Socioeconomic inequalities in the use of English public hospitals

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Abstract

Healthcare inequalities are a major issue in many developed countries. In this paper, we use a novel linked dataset to study variation in the use of public hospital care among the older population in England. Linking a detailed panel of survey data to administrative hospital records, we examine the extent to which healthcare utilisation varies across income and education groups, and whether this variation persists after controlling for detailed measures of observable medical needs. We find evidence of inequalities in the utilisation of outpatient hospital care with respect to both income and education. Conditional on observable need, individuals in the top income quintile use more than 20% more outpatient care than individuals in the bottom quintile. A similar relationship is also found between low and high education groups. Higher socioeconomic groups attend a greater number of both initial and follow-up outpatient appointments than do those with lower levels of income and education, with a greater number of referrals from both General Practitioners and hospital doctors. These differences are not explained by differential rates of cancellation or take-up of care post-referral. This has important policy implications given the explicit objective of the UK government to reduce health inequalities.

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1 Introduction

Inequalities in the use of healthcare are a major policy issue in many developed countries. Large variation in the quality and quantity of care across regions (e.g. Finkelstein et al., 2016; Skinner, 2011), providers (Doyle et al., 2017) and people with different characteristics (McClellan and Skinner, 2006; Cookson et al., 2016) has been documented across a number of countries in recent years. Understanding the extent of this variation, and designing ways to address these, is therefore high on the policymaking agenda.

This paper examines variation in the use of public hospital care among the population aged 65 years and older in England. We exploit a novel data linkage between a detailed panel of survey data on the socio-demographic characteristics of patients and 15 years of administrative public hospital records to study how the use of hospital care varies by income and education, and whether this variation persists after controlling for detailed measures of observable medical needs.

Existing work has noted a positive income and education gradient in the use of hospital care, both in England (Morris et al., 2005; Allin et al., 2011; Cookson et al., 2016) and in other universal healthcare systems (van Doorslaer et al., 1999; van Dooerslaer et al., 2004; van Doorslaer and Masseria, 2004; Watanabe and Hashimoto, 2012; Devaux, 2015; Terraneo, 2015). However, this work has been limited by data quality and scope, often relying on basic measures of self-reported hospital use that may suffer from a number of limitations. We contribute to this literature by using much more detailed data, which enables us to better track the use of different hospital services and to control for much more granular measures of medical need.

We find evidence of strong positive relationships between income and the use of public outpatient (or specialist) hospital care. For example, individuals within the top income quintile have 0.55 more outpatient visits each year than those in the bottom quintile after controlling for observable medical need. This is a difference of more than 20% of the mean number of visits among this age group. A similar relationship is also found for education. Conditional on need, richer and more educated individuals have a greater number of both initial and follow-up visits, and a greater number of referrals from both General Practitioners and hospital doctors, than do those with lower levels of income and education. These differences cannot be explained by differential rates of cancellation or take-up across groups. We find weaker evidence that poorer individuals consume less elective (non-emergency) inpatient care, while richer individuals consume more emergency inpatient care, including via admissions from the emergency department. In contrast, we find no significant effect of education on utilisation of inpatient care or the emergency department. These results are robust to a number of alternative specifications.

Our results provide evidence on the degree to which use of hospital care varies across dimensions other than clinical need. This has important policy implications, not least because many health care systems (including the English National Health Service) have explicit objectives relating to the promotion of equity and the reduction of health inequalities. Variation in use of health care between socio-economic groups is also likely to be of particular concern given recent evidence documenting widening life expectancy inequalities in England (Bennett et al., 2018) and elsewhere (Case and Deaton, 2015).

The rest of the paper is organised as follows. Section 2 sets out the institutional background and a framework for why hospital utilisation may vary across socio-economic characteristics. Section 3 describes the data. Section 4 sets out our empirical strategy and Section 5 presents the results. We then discuss these results in Section 6.

2 Institutional background

2.1 Public hospital care in England

Our analysis focuses on use of public hospitals among the elderly population in England. The majority of health care in England is funded by the government and provided by the National Health Service (NHS). Secondary (or acute) care, the focus of this study, is typically provided free at the point of use by large, publicly owned hospitals. There are three broad types of secondary care: Emergency Department (ED), Outpatient and Inpatient services.[1]

Patients typically access inpatient services via the ED or an outpatient appointment. Emergency care is initially provided through the ED attached to a hospital. This care is not pre-planned: patients arrive when required, either by ambulance or other means. Upon arrival, patients are triaged and after undergoing basic treatment and preliminary investigations, are either discharged home, or admitted to hospital for further treatment.

Outpatient care is provided to patients at hospitals with admitting patients. This includes consultations with senior hospital doctors (known as consultants), diagnostic tests, and some basic treatments including physiotherapy. These appointments are often used by consultants to decide whether patients require further care within the inpatient department in the hospital. Outpatient visits can occur both prior to inpatient treatment (to decide whether such treatment is necessary) and other treatment (to follow up with patients and continue recovery). Outpatient appointments typically require an initial referral from another member of medical staff. In around 85% of cases, this comes from a General Practitioner (GP), who acts as a gatekeeper for the hospital system, or a hospital consultant (in roughly equal proportions).[2] A referral from a hospital consultant can follow an emergency inpatient admission, an ED attendance, a domiciliary visit or another planned hospital episode (for example, to check on the progress of patients after planned surgery).

Inpatient care is provided to patients who are admitted to hospital. This care is often more extensive and expensive than care provided in other hospital settings (for example, many patients undergo more invasive testing or operations as an inpatient). An inpatient admission can be an unplanned emergency admission - often following presentation at the ED - or a pre-planned elective (non-emergency) stay. In both cases, hospital stays may range from a single day to a period of months. Elective care is rationed by waiting times and typically requires an initial referral from a family doctor (General Practitioner, or GP) and a decision to admit by a hospital consultant following an outpatient visit.

[1] EDs in the UK are usually referred to as Accident & Emergency (A&E) departments.

[2] Patients can also be referred from alternative sources, including from a general dental practitioner, optometrist, prosthetist or national screening programme.

2.2 Healthcare inequalities

England provides an interesting context in which to study inequalities in the utilisation of health care services. The healthcare system is universal: the NHS provides the majority of services free at the point of use to all, regardless of ability to pay. The ultimate aim is to provide care to all solely according to clinical need. In this respect, it is similar to healthcare systems in many other wealthy countries. However, while many countries have objectives relating to equity in access and delivery of care, the English NHS is unusual in having a legal duty to reduce inequalities in healthcare outcomes and inequalities in individuals' ability to access care (Cookson et al., 2016; Department of Health, 2012).

Previous work has found that by international standards, the distribution of healthcare in the UK is relatively equitable (Van Doorslaer and Masseria, 2004; Davis et al., 2014; Devaux, 2015). Nonetheless, various studies have found some evidence of inequalities in utilisation of healthcare, particularly for specialist and preventative care provided by hospitals (Morris et al., 2005; Dixon et. al., 2007; Allin et al., 2011). Such inequalities could arise for a number of reasons, as we set out below.

First, there may be differential access to care across groups. This could be due to geographical differences in the supply of hospital care, with populations with particular characteristics located in areas with better or worse supply. Policies that reduce variation in the supply of care across regions would be required to address this problem.

Second, physicians may interact with certain groups differently. This could lead to differences in referral and treatment patterns. This could occur because doctors are more willing to listen to the complaints of particular groups (and more dismissive of others), or because those groups find it easier to engage with medical professionals about their condition and treatment. More generally, better educated patients may find it easier to navigate the system, and so may be both more likely to seek an initial referral and also attend subsequent appointments. Policy prescriptions to address these channels would be quite different, but identifying which channels are quantitatively important are challenging.

Finally, tastes and preferences for hospital care may vary across socio-economic groups. Differences in use may therefore simply reflect differences in the demand for care (even for the same levels of objective 'need'), rather than systematic differences in access to care. In this case, variation in use of hospitals should not be interpreted as evidence of inequity. However, policymakers may still be concerned if different groups have very different expectations of good health.

3 Data

3.1 Data sources

Our analysis is based on a new linked dataset, combining seven waves (2002-03 to 2014-15) of the English Longitudinal Study of Ageing (ELSA) with the census of public hospital records in England, the Hospital Episode Statistics (HES). These data provide detailed information on the demographic, economic and health characteristics of patients, alongside a complete picture of their hospital use over a 15 year period. This is a major advance on previously available data, which typically contained far less detail on individuals' circumstances and cruder self-reported measures of healthcare utilisation.

3.1.1 English Longitudinal Study of Ageing

ELSA is a panel survey of a representative sample of the English household population aged 50 and above. The survey is administered every two years, and follows the same individuals over time. Respondents are interviewed on a range of core topics including demographic and economic characteristics, their health and wellbeing, and household and family structure. We use the first seven waves of the survey, collected between 2002-03 and 2014-15.[3]

All participants have a face-to-face interview, which consists of a self-completion questionnaire and a computer-assisted interview with a trained interviewer. In the second, fourth and sixth survey the core interview was supplemented with an assessment by a trained nurse, where a number of objective measures of health were recorded. ELSA data are also linked to the Office for National Statistics database of death registrations to track mortality among survey participants.

Collected demographic information includes age, sex, whether the participant was in a couple and whether they were in paid work. A range of health measures are collected as part of the survey. This includes self-reported information on a number of dimensions of health, including self-reported general health, presence of a limiting and/or longstanding illness, and difficulties with mobility and activities of daily living. Self-reported general health is reported on a five-point scale, but some waves use the US (Health and Retirement Study, HRS) version of the scale (excellent, very good, good, fair and poor) and others the European (SHARE) version (very good, good, fair, bad and very bad). In order to provide a consistent measure over all waves, we recode self-reported health on a three-point scale. If the question was asked using the US scale, we group those who reported "excellent" or "very good" health; those who reported "good" health are placed in a second band; and we group those who reported "fair" or "poor" health into a third band. In wave 3, where the US question was not asked, we impute a comparable measure as follows: those reporting "very good" health are placed in the first band, those reporting "good" health are placed in the second, and those reporting "fair", "bad" or "very bad" health in the third. This self-reported information is collected in every interview, in addition to information on whether individuals are in receipt of formal or informal care and whether they have private health insurance coverage. This is supplemented with more objective measures of health collected as part of the nurse assessment in the even survey waves (wave 2, 4 and 6). These include body mass index (BMI), lung capacity, blood pressure and hand grip strength.

ELSA also includes a rich set of economic characteristics, including equivalised household income and educational achievement. Ideally we would like to observe lifetime resources, but this is unobserved. As a result, we proxy lifetime income by constructing age and survey wave-specific income quintiles. We do this by assigning each observation (respondent-survey wave combination) to a quintile based on their equivalised household income and that of other survey

[3] Survey collections took place in 2002-03, 2004-05, 2006-07, 2008-09, 2010-11, 2012-13 and 2014-15.

respondents in the same wave in the same 5-year age band.[4] Education is classified as low (no formal qualifications), middle (completed compulsory education) or high (at least some higher education).

3.1.2 Hospital Episode Statistics

HES contains the census of visits to publicly funded hospitals in England.[5] Using a pseudonymised unique identifier, we are able to link ELSA survey data to administrative hospital records. These records include all inpatient (admitted) and outpatient care, and emergency department (ED) visits[6], for different periods of time (as set out below).[7]

The inpatient records cover all inpatient admissions between April 1997 and March 2017 (covering all survey waves), and include admission and discharge dates, diagnosis codes and details on the procedures undergone by the patient. The data include admission method, which we use to categorise inpatient treatment into emergency and non-emergency (elective) spells.

The outpatient data are available between April 2003 and March 2017 (survey waves 2 to 7), and contain similar information on date, diagnosis and procedure codes, along with the referral source. This means we can distinguish between patients whose appointment is the result of referral from their family doctor (General Practitioner, or GP) and those who were referred (for example) from elsewhere in the hospital. The data contain information on whether the patient is making a first or follow-up attendance, and whether the patient attended the outpatient appointment in question.[8]

The ED data are available from April 2007 to March 2017 (survey waves 4 to 7) and are recorded at the visit level. These include the date of arrival, whether the patient arrived by ambulance, whether the patient was admitted for further treatment, and a broad diagnosis code.

3.2 Sample construction

The analysis is conducted at the interview (respondent-survey wave) level, with each survey respondent treated as a single observation. All results are clustered at the individual level.

Our analysis sample contains only ELSA respondents who gave their consent to have their survey responses linked to administrative hospital data. 80% of individuals (14,777 of 18,489) gave consent. These individuals account for 85% of observations (62,034 of 72,893) and do not appear to differ along any important dimension from the overall ELSA sample (which in turn is representative of the overall English household population).

Our analysis focuses on ELSA sample members aged 65 and over, due to low sample sizes at younger ages. This is a population of particular interest given that older individuals typically

[4] All those aged 85 and above are grouped into one age band.

[5] This includes care in public hospitals, and publicly funded care in private hospitals.

[6] EDs in England are commonly known as Accident and Emergency, or A&E, departments.

[7] HES started to record inpatient treatment from April 1997, outpatient treatment from April 2003, and ED treatment from April 2008.

[8] If the patient did not attend, this is not counted towards our measure of hospital use over the year. We are also able to observe the reason for lack of attendance (e.g. whether the patient or hospital cancelled in advance, or whether the patient simply failed to show up).

use more, and more expensive care, than younger individuals[9], and that the number of people aged 65 and over is projected by more than 4 million over the next 15 years alone (ONS, 2016).

We further restrict our sample to include only those with full income and wealth information available in ELSA. This excludes a small number of institutional respondents and those for whom income or wealth data could not be imputed (579 observations in total). We also drop 9 observations for whom no information on limitations with mobility is provided. This leaves us with a final sample of 8,381 unique individuals and 29,269 observations across seven survey waves. As discussed above, outpatient data is unavailable for wave 1, and ED data is unavailable for waves 1 to 3. The sample size in those cases is reduced to 24,912 and 17,275 observations, respectively.

For each observation, we then construct a range of measures of hospital use. In particular, we construct a binary indicator and count of A&E visits, A&E admissions, inpatient stays (split by emergency and elective), and outpatient visits (split by GP and hospital referrals, and by first and follow-up attendances) in the 365 days prior to and after the interview date.[10]

3.3 Summary statistics

Table 1 reports summary statistics for health and demographic characteristics by wave- and age-specific income quintile. Richer individuals are, on average, more likely to be male, in a couple and in paid work. They are generally healthier - in that they are more likely to report being in very good health, and less likely to report being in poor health or having a longstanding or limiting illness. They also report having fewer difficulties with mobility, on average. Unsurprisingly, higher income individuals are far more likely to be covered by private health insurance: 22.3% of those in the top quintile are covered, versus just 4.3% in the bottom quintile, and 9.8% across the whole sample.

Table 2 presents the same summary statistics by education level, where we observe similar patterns across socioeconomic groups. For instance, 42% of highly educated individuals report being in very good health, compared to 25% of those in the low education group. 34% of those with high education report having a longstanding and limiting illness; the equivalent figure for those with low education is 47%.

These descriptive statistics reflect a well-known fact: people from lower socio-economic groups are, on average, sicker. They therefore have greater need for healthcare. We now turn to the raw distribution of hospital utilisation across these groups. Table 3 illustrates how utilisation of different types of hospital care vary across income groups. Panel A shows that ED visits and subsequent admissions through this route are relatively rare and decline slightly with income. Those in the lowest income quintile made 0.28 ED visits in the previous year, compared to 0.24 for those in the top quintile.

Inpatient hospital stays are more common, as shown in Panel B. Individuals had on average 0.5 admissions to hospital in the past year, of which around two-thirds were emergency admissions. Utilisation is slightly higher amongst those in the middle of the income distribu-

[9] For instance, average hospital spending for an 89 year old man is around three times higher than the average spending for a 70 year old and almost nine times more than a 50 year old (Kelly et. al., 2016).

[10] In Section 5 we test whether our results are robust to different ways of assigning hospital visits to survey information, and find little impact of changing this definition.

tion than those at the bottom or top. By far the most commonly used type of hospital care is outpatient treatment (Panel C). The average for the whole sample is 2.45 outpatient visits per year. Around 86% of these visits are the result of a referral from a GP or hospital doctor, with the average patient having just over one of each type of referral per year.[11] There is a clearer variation across income groups in utilisation of outpatient hospital services, driven almost entirely by the number of hospital referrals. Those in the bottom income quintile had 2.28 outpatient visits on average in the previous year, compared to 2.55 and 2.39 for the middle and top quintiles, respectively. In addition, while the number of first attendances for outpatient care is broadly flat across the income distribution, low income individuals have fewer follow-up attendances than do those in higher income groups. So even before controlling for any health or demographic characteristics, utilisation of outpatient care is lowest amongst the poorest individuals, and highest amongst those in the middle of the distribution. Relative use of different hospital services by income is illustrated in Figure 1.

We can also compare hospital utilisation rates across different education groups (Table 4 and Figure 2, below). Highly educated individuals make fewer visits to A&E (and have fewer admissions via A&E) and have fewer inpatient hospital spells (driven primarily by elective admissions). They have slightly fewer total outpatient visits than those with low or mid-level education. Interestingly, within that total, highly educated individuals in our sample have the greatest number of hospital referrals for outpatient care and considerably fewer GP referrals. Utilisation of all types of outpatient care is greatest for those in the middle of the education distribution.

4 Empirical Strategy

We now turn to investigating the existence and extent of income and education-related inequalities in the use of hospital care. That is, after controlling for individuals' health and demographic characteristics, do we still observe systematic variation in how much different socio-economic groups use public hospital services?

For ease of exposition and discussion, we present our main set of results using OLS. As noted in Cookson et. al. (2016), much of the health economics literature reports only odds ratios and concentration indices, which can be misleading and impede comparison between different studies. Presentation of OLS coefficients therefore allows for an easier interpretation.

However, given that hospital utilisation have a very skewed distribution - the number of visits is limited to non-negative values, there are lots of zeroes and small numbers, and very few big numbers - OLS may not be the most appropriate model for the data. We therefore repeat the analysis using a zero-inflated negative binominal regresion model as a robustness test. These results are reported in Section 5.3.

4.1 Baseline strategy

We estimate the following baseline specification:

[11] As noted in section 3, these two referral sources do not account for the entirety of outpatient visits because individuals can also be referred by, for example, a dentist, optometrist, prosthetist, specialised nurse or national screening programme.

$$y_{it} = \beta M_{it} + \delta D_{it} + \mu H_{it} + \gamma_t + \epsilon_{it} \quad (1)$$

where y_{it} is a measure of hospital use by individual i in the 365 days prior to the interview in survey wave t.[12] M_{it} represents the age- and wave-specific equivalised income quintile of individual i in wave t, which we treat as a proxy for lifetime financial resources. D_{it} and H_{it} represent a rich set of demographic and self-reported health characteristics, respectively. γ_t is a survey wave dummy to capture the national time trend in hospital use; ϵ_{it} is an error term. We also repeat the analysis replacing income with education level (low, middle and high).

β is the object of interest and represents the relationship between equivalised income quintile and hospital use, after controlling for medical needs and other personal characteristics. Interpreting this as a causal impact of income on hospital use relies on the identifying assumption that, conditional on the other covariates, income (or education in the alternative specification) is unrelated to the error term.

This assumption would be violated if unobserved dimensions of need for hospital care are related to income or education groups, and would bias our estimates of $\hat{\beta}$. We might also worry about systematic bias in the self-reporting of health measures. If, for instance, poorer people under-state their true level of sickness, or under-report having been diagnosed with particular conditions, our set of controls will not fully capture the morbidity of those individuals. To address this concern we control for a range of subjective measures of health, and in Section 5.3, we conduct a number of robustness checks where we include a rich set of objective health measures collected as part of the nurse assessment.[13]

However, some unobservable differences may remain between income and education groups. To the extent that we would expect individuals in higher income or education groups to be unobservably healthier (e.g. they could make unobserved investments in their health which reduce the requirement for hospital care or undertake less poor health behaviours) then this would bias our estimates of $\hat{\beta}$ downwards (i.e. we would underestimate the true income or education gradient in hospital use). This would mean that our estimates of the impact of income and education on hospital use should be treated as a lower bound.

It is also important to highlight that these estimates capture the relationship between income (or education) and *use* of hospital care. As discussed in Section 2.2, any differences in use could occur through a number of channels, including systematic differences in access to care, tastes or preferences for medical care, and the ability to engage with treatment. Understanding the mechanisms that drive these results will be important for policymakers in future as different channels would require different policy reforms to target. For example, differences in access to care might require changes to the supply side, while differences in tastes or preferences might be addressed through increased public health awareness or education.

[12] Results are robust to defining hospital use over the 365 days after the interview. We discuss this in more detail in Section 5.3.

[13] This includes measures such as blood pressure and BMI. Note that we do not include these in our baseline results as their inclusion reduces the sample size by half, as these measures are only collected in survey waves 2, 4 and 6.

5 Results

We first study the relationship between income and hospital use at a relatively high level, considering the number of outpatient, inpatient and ED visits, before examining how this relationship varies between different types of visit. We then perform similar analysis to examine the relationship between education and hospital use, before testing the robustness of our results to the inclusion of objective health measures and alternative empirical approaches.

5.1 How does hospital use vary by income?

Table 5 shows the estimated impact of income, demographic and self-reported health characteristics on annual utilisation of different types of hospital care. In all specifications, the dependent variable is regressed upon the set of variables shown and survey wave dummies.

The results in column one indicates a positive income gradient in use of outpatient hospital care. Conditional on health and demographic characteristics, those in the bottom income quintile had 0.26 fewer visits than those in the third (middle) quintile, while in the top quintile had 0.29 additional visits. The richest individuals, therefore, have around 0.55 extra visits per year than the poorest, conditional on need. This difference is sizeable, equivalent to 22.4% of a mean of 2.45 annual visits for the whole sample.

Column two repeats the analysis for the number of inpatient stays in the past year. The results again indicate that a positive relationship between income and hospital use. Those in the top income group have 0.061 additional inpatient stays to those in the middle of the distribution. However, those at the bottom of the income distribution do not differ significantly from those in the middle. Differences in the use of inpatient care therefore appear to be driven by greater use by those at the very top of the income distribution.

The third column in Table 5 shows the results for the number of visits to the ED. The coefficients on all income quintiles are close to and not statistically significant different from zero, suggesting no relationship between income group and the use of care in the emergency department.

In all columns, the relationships between the outcomes and the control variables are as expected. Older and sicker patients - as captured by various measures including self-reported health, difficulties with activities and proximity to death - use more care.[14] Private health insurance is associated with lower use of both outpatient and inpatient care, presumably at least in part because these individuals may alternatively use private hospital care. This contrasts to ED care, where there is no private market, and there are no statistically significant differences in use.

The detailed data available within HES allow us to further distinguish between different types of hospital visit within these high-level categories. All subsequent analysis is conducted with the same set of demographic and health controls as in Table 5.

In Tables 6 and 7 we further examine the income gradient in outpatient use. First, we examine whether this relationship varies by referral source. Outpatient referrals are typically

[14]This is consistent with recent work that shows hospital spending increases rapidly immediately before death (Howdon and Rice, 2018).

made either by a GP or another hospital doctor. Table 6 therefore sets out results separately for outpatient appointments arising from these two channels. Column one presents the same results as in Table 5 for comparison. Column two and column three show results for GP and hospital referrals respectively. For GP referrals, there is no statistically significant difference between those at the bottom and those in the middle, but those in the top fifth of the income distribution have significantly more GP referrals: the richest individuals have 0.158 more GP-referred outpatient visits per year than those in the third quintile, conditional on need. Looking instead at referrals from other hospital doctors, those in the top quintile do not differ significantly from those in the middle. But there is still evidence of a positive income gradient at the bottom: those in the lowest income quintile have 0.32 fewer hospital referred visits than do those in the middle of the distribution.

These results suggest that differences in GP referrals drive the differences in the use of outpatient care at the top of the income distribution, while hospital referrals drive the differences at the bottom. One explanation for this could be that richer individuals are more likely to have an initial referral, while poorer individuals use less outpatient care even after they have already engaged with the hospital system (for example, after being treated for a condition they may have fewer follow up appointments).

We examine this directly by separately analysing the take-up of initial ('first') and subsequent ('follow-up') appointments. The results are shown in Table 7. Column one shows the results for all first outpatient attendances. Columns two and three then separate these for GP and hospital referrals. These results show that those at the top of the income distribution have more first attendances than those elsewhere in the distribution. However, there are no statistically significant differences between the middle and the bottom of the distribution. This is true for both GP and hospital referrals. In column four, we shows the income gradient in follow-up appointments. By contrast, there are significant differences across the income gradient, with those in the bottom quintile attending 0.24 fewer follow-up appointments than those in the middle of the distribution, and those in the top quintile attending 0.2 more.

This suggests that conditional on need for care, the richest individuals are both better at getting into the hospital system (have a greater number of initial referrals) and are better at staying there once in (have more follow-up care), while those at the bottom of the distribution do not make as many follow-up visits. We find no significant relationship between income and number of unattended appointments (whether cancelled by the hospital, cancelled by the patient, or missed with no advance warning). This suggests that the effects are not being driven by differential take-up of available outpatient care post-referral.

The results presented in Table 5 indicate a degree of income-related inequality in use of inpatient hospital care, limited to those at the very top of the distribution. We now split this by emergency and elective care. Emergency admissions account for around three-fifths of inpatient spells in hospital amongst our sample. We might expect any inequalities in access or use of emergency services to be more limited, by nature of the unplanned and acute nature of these episodes. Previous studies have struggled to disentangle the relationship between income and use of emergency and elective care; our data allow us to do just that. Our analysis provides weak evidence that the poorest quintile have fewer elective visits, while the richest have more emergency admissions (Table 8). These results are statistically significant at the 10% level. The fact that those with low income receive less elective care (conditional on need) is consistent with them being less successful at obtaining referrals from other parts of the healthcare system.

As well as the number of visits to the Emergency Department (ED) in the past year, we are also able to analyse the number of admissions to hospital via the ED (Table 9). There is little evidence of income-related inequality at the lower end of the income distribution, but our analysis suggests that richer individuals have a greater number of admissions to hospital via this route than lower income individuals. This could again be consistent with individuals from higher socio-economic groups being better at convincing doctors of their need for further treatment, and is consistent with our findings on emergency inpatient care shown in Table 8.

In summary, we have provided strong evidence of a positive relationship between income and the utilisation of outpatient hospital services. The richest 20% of individuals have more referrals for initial outpatient care from both GPs and hospital doctors, and also receive more follow-up care, than others elsewhere in the income distribution. The bottom income quintile also use less specialist care than those in the middle of the distribution. There is some (weaker) evidence that those with the lowest income also consume less elective inpatient hospital care. There is no evidence of inequality in the number of visits to the ED between income groups, but richer individuals have a greater number of admissions via the ED.

5.2 How does hospital use vary by education?

As well as considering inequalities along the dimension of income, we also examine whether hospital utilisation differs across individuals of different education levels. Education is likely to be strongly related to lifetime resources and socio-economic background; we therefore might expect the results to look relatively similar to income.

We find strong evidence of a pro-education gradient in the use of outpatient hospital care. The first column of Table 10 shows that highly educated individuals have 0.48 extra visits per year relative to those with no formal qualifications, after controlling for observable need. This is equivalent to 19.6% of the sample mean. Those of mid-level education also consume significantly more outpatient hospital care than those with low-level education.

Table 10 also shows no evidence of education-related inequalities in utilisation of inpatient hospital services. This is true for both emergency and elective admissions. Our results also indicate that, if anything, those with the most education make fewer visits to A&E, conditional on need.

As with income, we now try to decompose the impact on outpatient visits by referral source (Table 11). We find evidence that the low education group have fewer GP referrals for outpatient care from their GP, with the gap between the low and middle-education group particularly marked. The number of hospital referrals for outpatient care is strongly increasing in education. In further analysis not included here, we also find that a higher level of education is strongly associated with greater use of both initial and follow-up outpatient care. Highly educated individuals are in fact more likely to have cancelled an outpatient appointment, again suggesting that differential take-up between groups is not a convincing explanation.

Our analysis provides strong evidence of education-related inequalities in use of outpatient care (for referrals from both GPs and hospital doctors, and in both initial and follow-up care), but no evidence of inequality in the use of inpatient or A&E services. We now consider the robustness of these findings to the inclusion of objective health measures, alternative measures of hospital use, and an alternative empirical strategy.

5.3 Robustness checks

One concern with our approach is that by looking at use of hospital in the past year, conditional on self-reported health, we risk picking up some reverse causality. That is, individuals report being in better health *because* they obtained more medical treatment in hospital in the last year. We therefore perform the same analysis, with the dependent variable instead being use of hospital care in the year *following* interview (rather than the year preceding interview). Tables 12 and 13 show that our results for use of outpatient hospital care are strongly robust to this change: there remains a strong pro-rich and pro-education gradient in use, after controlling for need.

Our analysis so far has used self-reported measures of health to control for individuals' need for medical care, in line with much of the existing literature. General self-reported health has been shown to have a strong association with mortality and healthcare utilisation (DeSalvo et al., 2005), and we supplement this with other self-reported health complaints. But self-reported measures alone may not be able to fully capture the extent of an individual's morbidity, and we might worry about differential reporting across individuals from different backgrounds (Dowd and Todd, 2011; Sen, 2002). We now make use of the objective health measures included in waves 2, 4 and 6 of ELSA, when the core interview was supplemented by a nurse interview. This limits the sample size as these tests were not carried out in every wave, and not all medical assessments were successfully performed every respondent. We repeat our analysis, testing first whether our previous results change when using this smaller sample, and then whether the results are robust to the inclusion of blood pressure, lung capacity, BMI and hand grip strength as control variables.

Table 14 shows the results of this exercise when considering the relationship between income and the use of outpatient care. With the smaller sample (8,305 vs 24,912) there is no evidence of income-related differences in the total number of outpatient visits. But columns 5 and 6 show that there remains evidence that the very poorest individuals have fewer hospital-referred outpatient visits, and that this result is robust to the inclusion of objective health measures. The inclusion of BMI, blood pressure, grip strength and lung capacity does not alter the coefficients on income quintile in any meaningful way: we interpret this as evidence that our included self-reported health measures are effectively capturing individuals' need for medical care. Table 15 shows that our results for education are similarly robust: there remains a strong education gradient in the use of outpatient care, driven by hospital referrals, both when using our smaller sample and after controlling for objective health measures.

As discussed in section 4, healthcare utilisation data have a very skewed distribution. The number of visits is limited to non-negative values, and there are lots of small numbers and very few large numbers. The variance of the number of hospital visits within each income/education group is greater than the mean, which indicates over-dispersion. And many individuals don't make any visits to hospital at all in a given year - either because they did not require treatment or because they failed to access care. Given the presence of excessive zeros and over-dispersion, we test the robustness of our results in section 5 to the use of a zero-inflated negative binomial regression model. Under this approach, a logit model is used to predict excess zeroes, and a negative binomial model is used to model the count process.

Table 16 shows the results when examining the relationship between education and outpatient care. The coefficient on high education represents the expected difference in the log number of outpatient visits between high and low education individuals, holding other variables constant. This can also be interpreted as the log of the ratio of expected number of visits. The results show that those with high education had around 18% more outpatient visits than those with low education.[15] Similarly, mid-education individuals made approximately 8% more outpatient visits.

We also show in Table 16 the results for education after splitting by source of referral. There is weak evidence that mid-educated people have a greater number of GP referrals, conditional on need, but the effects are strongest for hospital referrals. Being highly educated is associated with an increase in the log of expected hospital referrals of 0.25 relative to the low educated. Equivalently, after controlling for need, the highly educated attended 28% more appointments following referral from hospital doctors than do those with no formal qualifications.[16] This is consistent with the findings of our analysis in section 5.2. Similar analysis reveals a strong pro-education gradient in the number of both first attendances and follow-up visits, and no significant relationship between education and utilisation of inpatient care or the emergency department.

Our results in section 5.1 are also robust to a zero-inflated negative binomial regression model: high (low) income individuals receive more (less) outpatient care than those in the middle of the distribution. This is true of both first attendances and subsequent follow-up care.

6 Conclusion

Reducing inequalities in access to and the use of healthcare is a major objective for healthcare systems in many developed countries. In this paper, we exploit a unique linked dataset in England to document the extent to which utilisation of hospital care varies across income and education groups, after controlling for detailed measures of observable medical needs.

We find evidence of differences in the utilisation of outpatient hospital care with respect to both income and education. Richer and more educated individuals attend a greater number of initial appointments following a referral from both General Practitioners and hospital doctors, and receive more follow-up care following that first attendance. These differences are not explained by variation in the number of cancellations or missed appointments. These findings build on previous work showing pro-rich inequality in the utilisation of outpatient and specialist care (van Doorslaer et al., 2004; Morris et al., 2005; Allin et al., 2011). There is some evidence of additional use of emergency inpatient care by people in the top quintile of the income distribution. This is driven in part by increased admissions via the emergency department. Those in

[15] The log ratio of expected visits is 0.162, so the incidence-rate ratio $\approx \exp(0.162) \approx 1.18$.

[16] Incidence-rate ratio $\approx \exp(0.25) \approx 1.28$.

the lowest income quintile also use less elective inpatient care. In contrast, we find no significant relationship between education and use of inpatient hospital care or the emergency department. Our results are robust to alternative measures of hospital use, the inclusion of objective measures of health alongside self-reported measures, and alternative empirical specifications.

The availability of new data on both the characteristics of patients and their use of hospitals has allowed us to provide a detailed description of the patterns of hospital use across income and education. An important next step will be to explain why such patterns occur. Differences in tastes or preferences for care, access, and ability to engage with care could all play an important role in driving variation in the use of care. Understanding the importance of each channel is an essential next step in developing policy to address healthcare inequities.

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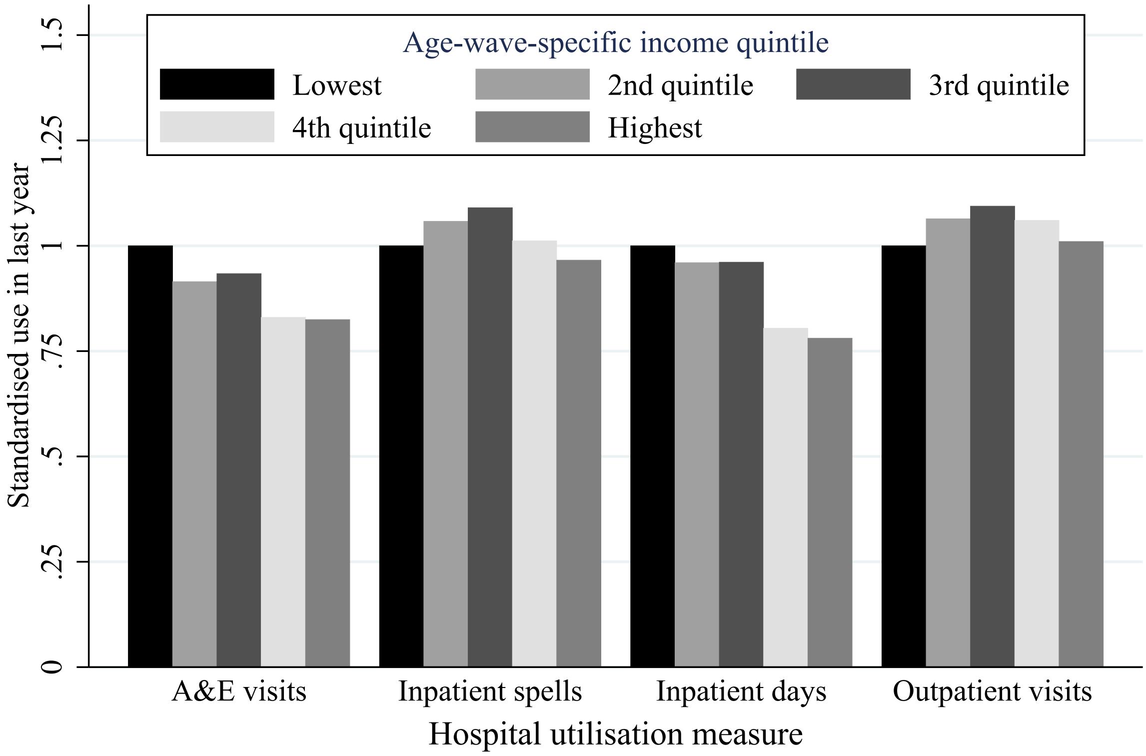
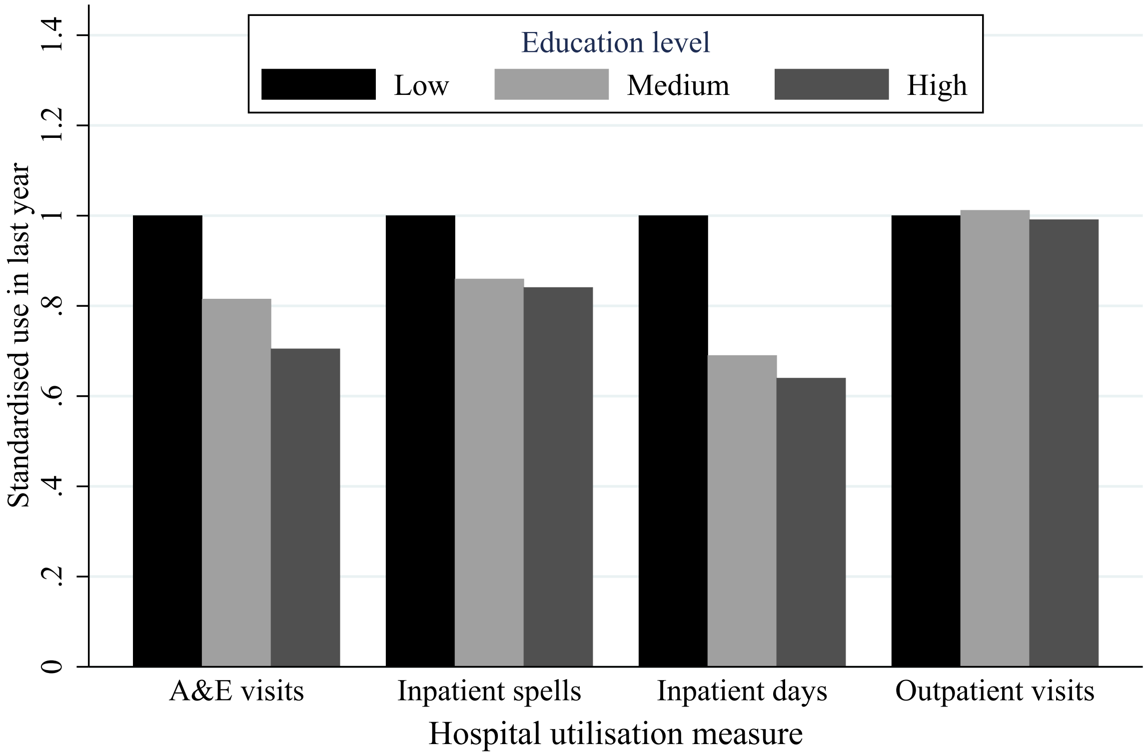
Figures and tables

Figure 1: Relative hospital use by income quintile



Note: all measures of hospital utilisation have been standardised relative to use amongst those in the lowest income quintile

Figure 2: Relative hospital use by education group



Note: all measures of hospital utilisation have been standardised relative to use amongst those in the lowest education group.

Table 1: Demographic and self-reported health characteristics by income

	Wave- and age-specific income quintile				
	Lowest	2nd	3rd	4th	Highest
Demographics					
Age†	74.19	74.06	74.11	74.04	73.97
	(6.57)	(6.43)	(6.52)	(6.50)	(6.62)
Female	0.69	0.58	0.52	0.49	0.43
	(0.46)	(0.49)	(0.50)	(0.50)	(0.50)
In a couple	0.19	0.53	0.69	0.80	0.88
	(0.39)	(0.50)	(0.46)	(0.40)	(0.32)
In paid work	0.03	0.05	0.07	0.12	0.16
	(0.17)	(0.21)	(0.25)	(0.32)	(0.37)
Health					
Percentage reporting:					
Very good health	0.28	0.28	0.28	0.35	0.41
	(0.45)	(0.45)	(0.45)	(0.48)	(0.49)
Good health	0.32	0.33	0.32	0.34	0.35
	(0.47)	(0.47	(0.47)	(0.47)	(0.48)
Poor health	0.40	0.39	0.40	0.32	0.24
	(0.49)	(0.49	(0.49)	(0.47)	(0.43)
Longstanding illness	0.62	0.63	0.64	0.62	0.58
	(0.49)	(0.48)	(0.48)	(0.49)	(0.49)
Limiting illness	0.43	0.44	0.45	0.41	0.35
	(0.50)	(0.50)	(0.50)	(0.49)	(0.48)
Difficulties with mobility:					
None	0.29	0.30	0.31	0.34	0.42
	(0.46)	(0.46)	(0.46)	(0.47)	(0.49)
One	0.15	0.16	0.16	0.17	0.18
	(0.35)	(0.37)	(0.36)	(0.38)	(0.38)
Two or three	0.23	0.22	0.20	0.20	0.20
	(0.42)	(0.41)	(0.40)	(0.40)	(0.40)
Four or more	0.33	0.33	0.34	0.29	0.20
	(0.47)	(0.47)	(0.47)	(0.45)	(0.40)
Formal social care receipt	0.06	0.07	0.06	0.05	0.05
	(0.24)	(0.25)	(0.24)	(0.23)	(0.22)
Informal social care receipt	0.21	0.24	0.26	0.22	0.17
	(0.41)	(0.42)	(0.44)	(0.42)	(0.38)
Private health insurance	0.04	0.05	0.07	0.10	0.22
	(0.20)	(0.21)	(0.25)	(0.30)	(0.41)
Death within two years	0.05	0.06	0.06	0.05	0.04
	(0.23)	(0.23)	(0.23)	(0.22)	(0.21)
N	5778	5860	5888	5912	5831

Sample-weighted mean values are shown for each quintile, with standard deviations displayed in parentheses.
† The sample is restricted to those aged 65 and above.

Table 2: Demographic and self-reported health characteristics by education

	Education level		
	Low	Mid	High
Demographics			
Age†	75.17	73.42	72.89
	(6.62)	(6.32)	(6.30)
Female	0.62	0.53	0.41
	(0.49)	(0.50)	(0.49)
In a couple	0.53	0.65	0.72
	(0.50)	(0.48)	(0.45)
In paid work	0.05	0.10	0.12
	(0.22)	(0.30)	(0.33)
Health			
Percentage reporting:			
Very good health	0.25	0.35	0.42
	(0.43)	(0.48)	(0.49)
Good health	0.31	0.34	0.36
	(0.46)	(0.47	(0.48)
Poor health	0.44	0.31	0.22
	(0.50)	(0.46	(0.41)
Longstanding illness	0.65	0.60	0.58
	(0.48)	(0.49)	(0.49)
Limiting illness	0.47	0.39	0.34
	(0.50)	(0.49)	(0.47)
Difficulties with mobility:			
None	0.26	0.35	0.44
	(0.44)	(0.48)	(0.50)
One	0.15	0.17	0.18
	(0.35)	(0.37)	(0.39)
Two or three	0.21	0.22	0.19
	(0.41)	(0.41)	(0.39)
Four or more	0.38	0.27	0.18
	(0.49)	(0.44)	(0.38)
Formal social care receipt	0.07	0.05	0.04
	(0.26)	(0.23)	(0.21)
Informal social care receipt	0.28	0.19	0.13
	(0.45)	(0.40)	(0.34)
Private health insurance	0.05	0.10	0.17
	(0.22)	(0.30)	(0.37)
Death within two years	0.07	0.04	0.04
	(0.25)	(0.21)	(0.19)
N	11538	10697	7034

Sample-weighted mean values are shown for each education group, with standard deviations displayed in parentheses.

† The sample is restricted to those aged 65 and above.

Table 3: Mean hospital visits by income quintile

	Wave- and age-specific income quintile				
	Lowest	2nd	3rd	4th	Highest
Panel A:					
A&E visits	0.28	0.27	0.26	0.24	0.24
	(0.79)	(0.84)	(0.69)	(0.82)	(0.71)
A&E admissions	0.12	0.13	0.11	0.09	0.09
	(0.52)	(0.54)	(0.40)	(0.44)	(0.43)
Panel B:					
Inpatient spells	0.48	0.51	0.53	0.49	0.46
	(1.70)	(1.73)	(1.63)	(1.69)	(1.56)
of which:					
Emergency	0.32	0.34	0.36	0.36	0.34
	(1.56)	(1.54)	(1.44)	(1.50)	(1.43)
Elective	0.16	0.17	0.17	0.14	0.13
	(0.59)	(0.60)	(0.55)	(0.54)	(0.49)
Panel C:					
Outpatient spells	2.28	2.49	2.55	2.52	2.39
	(4.20)	(4.42)	(4.19)	(4.07)	(4.27)
of which:					
Hospital referral	0.91	1.10	1.20	1.13	1.03
	(2.60)	(2.74)	(2.92)	(2.81)	(2.92)
GP referral	1.00	1.01	1.02	1.03	1.03
	(2.12)	(1.94)	(2.02)	(1.99)	(2.18)
Other	0.31	0.32	0.28	0.30	0.27
	(1.82)	(1.97)	(1.20)	(1.28)	(1.10)
First attendances	0.62	0.65	0.64	0.64	0.64
	(1.09)	(1.16)	(1.06)	(1.08)	(1.13)
Follow-up attendances	1.66	1.83	1.91	1.88	1.75
	(3.64)	(3.86)	(3.62)	(3.48)	(3.70)
N	3435	3466	3499	3494	3381

Sample-weighted mean values are shown for each quintile, with standard deviations displayed in parentheses.

Table 4: Mean hospital visits by education

	Education level		
	Low	Mid	High
Panel A:			
A&E visits	0.30	0.24	0.20
	(0.88)	(0.75)	(0.61)
A&E admissions	0.14	0.10	0.07
	(0.57)	(0.44)	(0.31)
Panel B:			
Inpatient spells	0.54	0.47	0.45
	(1.86)	(1.42)	(1.59)
of which:			
Emergency	0.36	0.33	0.34
	(1.69)	(1.24)	(1.46)
Elective	0.18	0.14	0.11
	(0.63)	(0.52)	(0.43)
Panel C:			
Outpatient spells	2.45	2.47	2.40
	(4.05)	(4.27)	(4.51)
of which:			
Hospital referral	1.06	1.07	1.11
	(2.62)	(2.73)	(3.23)
GP referral	1.02	1.06	0.95
	(2.03)	(2.09)	(2.00)
Other	0.29	0.30	0.29
	(1.52)	(1.62)	(1.36)
First attendances	0.63	0.65	0.63
	(1.08)	(1.12)	(1.11)
Follow-up attendances	1.81	1.82	1.77
	(3.52)	(3.65)	(3.95)
N	5777	6783	4715

Sample-weighted mean values are shown for each quintile, with standard deviations displayed in parentheses.

Table 5: Effect of income, self-reported health and demographics on number of hospital visits in last year

	Outpatient visits		Inpatient stays		ED visits	
	OLS (1)		OLS (2)		OLS (3)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Income quintile [a]						
Lowest	-0.262**	0.103	-0.047	0.035	-0.006	0.022
2nd	-0.062	0.091	-0.021	0.030	0.004	0.020
4th	0.165*	0.086	0.019	0.030	0.006	0.021
Highest	0.292***	0.100	0.061**	0.031	0.025	0.020
Age	0.412***	0.114	0.114***	0.039	0.001	0.027
Age^2	-0.003***	0.001	-0.001***	0.000	0.000	0.000
Female	2.400***	0.823	0.354	0.295	0.218	0.182
Female * age	-0.032***	0.011	-0.005	0.004	-0.003	0.003
In a couple	-0.094	0.093	-0.043	0.029	-0.050**	0.023
In paid work	-0.165*	0.097	-0.086***	0.028	0.021	0.015
Self-reported health [b]						
Good	-0.891***	0.084	-0.291***	0.030	-0.116***	0.017
Excellent/very good	-1.281***	0.087	-0.365***	0.030	-0.148***	0.017
Number of difficulties with mobility	0.163***	0.036	0.036***	0.012	0.029***	0.007
Female * difficulties with mobility	-0.105***	0.036	-0.031**	0.013	-0.020***	0.007
Formal care receipt	0.159	0.192	0.214***	0.068	0.139***	0.044
Informal care receipt	0.308***	0.118	0.119***	0.040	0.008	0.028
Longstanding illness	0.531***	0.067	0.068***	0.024	0.011	0.012
Limiting & longstanding illness	0.367***	0.089	0.061*	0.032	0.034*	0.019
Private health insurance	-0.318***	0.098	-0.124***	0.024	0.005	0.020
Death in two years after interview	1.165***	0.188	0.630***	0.103	0.293***	0.060
Wave dummy	Yes		Yes		Yes	
N	24912		29269		17275	
Adjusted R^2	0.096		0.043		0.051	

Note: Robust standard errors shown are clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.

[b] Baseline is those who reported fair or poor health.

Table 6: Effect of income on outpatient hospital use

	Outpatient visits in last year		
	All	GP referral	Hospital referral
	(1)	(2)	(3)
	OLS	OLS	OLS
Income quintile [a]			
Lowest	-0.262**	0.014	-0.321***
	(0.103)	(0.050)	(0.072)
2nd	-0.062	0.005	-0.114*
	(0.091)	(0.041)	(0.060)
4th	0.165*	0.075*	0.044
	(0.086)	(0.041)	(0.061)
Highest	0.292***	0.158***	0.084
	(0.100)	(0.049)	(0.073)
Wave dummy	Yes	Yes	Yes
Demographic variables [b]	Yes	Yes	Yes
Health variables [c]	Yes	Yes	Yes
Observations	24912	24912	24912
Adjusted R^2	0.096	0.052	0.058

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 7: Effect of income on use of initial and follow-up outpatient care

	Number of outpatient visits in last year			
	First attendances, by referral source:			
	All	GP	Hospital	Follow-up visits
	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	OLS
Income quintile [a]				
Lowest	-0.024	-0.005	-0.019	-0.235**
	(0.025)	(0.016)	(0.014)	(0.092)
2nd	0.012	0.005	0.001	-0.072
	(0.023)	(0.014)	(0.013)	(0.081)
4th	0.041*	0.018	0.015	0.126*
	(0.022)	(0.014)	(0.013)	(0.075)
Highest	0.093***	0.052***	0.029**	0.200**
	(0.024)	(0.016)	(0.013)	(0.089)
Wave dummy	Yes	Yes	Yes	Yes
Demographic variables [b]	Yes	Yes	Yes	Yes
Health variables [c]	Yes	Yes	Yes	Yes
Observations	24912	24912	24912	24912
Adjusted R^2	0.072	0.039	0.041	0.078

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 8: Effect of income on inpatient hospital use

	Inpatient spells in last year		
	All	Emergency	Elective
	(1)	(2)	(3)
	OLS	OLS	OLS
Income quintile [a]			
Lowest	-0.047	-0.024	-0.023*
	(0.035)	(0.031)	(0.013)
2nd	-0.021	-0.021	-0.000
	(0.030)	(0.027)	(0.011)
4th	0.019	0.022	-0.003
	(0.030)	(0.026)	(0.011)
Highest	0.061**	0.050*	0.012
	(0.031)	(0.028)	(0.011)
Wave dummy	Yes	Yes	Yes
Demographic variables [b]	Yes	Yes	Yes
Health variables [c]	Yes	Yes	Yes
Observations	29269	29269	29269
Adjusted R^2	0.043	0.019	0.071

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 9: Effect of income on use of ED services

	Emergency Department	
	Visits	Admissions
	(1)	(2)
	OLS	OLS
Income quintile [a]		
Lowest	-0.006	-0.003
	(0.022)	(0.014)
2nd	0.004	0.014
	(0.020)	(0.012)
4th	0.006	0.005
	(0.021)	(0.012)
Highest	0.025	0.023**
	(0.020)	(0.012)
Wave dummy	Yes	Yes
Demographic variables [b]	Yes	Yes
Health variables [c]	Yes	Yes
Observations	17275	17275
Adjusted R^2	0.051	0.066

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 10: Effect of education, self-reported health and demographics on number of hospital visits in last year

	Outpatient visits		Inpatient stays		ED visits	
	OLS (1)		OLS (2)		OLS (3)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Education level [a]						
Mid	0.300***	0.082	-0.005	0.028	-0.008	0.019
High	0.476***	0.100	0.033	0.033	-0.023	0.016
Age	0.425***	0.114	0.113***	0.039	-0.000	0.027
Age^2	-0.003***	0.001	-0.001***	0.000	0.000	0.000
Female	2.427***	0.829	0.374	0.298	0.225	0.181
Female * age	-0.032***	0.012	-0.006	0.004	-0.003	0.003
In a couple	0.071	0.079	-0.008	0.026	-0.040**	0.020
In paid work	-0.085	0.095	-0.068**	0.028	0.026*	0.015
Self-reported health [b]						
Good	-0.913***	0.084	-0.288***	0.030	-0.112***	0.016
Excellent/very good	-1.306***	0.089	-0.359***	0.030	-0.142***	0.016
Number of difficulties with mobility	0.168***	0.036	0.036***	0.012	0.028***	0.007
Female * difficulties with mobility	-0.105***	0.036	-0.031**	0.014	-0.019***	0.007
Formal care receipt	0.175	0.191	0.221***	0.068	0.143***	0.044
Informal care receipt	0.323***	0.118	0.120***	0.040	0.007	0.028
Longstanding illness	0.533***	0.066	0.070***	0.025	0.013	0.012
Limiting & longstanding illness	0.359***	0.089	0.062*	0.032	0.035*	0.019
Private health insurance	-0.299***	0.097	-0.108***	0.024	0.014	0.019
Death in two years after interview	1.174***	0.188	0.630***	0.103	0.292***	0.060
Wave dummy	Yes		Yes		Yes	
N	24912		29269		17275	
Adjusted R^2	0.096		0.043		0.051	

Note: Robust standard errors shown are clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Baseline is those with low education (no formal qualifations).
[b] Baseline is those who reported fair or poor health.

Table 11: Effect of education on outpatient hospital use

	Outpatient visits in last year		
	All	GP referral	Hospital referral
	(1)	(2)	(3)
	OLS	OLS	OLS
Education level [a]			
Mid	0.300***	0.122***	0.149***
	(0.082)	(0.040)	(0.053)
High	0.476***	0.101**	0.321***
	(0.100)	(0.044)	(0.072)
Wave dummy	Yes	Yes	Yes
Demographic variables [b]	Yes	Yes	Yes
Health variables [c]	Yes	Yes	Yes
Observations	24912	24912	24912
Adjusted R^2	0.096	0.052	0.058

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Baseline is those with low education (no formal qualifations).
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 12: Robustness of income results to alternative measure of hospital use

	Outpatient visits in year after interview		
	All (1) OLS	GP referral (2) OLS	Hospital referral (3) OLS
Income quintile [a]			
Lowest	-0.311***	-0.006	-0.303***
	(0.097)	(0.046)	(0.067)
2nd	-0.188**	-0.007	-0.193***
	(0.082)	(0.037)	(0.060)
4th	-0.012	0.059	-0.078
	(0.080)	(0.037)	(0.058)
Highest	0.083	0.079*	0.009
	(0.100)	(0.042)	(0.077)
Wave dummy	Yes	Yes	Yes
Demographic variables [b]	Yes	Yes	Yes
Health variables [c]	Yes	Yes	Yes
Observations	29269	29269	29269
Adjusted R^2	0.101	0.064	0.056

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 13: Robustness of education results to alternative measure of hospital use

	Outpatient visits in year after interview		
	All	GP referral	Hospital referral
	(1)	(2)	(3)
	OLS	OLS	OLS
Education level [a]			
Mid	0.286***	0.111***	0.147***
	(0.075)	(0.035)	(0.050)
High	0.373***	0.073*	0.254***
	(0.096)	(0.039)	(0.073)
Wave dummy	Yes	Yes	Yes
Demographic variables [b]	Yes	Yes	Yes
Health variables [c]	Yes	Yes	Yes
Observations	29269	29269	29269
Adjusted R^2	0.102	0.065	0.056

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Baseline is those with low education (no formal qualifations).
[b] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[c] Health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care, a dummy for private health insurance coverage and a dummy for having died in the two years after interview.

Table 14: Robustness of income results to inclusion of objective health measures

	Number of outpatient visits in last year					
			Referral source:			
	All	All	GP	GP	Hospital	Hospital
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
Income quintile [a]						
Lowest	-0.207	-0.197	0.036	0.043	-0.279***	-0.275***
	(0.133)	(0.133)	(0.069)	(0.069)	(0.092)	(0.092)
2nd	-0.005	0.006	-0.006	-0.003	-0.076	-0.070
	(0.121)	(0.120)	(0.063)	(0.063)	(0.083)	(0.083)
4th	0.116	0.124	0.088	0.088	0.001	0.008
	(0.118)	(0.118)	(0.062)	(0.062)	(0.082)	(0.082)
Highest	0.004	0.007	0.100	0.096	-0.105	-0.100
	(0.121)	(0.121)	(0.063)	(0.063)	(0.083)	(0.084)
Obese BMI [b]		-0.024		-0.022		0.022
		(0.087)		(0.045)		(0.060)
Blood pressure		-0.012***		-0.002		-0.008***
		(0.003)		(0.002)		(0.002)
Average grip strength		-0.008		-0.004		-0.004
		(0.006)		(0.003)		(0.004)
Lung capacity		0.063		0.061*		0.017
		(0.062)		(0.032)		(0.043)
Wave dummy	Yes	Yes	Yes	Yes	Yes	Yes
Demographic variables [c]	Yes	Yes	Yes	Yes	Yes	Yes
Self-reported health variables [d]	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8305	8305	8305	8305	8305	8305
Adjusted R^2	0.084	0.086	0.052	0.052	0.047	0.048

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
[a] Income quintiles are wave- and age-specific. The baseline is the third quintile.
[b] This represents a dummy variable that is equal to one if BMI is greater than or equal to 30.
[c] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.
[d] Self-reported health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care and a dummy for private health insurance coverage.

Table 15: Robustness of education results to inclusion of objective health measures

	Number of outpatient visits in last year					
			Referral source:			
	All	All	GP	GP	Hospital	Hospital
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
Education level [a]						
Mid	0.175*	0.171*	0.062	0.057	0.123**	0.124**
	(0.090)	(0.091)	(0.047)	(0.047)	(0.062)	(0.062)
High	0.355***	0.352***	0.113**	0.106*	0.224***	0.228***
	(0.103)	(0.104)	(0.053)	(0.054)	(0.071)	(0.072)
Obese BMI [b]		-0.005		-0.018		0.035
		(0.087)		(0.045)		(0.060)
Blood pressure		-0.012***		-0.002		-0.008***
		(0.003)		(0.002)		(0.002)
Average grip strength		-0.010*		-0.004		-0.005
		(0.006)		(0.003)		(0.004)
Lung capacity		0.053		0.059*		0.011
		(0.062)		(0.032)		(0.043)
Wave dummy	Yes	Yes	Yes	Yes	Yes	Yes
Demographic variables [c]	Yes	Yes	Yes	Yes	Yes	Yes
Self-reported health variables [d]	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8305	8305	8305	8305	8305	8305
Adjusted R^2	0.085	0.087	0.052	0.053	0.047	0.048

Note: Robust standard errors clustered at the individual level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[a] Baseline is those with low education (no formal qualifations).

[b] This represents a dummy variable that is equal to one if BMI is greater than or equal to 30.

[c] Demographic variables include age, age^2, female, female * age, and dummies for being in a couple and in paid work.

[d] Self-reported health variables include self-reported health, number of difficulties with mobility, female * number of difficulties with mobility, reporting a longstanding illness,reporting a longstanding and limiting illness, being in receipt of formal social care, being in receipt of informal social care and a dummy for private health insurance coverage.

Table 16: Robustness of results to use of zero-inflated negative binomial regression model

	Number of outpatient visits in last year					
			Referral source:			
	All		GP		Hospital	
	Zero-inflated negative binomial (1)		Zero-inflated negative binomial (2)		Zero-inflated negative binomial (3)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Education level [a]						
Mid	0.077**	0.033	0.078*	0.042	0.082	0.054
High	0.162***	0.040	0.062	0.047	0.250***	0.068
Age	0.156***	0.046	0.168***	0.057	0.162**	0.075
Age^2	-0.001***	0.000	-0.001***	0.000	-0.001**	0.000
Female	0.889***	0.325	0.954**	0.423	0.813	0.536
Female * age	-0.012***	0.004	-0.013**	0.006	-0.011	0.007
In a couple	-0.002	0.032	0.042	0.041	-0.037	0.055
In paid work	-0.057	0.054	0.140*	0.077	-0.073	0.090
Self-reported health [b]						
Good	-0.265***	0.034	-0.256***	0.039	-0.250***	0.058
Excellent/very good	-0.406***	0.038	-0.239***	0.050	-0.450***	0.068
Number of difficulties with mobility	0.038***	0.009	0.030***	0.011	0.025*	0.015
Female * difficulties with mobility	-0.023**	0.010	-0.010	0.012	-0.027	0.016
Formal care receipt	0.033	0.053	-0.009	0.066	-0.010	0.078
Informal care receipt	0.064*	0.037	0.049	0.048	0.174***	0.061
Longstanding illness	0.164***	0.038	0.074	0.049	0.140**	0.068
Limiting & longstanding illness	0.070*	0.038	0.118**	0.047	0.025	0.066
Private health insurance	-0.107**	0.052	-0.068	0.061	-0.033	0.085
Death in two years after interview	0.301***	0.042	0.108*	0.057	0.360***	0.059
Wave dummy	Yes		Yes		Yes	
N	24912		24912		24912	
Inflation model	logit		logit		logit	

Note: Robust standard errors shown are clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Zero outcomes are inflated using a logit model with the same set of variables as used in the negative binomial model shown above.
[a] Baseline is those with low education (no formal qualifations).
[b] Baseline is those who reported fair or poor health.