued that these results provide evidence of pro-rich horizontal inequity in primary care use. However, we also found that individuals in lower employment status groups have greater than expected use of practice nurse services, which may indicate that a higher degree of substitution between GPs and practice nurses occur among those individuals with relatively low employment status. Analyses of primary care than focus only on GP use fail to account

for this substitution effect. The impact of education appears to be consistent in the use of both services provided in primary care. For GP consultations, according to our findings, those with lower educational attainment are more likely to visit their GP, and the same effect has been found in previous literature (Abásolo et al., 2001; Morris et al., 2005). We found that this is also the case for the probability of visiting a practice nurse, which provides more evidence of inequalities in the use of primary care favouring those with lower education.

When analysing whether an individual that visited a GP is more or less likely to have a practice nurse consultation, we found evidence that there are unobserved characteristics not included in our set of covariates that are positively correlated with the probability of seeing a GP and are also positively related with nurse consultations. However, we also found that some patients, especially those with acute sickness, are more likely to see the GP. Other patients, in particular those with chronic illness, are more likely to see the practice nurse alone, which provides some evidence of the substitution between those services in these groups.

In terms of the IV results, assuming that our instrument is valid, the effect of a GP visit on practice nurse consultations becomes negative and insignificant. A plausible explanation is that the effect of the GP variable in the univariate probit model was picking up the reverse causality effect, i.e. having a practice nurse visit affects the probability of seeing a GP. We will undertake further research to investigate the impact of having a practice nurse visit on the probability of visiting a GP. A simple probit regression model suggests that the effect is positive and significant (AME = 0.16, z = 14.43), though this fails to account for endogeneity.

In summary, we conclude that use of practice nurses is not only determined by morbidity and severity factors, but the socio-economic characteristics of individuals play also a role on the probability of using these health services. Whether practice nurse visits are complements or substitutes for GP visits depends on the characteristics of the patient. Severe acute sickness is more likely to be dealt by GPs, but chronically ill patients are more likely to be treated by practice nurses.

Issues for discussion

We would be grateful for your views on the whether or not the instrument in the IV model is valid, and what an appropriate instrument for practice nurse visits in a model of GP visits might be.

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Table 1. Sample-weighted Summary Statistics HSE data 2001-2002, n = 38,038

Variable	Mean	Std. Dev.	Variable	Mean	Std. Dev.	Variable	Mean	Std. Dev.	Variable	Mean	Std. Dev.
Health service utilisation			***Number of longstanding illnesses***			***Education***			***Marital status***		
Practice Nurse	0.062	0.241	0	0.599	0.490	Degree	0.118	0.322	Married	0.421	0.494
GP	0.149	0.356	1	0.255	0.436	Higher education less than degree	0.085	0.280	Single	0.428	0.495
Both	0.021	0.142	2	0.099	0.299	A level or equivalent	0.096	0.294	Separated	0.020	0.140
Health & psychological indicators			3	0.031	0.174	gcse or equivalent	0.180	0.384	Divorced	0.062	0.242
Self-reported general health			4 or more	0.015	0.120	cse or equivalent	0.043	0.203	Widowed	0.068	0.252
Very good	0.380	0.485	***GHQ-12 score***			other qualification	0.036	0.187	***Household composition***		
Good	0.402	0.490	0	0.444	0.497	no qualification	0.211	0.408	Household size	3.056	1.455
Fair	0.160	0.367	1	0.109	0.312	***Economic activity***			No of infants	0.094	0.31
Bad	0.044	0.206	2	0.060	0.238	In paid employment	0.424	0.494	No of children	0.831	1.122
Very bad	0.013	0.115	3	0.036	0.186	Going to school/college full time	0.042	0.200	***Degree of urbanisation***		
Limiting longstanding illness	0.222	0.416	4	0.024	0.154	Permanent long term sickness	0.032	0.177	Rural	0.232	0.422
Longstanding illness			5	0.020	0.140	Retired from paid work	0.169	0.375	Suburban	0.591	0.492
Neoplasms & benign growths	0.014	0.119	6	0.016	0.124	Looking after the home	0.080	0.272	Urban	0.177	0.382
Endocrine & metabolic	0.046	0.209	7	0.013	0.112	Waiting to take up paid job	0.002	0.048	***Tenure***		
Mental disorders	0.027	0.162	8	0.010	0.097	Looking for paid job	0.015	0.121	Own	0.244	0.430
Nervous system	0.033	0.180	9	0.008	0.088	Temporary sickness or injury	0.003	0.052	Mortgage	0.472	0.499
Eye complaints	0.022	0.147	10	0.008	0.088	Doing something else	0.003	0.050	Part mortgage	0.005	0.068
Ear complaints	0.023	0.151	11	0.006	0.078	***Ethnic group***			Rent	0.266	0.442
Heart & circulatory system	0.097	0.296	12	0.006	0.080	White	0.917	0.275	Free rent	0.010	0.100
Respiratory system	0.096	0.295	**Socio-economic variables**			Black Caribbean	0.013	0.113	**Supply variables**		
Digestive system	0.041	0.199	***Total income***	23,601	20,727	Black African	0.010	0.097	GP distance	12.091	0.602
Genito-urinary system	0.017	0.131	***Social class of head of household***			Indian	0.017	0.131	No GPs per 1000	0.522	0.110
Skin complaints	0.025	0.155	Professional	0.068	0.251	Pakistani	0.014	0.118	***Index of multiple deprivation***		
Musculo-skeletal system	0.155	0.362	Managerial/technical	0.310	0.462	Bangladeshi	0.005	0.073	Lowest deprivation	0.155	0.362
Infectious disease	0.002	0.048	Skilled non-manual	0.149	0.356	Chinese	0.003	0.050	2	0.146	0.354
Blood & related organs	0.006	0.075	Skilled manual	0.246	0.431	Other	0.021	0.142	3	0.180	0.384
Other complains	0.002	0.042	Semi-skilled manual	0.147	0.354	**Demographic characteristics**			4	0.208	0.406
Acute ill health (days cut down)			Unskilled manual	0.047	0.212	***Age and Sex***			Highest deprivation	0.282	0.450
0 days	0.842	0.365	Other	0.032	0.176	Female	0.541	0.498	**Year of data**		
1-3 days	0.054	0.226				Age (years/100)	0.385	0.234	HSE2001	0.516	0.500
4-6 days	0.026	0.159							HSE2002	0.484	0.500
7-13 days	0.025	0.155									
14 days	0.053	0.223									

Table 2. Probit Model and Bivariate Probit Model (Average marginal effects and z scores)

	Probit Model						Bivariate Probit Model							
	Nurse		Nurse (incl GP)		GP		No visits		Only GP		Only Nurse		Both visits	
	AME	z	AME	z	AME	z	AME	z	AME	z	AME	z	AME	z
GP			0.07	14.3										
Age and sex														
Female	-0.04	-4.0	-0.04	-3.9	-0.03	-3.0	0.06	4.5	-0.02	-1.9	-0.02	-3.9	-0.01	-5.0
Age	-0.06	-1.3	-0.06	-1.3	-0.14	-2.9	0.18	3.4	-0.97	-7.8	-0.48	-7.0	-0.42	-11.5
Age-squared	1.95	7.9	1.75	7.2	2.72	8.1	-3.77	-10.6	1.82	6.0	1.08	6.5	0.88	10.0
Age-cubed	-1.16	-6.5	-1.04	-5.9	-1.53	-6.1	2.16	8.1	-1.00	-4.4	-0.65	-5.3	-0.51	-8.0
Female*age	0.53	5.7	0.48	5.3	0.76	5.9	-1.06	-7.6	0.52	4.5	0.30	4.8	0.25	7.3
Female*age-squared	-1.22	-4.8	-1.13	-4.5	-1.82	-5.0	2.51	6.4	-1.25	-3.9	-0.69	-4.0	-0.57	-6.3
Female*age-cubed	0.77	3.9	0.71	3.7	1.13	3.9	-1.56	-5.1	0.77	3.0	0.43	3.3	0.36	5.1
Health indicators														
Self-reported general health														
Very good	Base		Base		Base		Base		Base		Base		Base	
Good	0.01	3.8	0.01	3.1	0.03	6.5	-0.04	-7.1	0.02	5.7	0.01	2.4	0.01	5.8
Fair	0.03	4.7	0.02	3.7	0.08	9.2	-0.09	-10.1	0.05	9.1	0.01	3.0	0.01	8.7
Bad	0.03	3.1	0.02	2.5	0.08	5.5	-0.09	-6.1	0.05	5.5	0.01	2.2	0.01	5.7
Very bad	0.02	1.4	0.01	0.6	0.11	4.9	-0.11	-5.0	0.08	5.5	0.001	0.2	0.01	3.8
Limiting longstanding illness														
Yes	0.002	0.4	0.002	0.5	-0.01	-1.3	0.01	1.0	-0.01	-1.4	0.002	0.6	-0.001	-0.3
Longstanding illness														
Neoplasms & benign growths	0.02	1.4	0.01	1.3	0.02	1.2	-0.03	-1.6	0.01	0.9	0.01	1.3	0.01	1.8
Endocrine & metabolic	0.05	5.1	0.04	4.7	0.05	4.5	-0.08	-6.1	0.03	3.7	0.02	5.1	0.02	7.2
Mental disorders	0.01	1.1	0.01	0.8	0.06	3.7	-0.06	-3.8	0.04	3.9	0.00	0.5	0.01	2.9
Nervous system	-0.02	-2.7	-0.02	-2.6	0.02	1.5	-0.01	-0.6	0.02	2.2	-0.01	-2.5	-0.001	-1.2
Eye complaints	-0.004	-0.5	-0.003	-0.4	0.01	0.4	-0.003	-0.2	0.01	0.5	-0.003	-0.5	-0.001	-0.2
Ear complaints	0.01	0.8	0.01	0.7	0.01	0.9	-0.02	-1.1	0.01	0.8	0.003	0.6	0.003	1.1
Heart & circulatory	0.03	4.4	0.03	4.1	0.04	4.2	-0.06	-5.8	0.03	3.5	0.02	4.1	0.01	6.4
Respiratory system	0.01	2.2	0.01	2.0	0.02	3.2	-0.03	-3.8	0.02	2.8	0.01	1.8	0.01	3.5
Digestive system	0.003	0.5	0.0003	0.0	0.04	3.3	-0.04	-3.1	0.03	3.5	-0.001	-0.3	0.005	1.9
Genito-urinary system	0.02	1.5	0.01	1.0	0.07	3.8	-0.07	-3.9	0.05	4.0	0.004	0.7	0.01	3.1
Skin complaints	0.01	1.2	0.01	0.8	0.05	3.8	-0.05	-3.9	0.04	3.9	0.002	0.4	0.01	2.8
Musculo-skeletal	-0.002	-0.3	-0.003	-0.6	0.02	2.4	-0.02	-2.0	0.02	2.6	-0.003	-0.9	0.001	0.8
Infectious disease	-0.03	-2.0	-0.03	-2.1	0.02	0.5	-0.001	-0.03	0.03	0.9	-0.03	-1.6	-0.01	-1.1
Blood & related organs	0.03	1.4	0.02	1.4	0.02	0.7	-0.03	-1.2	0.01	0.4	0.01	1.4	0.01	1.7
Other complains	-0.01	-0.5	-0.01	-0.5	-0.01	-0.4	0.02	0.6	-0.01	-0.3	-0.01	-0.4	-0.01	-0.6
Acute ill health (days cut down)														
0 days	Base		Base		Base		Base		Base		Base		Base	
1-3 days	0.01	1.7	0.002	0.4	0.12	11.4	-0.12	-11.2	0.09	12.7	-0.002	-0.6	0.01	6.9
4-6 days	0.02	2.8	0.01	1.2	0.20	11.9	-0.20	-12.2	0.13	13.8	0.001	0.3	0.02	9.1
7-13 days	0.03	3.0	0.01	1.2	0.27	15.4	-0.26	-16.2	0.16	17.8	0.0003	0.1	0.03	11.3
14 days	0.02	3.6	0.01	1.4	0.21	15.9	-0.20	-16.1	0.13	18.8	0.0005	0.1	0.02	11.6
Number of longstanding illnesses														
0 or 1	Base		Base		Base		Base		Base		Base		Base	
2	0.0001	0.01	0.001	0.2	-0.02	-1.9	0.02	1.6	-0.02	-1.9	0.002	0.4	-0.002	-0.7
3	-0.01	-1.2	-0.01	-1.0	-0.04	-3.1	0.04	3.2	-0.04	-2.5	-0.004	-0.6	-0.01	-2.2
4 or more	-0.01	-0.6	-0.01	-0.4	-0.06	-3.6	0.06	3.2	-0.06	-2.9	0.0002	0.01	-0.01	-1.8
GHQ-12 score														
0	Base		Base		Base		Base		Base		Base		Base	
1	0.01	1.1	0.003	0.7	0.02	3.1	-0.02	-3.1	0.02	3.1	0.001	0.3	0.004	2.3
2	0.001	0.1	-0.001	-0.2	0.02	2.6	-0.02	-2.3	0.02	2.6	-0.002	-0.5	0.002	1.3
3	-0.01	-1.1	-0.01	-1.4	0.04	3.1	-0.03	-2.4	0.03	3.6	-0.01	-1.7	0.001	0.5
4	-0.003	-0.3	-0.01	-0.7	0.03	2.2	-0.03	-1.8	0.03	2.5	-0.01	-0.9	0.002	0.7
5	0.001	0.1	-0.003	-0.4	0.05	3.4	-0.05	-3.0	0.04	3.7	-0.004	-0.7	0.005	1.5
6	-0.003	-0.4	-0.01	-1.0	0.06	3.4	-0.05	-3.0	0.05	3.8	-0.01	-1.2	0.004	1.2
7	0.01	0.9	0.005	0.4	0.04	2.2	-0.04	-2.1	0.03	2.2	0.002	0.2	0.01	1.6
8	0.01	0.7	0.001	0.04	0.10	4.0	-0.10	-4.0	0.07	4.5	0.007	-0.3	0.01	2.6
9	0.02	1.1	0.01	0.9	0.04	1.7	-0.04	-2.0	0.03	1.5	0.01	0.8	0.01	1.8
10	-0.01	-0.7	-0.01	-1.1	0.05	2.1	-0.04	-1.7	0.05	2.5	-0.01	-1.2	0.002	0.3
11	0.03	1.4	0.02	1.1	0.08	2.6	-0.08	-2.6	0.05	2.6	0.01	1.0	0.01	2.4
12	0.001	0.1	-0.01	-0.3	0.10	3.1	-0.09	-3.1	0.07	3.4	-0.01	-0.6	0.01	1.9

	Probit Model						Bivariate Probit Model							
	Nurse		Nurse (incl GP)		GP		No visits		Only GP		Only Nurse		Both visits	
	AME	z	AME	z	AME	z	AME	z	AME	z	AME	z	AME	z
Socio-economic variables														
Total income	0.002	0.9	0.002	1.1	-0.01	-1.9	0.004	1.3	-0.01	-2.1	0.002	1.3	-0.00004	-0.1
Social class of head of household														
Professional	Base		Base		Base		Base		Base		Base		Base	
Managerial/technical	0.0002	0.03	-0.0001	-0.02	0.003	0.3	-0.002	-0.2	0.002	0.3	-0.002	-0.04	0.0002	0.1
Skilled non-manual	0.004	0.6	0.004	0.6	0.003	0.3	-0.01	-0.5	0.001	0.1	0.00	0.5	0.001	0.6
Skilled manual	0.001	0.1	0.0003	0.04	0.01	0.9	-0.01	-0.8	0.01	0.8	-0.002	-0.1	0.001	0.5
Semi-skilled manual	0.004	0.5	0.003	0.4	0.01	1.3	-0.01	-1.3	0.01	1.2	0.001	0.2	0.002	1.0
Unskilled manual	0.02	1.8	0.02	1.7	0.001	0.1	-0.01	-0.9	-0.005	-0.4	0.01	1.9	0.005	1.6
Other	0.01	0.7	0.01	0.6	0.01	0.7	-0.01	-0.8	0.01	0.5	0.004	0.6	0.003	0.9
Education														
Degree	Base		Base		Base		Base		Base		Base		Base	
Higher education less than degree	0.01	1.7	0.01	1.5	0.01	1.0	-0.02	-1.7	0.01	0.7	0.01	1.5	0.004	2.0
A level or equivalent	0.02	2.7	0.02	2.7	0.01	1.5	-0.03	-2.6	0.01	0.9	0.01	2.7	0.01	3.3
gcse or equivalent	0.01	1.7	0.01	1.4	0.02	2.5	-0.02	-2.8	0.01	2.1	0.004	1.2	0.005	2.5
cse or equivalent	0.001	0.1	-0.001	-0.1	0.02	1.6	-0.02	-1.4	0.02	1.7	-0.001	-0.3	0.002	0.8
other qualification	0.02	2.1	0.02	1.9	0.03	2.0	-0.04	-2.7	0.02	1.7	0.01	1.9	0.01	2.9
no qualification	0.01	1.3	0.01	1.0	0.02	2.2	-0.02	-2.4	0.02	2.0	0.003	0.8	0.004	2.0
Economic activity														
In paid employment	Base		Base		Base		Base		Base		Base		Base	
Going to school/college full time	-0.01	-0.8	-0.002	-0.3	-0.04	-4.5	0.04	3.9	-0.04	-3.8	0.0004	0.1	-0.01	-2.3
Permanent long term sickness	0.02	2.5	0.02	2.7	-0.01	-0.5	-0.01	-0.9	-0.01	-1.1	0.01	3.1	0.01	2.2
Retired from paid work	0.005	0.9	0.01	1.0	-0.003	-0.3	-0.001	-0.1	-0.004	-0.5	0.004	1.0	0.001	0.6
Looking after the home	0.01	2.4	0.01	2.3	0.004	0.5	-0.01	-1.6	0.0003	0.04	0.01	2.4	0.004	2.5
Waiting to take up paid job	0.02	0.4	0.02	0.6	-0.01	-0.2	-0.01	-0.2	-0.01	-0.3	0.01	0.7	0.01	0.5
Looking for paid job	0.01	0.9	0.01	1.1	-0.03	-2.0	0.02	1.1	-0.03	-2.2	0.01	1.4	-0.0002	-0.04
Temporary sickness or injury	0.03	0.9	0.03	1.0	0.02	0.6	-0.04	-1.1	0.01	0.4	0.02	1.0	0.01	1.4
Doing something else	0.03	1.1	0.03	1.1	-0.02	-0.5	-0.01	-0.3	-0.02	-0.7	0.02	1.3	0.01	0.9
Ethnic group														
White	Base		Base		Base		Base		Base		Base		Base	
Black Caribbean	0.001	0.1	-0.001	-0.1	0.01	0.3	-0.005	-0.3	0.01	0.3	-0.001	-0.1	0.001	0.1
Black African	0.01	0.7	0.01	0.6	0.003	0.2	-0.01	-0.5	0.0004	0.02	0.01	0.7	0.003	0.7
Indian	-0.004	-0.3	-0.01	-0.5	-0.002	-0.1	0.01	0.3	-0.001	-0.1	-0.003	-0.4	-0.002	-0.4
Pakistani	0.01	0.6	0.004	0.3	0.06	2.7	-0.06	-2.6	0.04	2.9	0.001	0.1	0.01	1.8
Bangladeshi	0.003	0.1	0.01	0.2	0.01	0.4	-0.01	-0.4	0.01	0.4	0.002	0.2	0.003	0.3
Chinese	-0.02	-1.4	-0.03	-1.6	-0.02	-0.5	0.04	1.0	-0.01	-0.3	-0.02	-1.2	-0.01	-1.2
Other	-0.01	-0.9	-0.01	-0.9	0.02	1.1	-0.01	-0.7	0.02	1.4	-0.01	-0.9	-0.001	-0.2
Marital status														
Married	Base		Base		Base		Base		Base		Base		Base	
Single	-0.01	-2.2	-0.01	-1.8	-0.03	-4.0	0.04	4.4	-0.02	-3.6	-0.005	-1.4	-0.01	-3.6
Separated	-0.003	-0.4	-0.002	-0.3	-0.004	-0.3	0.01	0.4	-0.003	-0.2	-0.002	-0.3	-0.001	-0.4
Divorced	-0.01	-1.2	-0.01	-1.5	0.005	0.6	0.0000	0.01	0.01	0.9	-0.01	-1.4	-0.002	-0.9
Widowed	-0.01	-2.0	-0.01	-1.8	-0.02	-1.9	0.02	2.4	-0.01	-1.4	-0.01	-1.5	-0.01	-2.4
Household composition														
Household size	-0.003	-1.5	-0.003	-1.4	-0.01	-2.2	0.01	2.6	-0.005	-1.9	-0.001	-1.1	-0.002	-2.3
No of infants	0.01	2.1	0.01	1.7	0.03	4.0	-0.03	-4.1	0.02	3.6	0.004	1.3	0.01	3.3
No of children	-0.001	-0.4	-0.001	-0.3	-0.002	-0.6	0.003	0.7	-0.002	-0.5	-0.005	-0.3	-0.001	-0.6
Degree of urbanisation														
Rural	Base		Base		Base		Base		Base		Base		Base	
Suburban	-0.01	-2.5	-0.01	-2.4	0.0001	0.02	0.01	1.0	0.003	0.7	-0.01	-2.5	-0.003	-2.0
Urban	-0.01	-1.4	-0.01	-1.2	-0.01	-1.2	0.01	1.5	-0.01	-0.9	-0.003	-1.0	-0.003	-1.5

	Probit Model						Bivariate Probit Model							
	Nurse		Nurse (incl GP)		GP		No visits		Only GP		Only Nurse		Both visits	
	AME	z	AME	z	AME	z	AME	z	AME	z	AME	z	AME	z
Tenure														
Own	Base		Base		Base		Base		Base		Base		Base	
Mortgage	-0.002	-0.6	-0.002	-0.4	-0.0003	-0.1	0.001	0.2	0.0003	0.1	-0.001	-0.4	-0.001	-0.4
Part mortgage	0.01	0.3	0.01	0.5	-0.03	-1.4	0.02	0.7	-0.03	-1.4	0.01	0.6	-0.001	-0.1
Rent	-0.003	-0.8	-0.003	-0.9	0.003	0.6	-0.001	-0.1	0.004	0.7	-0.003	-0.9	-0.001	-0.5
Free rent	-0.01	-1.0	-0.01	-1.0	-0.02	-0.9	0.03	1.1	-0.01	-0.7	-0.01	-0.8	-0.01	-1.2
Supply variables														
GP distance	0.02	1.3	0.02	1.4	0.00	-0.2	-0.01	-0.2	-0.01	-0.6	0.01	1.5	0.004	0.8
No GPs per 1000	-0.0003	-0.01	0.002	0.1	-0.05	-2.1	0.05	1.8	-0.04	-2.1	0.004	0.3	-0.01	-0.8
Index of multiple deprivation														
Lowest deprivation	Base		Base		Base		Base		Base		Base		Base	
2 quintile	0.01	1.4	0.01	1.2	0.004	0.5	-0.01	-1.0	0.001	0.1	0.004	1.2	0.002	1.3
3 quintile	0.002	0.4	0.001	0.3	0.001	0.2	-0.002	-0.3	0.0004	0.1	0.001	0.3	0.001	0.3
4 quintile	-0.001	-0.2	-0.001	-0.2	-0.01	-1.1	0.01	1.1	-0.01	-1.0	-0.003	-0.1	-0.001	-0.8
Highest deprivation	0.001	0.1	-0.004	-0.1	0.005	0.6	-0.004	-0.5	0.004	0.6	-0.001	-0.1	0.0005	0.2
Year of data														
HSE2001	-0.01	-2.4	-0.01	-2.4	0.0004	0.1	0.004	1.0	0.002	0.7	-0.005	-2.4	-0.002	-2.1
Test restrictions														
Age and sex = 0	F = 106.79, p <0.001		F = 87.90, P < 0.0001		F = 159.57, p < 0.0001									
Self-assessed health = 0	F = 29.51, p <0.001		F = 18.17, P = 0.0011		F = 114.2, p < 0.0001									
Type long-standing illness = 0	F = 96.78, p < 0.001		F = 87, p < 0.0001		F = 68.09, p < 0.0001									
Acute ill-health = 0	F = 31.07, p < 0.001		F = 4.04, p = 0.4010		F = 822, p < 0.0001									
Number of long-standing illness = 0	F = 2.60, p = 0.4583		F = 2.31, p = 0.5107		F = 10.09, p = 0.0178									
GHQ-12 = 0	F = 9.12, p < 0.6922		F = 8.18, p = 0.7707		F = 74.55, p < 0.0001									
Social class = 0	F = 8.16, p < 0.2269		F = 7.69, p = 0.2620		F = 4.24, p = 0.6438									
Education = 0	F = 14.06, p < 0.0290		F = 13.62, p = 0.0341		F = 8.49, p = 0.2043									
Employment status = 0	F = 15.80, p < 0.045		F = 16.33, p = 0.0379		F = 21.49, p = 0.006									
Ethnicity = 0	F = 2.72, p < 0.9094		F = 2.73, p = 0.9092		F = 10.66, p = 0.1541									
Marital status = 0	F = 7.65, p = 0.1054		F = 5.92, p = 0.2053		F = 20.16, p = 0.0005									
Household composition = 0	F = 8.7, p = 0.0336		F = 6.39, p = 0.0941		F = 31.20, p < 0.0001									
Urbanisation = 0	F = 6.63, p = 0.0364		F = 6.20, p = 0.0450		F = 2.38, p = 0.3047									
Tenure = 0	F = 1.39, p < 0.8468		F = 1.62, p = 0.8049		F = 3.24, p = 0.5178									
Supply variables = 0	F = 2.05, p = 0.3589		F = 1.5, p = 0.4729		F = 15.35, p = 0.0005									
Index of deprivation = 0	F = 3.18, p < 0.5289		F = 2.53, p = 0.6399		F = 5.74, p = 0.2195									
Item non-response = 0	F = 27.72, p = 0.002		F = 26.45, p = 0.0032		F = 23.75, p = 0.0083									
Ha dummies = 0	F = 158, p < 0.0001		F = 151.59, p < 0.0001		F = 150.56, p < 0.0001									
N	38022		38019		38019		38019							
(Pseudo-)R2	0.0935		0.1192		0.1166									
ρ							Rho = 0.318, Wald test of rho=0: χ^2= 330, p < 0.0001							

Figure 1. Age effect on nurse service utilisation by gender

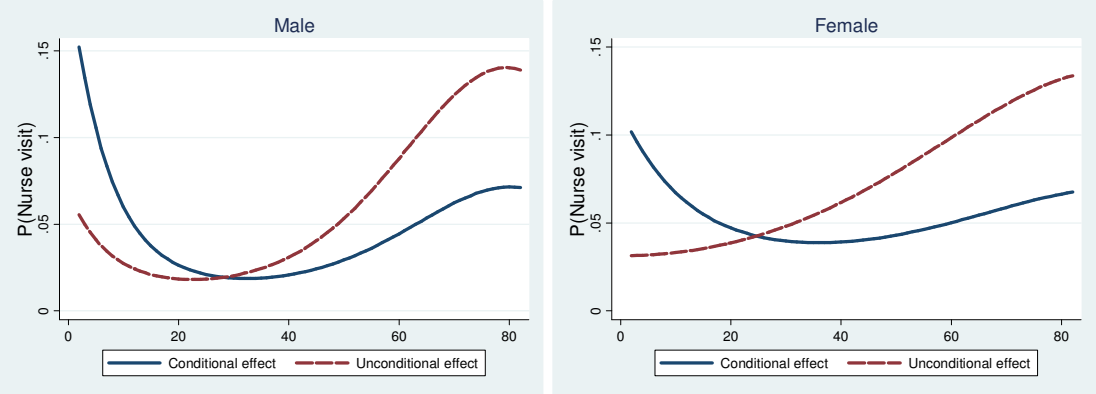

Figure 2. Age effect on GP service utilisation by gender

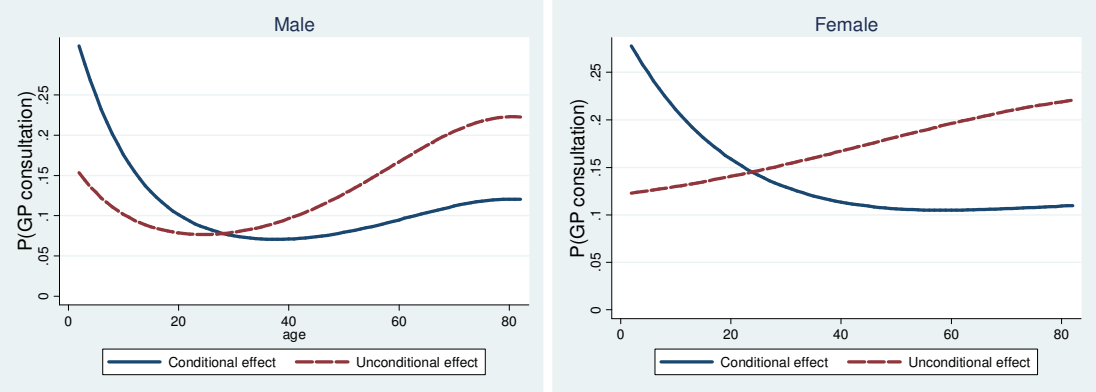

Table 3. Instrumental variable regression

	Coef.	z	AME
Impact of GP consultation on practice nurse visit			
GP	-0.063	-0.57	-0.0064
ρ	0.352		
Wald test ρ=0	$\chi2 = 27.77$	$p < 0.0001$	
Impact of the instrument on GP consultation			
	0.395	11.22	
F-test instrument = 0	F = 136.14	$p < 0.0001$	