Journal of
Epidemiology &
Community Health

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Journal:	*Journal of Epidemiology & Community Health*
Manuscript ID	jech-2016-207447
Article Type:	Research report
Date Submitted by the Author:	26-Feb-2016
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Keywords:	ECONOMICS, Health inequalities, INEQUALITIES, NHS, SOCIO-ECONOMIC

The costs of inequality: whole-population study of lifetime hospital costs in the English NHS

Miqdad Asaria, Tim Doran, Richard Cookson

What is already known on this subject?

Poorer people tend to use more healthcare at any given age, because they are sicker, but also tend to have shorter lives

It is not known how these two sets of inequalities interact to produce lifetime healthcare costs for different socioeconomic groups.

What this study adds?

There is a social gradient in both current and lifetime hospital costs. Despite dying at a younger age, people from more deprived neighbourhoods tend to require more healthcare and cost the NHS more over their lifetimes than people from more affluent neighbourhoods.

Socioeconomic inequality cost the NHS in England £4.8 billion in 2011/12 as a result of excess hospital admissions.

There is a financial as well as a moral case for tackling socioeconomic inequality: reducing socioeconomic inequalities in health would save the healthcare system more money by reducing morbidity than would be lost due to longevity gains.

Acknowledgements: The authors would like to thank Katja Grasic, Mauro Laudicella, Eldon Spackman, Susan Griffin, Simon Walker and HEDG seminar participants at the University of York for their useful comments and suggestions on this work.

Abstract

Background: There are substantial socioeconomic inequalities in both life expectancy and healthcare utilisation in England. In this study we describe how these two sets of inequalities interact by estimating the social gradient in hospital costs across the life course.

Methods: Hospital episode statistics, population and index of multiple deprivation data were combined at lower layer super output area level to estimate inpatient hospital costs for 2011/12 by age, sex and deprivation quintile. Survival curves were estimated for each of the deprivation groups and used to estimate expected annual costs and cumulative lifetime costs.

Results: A steep social gradient was observed in overall inpatient hospital admissions, with rates ranging from 31,298 per 100,000 population in the most affluent fifth of areas to 43,385 in the most deprived fifth. This gradient was steeper for emergency than for elective admissions. The total cost associated with this inequality in 2011/12 was £4,775,573,701. A social gradient was also observed in the modelled lifetime costs where the decrease in life expectancy was not sufficient to outweigh the increasing average costs in the more deprived populations. Lifetime costs for women were 14% greater than for men, due to higher costs in the reproductive years and greater life expectancy.

Conclusion: Socioeconomic inequalities result in both increased morbidity and decreased life expectancy. Interventions to reduce inequality and improve health in more deprived neighbourhoods have the potential to save money for health systems not only within years but across peoples' entire lifetimes, despite increased costs due to longer life expectancies.

Introduction

Health care systems in most high income countries aspire to provide equitable care, adopting the principle of equal access to services for equal need,[1] even when this is difficult to define and implement in practice.[2] Some go further, and aim for equal utilisation or even equal outcomes.[3] However, health status is powerfully influenced by socio-economic factors, with lower income associated with greater health care needs. So for a system to be equitable it must de-couple use of healthcare services from individual income and contributions towards system costs. This is usually achieved through social insurance schemes, or - as in the case of the English National Health Service (NHS) - by funding system costs through progressive income taxation. Through the use of such funding arrangements, healthier people subsidise care for those who fall ill and more affluent sections of society subsidise the more deprived.

There is a widespread assumption that over the life course such systems disproportionately favour people lower down the socio-economic scale, in terms of the imbalance between their contribution to the costs of health services and their use of those services.[4] Lower socio-economic status is associated with lower incomes, and therefore smaller income tax and social insurance contributions, but also with greater healthcare need, in particular the earlier development of multiple chronic morbidities.[5] However, evidence on actual use of services is more nuanced. More deprived populations tend to make greater use of unplanned (emergency) services than affluent populations, and are slightly more likely to visit the GP,[6] but are less likely to visit a medical specialist or to use many types of planned and preventative services.[7]

Most studies to date on the costs and utilisation of services by different socio-economic groups have been cross-sectional. This is an important limitation, because morbidity and mortality may have opposing impacts on lifetime healthcare costs – greater morbidity will tend to increase lifetime costs, whereas dying younger will tend to reduce them. After early childhood, average current-year health care costs for individuals increase throughout life, rising dramatically from the age of 50.[8] These higher health care costs for poorer people in life may be partially offset by a shorter lifespan. Alternatively, given that the rising costs in older age are largely driven by the onset of chronic disease, earlier onset of these diseases in poorer populations may simply shift the health care costs to younger age groups.

Consideration of these longitudinal relationships is necessary in order to determine the impact of socioeconomic factors on health system costs. Measuring the size of this impact is important not just to quantify the relative health care benefits received by different social groups, but to understand the costs borne by the health service as a consequence of social inequality. In this study we aimed to measure the costs to the NHS of socio-economic inequality, by estimating the lifetime hospital utilisation costs of the whole English population by socio-economic status.

Methods

Data

This study focuses on socio-economic differences in inpatient hospital costs across the life course. Hospital admissions in England are recorded in the Hospital Episode Statistics (HES) dataset used to reimburse hospitals for provided care. This dataset contains details on every episode of care, and a new finished consultant episode (FCE) record is created for every new admission and every time responsibility for the care of a patient passes from one consultant to another. The HES FCE records data about the patient (age, sex, place of residence) and their hospital stay (diagnoses, procedures, length of stay). Using this information the FCE is allocated to a healthcare resource group (HRG), which collates hospital stays that use similar levels of resources – this is the English version of diagnosis related groups (DRGs) used in the USA. Hospitals are reimbursed by the NHS through the payments by results (PbR) system based on the HRG, adjusted for the specifics of the case – e.g. a more complicated case with longer than usual length of stay attracts additional reimbursement. Reimbursement is also adjusted for local cost variations (termed 'market forces factors'). Costs attached to each HRG for each year and variations for more complex cases are given in the NHS national reference costs.[9] Details of how to derive costs from HES data are available in the PbR documentation [10] and their use in health economic analysis in discussed in Asaria et al.[11] We use HES inpatient data for 2011/12 and associated reference costs in this study.

The basic geographical unit of analysis in this study is the lower layer super output area (LSOA). The country is divided into 32,482 LSOAs each containing on average 1,500 people (range 1,000 to 3,000). Population data for 2011/12 are taken from Office for National Statistics (ONS) mid-year population estimates split by LSOA, sex and age (ages 0-84 in single year estimates and then 85+). This data estimates the total resident population, including homeless people and people living in institutions. Mortality data for 2011/12 are taken from the ONS, split by LSOA, sex and age (ages 0-84 in 5-year age bands and then 85+). Area deprivation for LSOAs is measured using the index of multiple deprivation (IMD) for 2010. The IMD includes seven domains: (i) income; (ii) employment; (iii) health deprivation and disability; (iv) education skills and training; (v) barriers to housing and services; (vi) crime; and (vii) living environment. These domains are combined to produce an overall deprivation rank for each LSOA. We grouped LSOAs into deprivation quintiles based on this rank ranging from Q1 (the most deprived fifth of LSOAs) to Q5 (the least deprived fifth of LSOAs).

Analysis

We grouped HES inpatient data into age, sex and IMD quintile categories. Of the 18,808,903 episodes in our 2011/12 HES dataset 1,659,295 episodes (8.8%) could not be grouped due to missing data on either age, sex or LSOA of residence and were dropped from the analysis. We then calculated the total

cost for each age, sex and IMD quintile group using the HRGs and the relevant reference costs. Market forces factors adjustments were not made as we are interested in the variation in resource use by deprivation group rather than local cost variations. We then inflated these costs by 8.8% to account for the missing data (we assumed that missing data were equally distributed across all patient groups and HRGs). Finally we divided by the population in each age, sex and IMD quintile group using ONS population estimates to estimate average costs for each group:

$$average\_cost_{age,sex,imd} = \frac{\sum hospital\_costs_{age,sex,imd} \times 1.088}{\sum population_{age,sex,imd}}$$

We used these average costs to calculate the total cost associated with inequality in 2011/12 by comparing the costs as observed in the data with the costs calculated by assuming each individual experienced the average costs (split by age and sex) experienced in the least deprived fifth of areas:

$$cost\_of\_inequality_{imd} = \sum^{age,sex} [population_{age,sex,imd} \times (average\_cost_{age,sex,imd} - average\_cost_{age,sex,imd=Q5})]$$

Next we used the mortality data to calculate mortality rates by age, sex and IMD quintile group and used these in turn to calculate survival curves for each group:

$$mortality\_rate_{age,sex,imd} = \frac{\sum deaths_{age,sex,imd}}{\sum population_{age,sex,imd}}$$

$$survival_{age,sex,imd} = \begin{cases} 1, & age = 0 \\ survival_{age-1,sex,imd} \times (1 - mortality\_rate_{age-1,sex,imd}), & age > 0 \end{cases}$$

We used these survival curves to calculate expected cost at each age split by sex and IMD quintile group by adjusting the average cost for the probability of an individual from each group being alive to incur that cost. Finally, we summed across these age groups to get an expected lifetime cost for an individual in each sex and IMD quintile group (assuming mortality experience and hospital costs remained constant at 2011/12 level):

$$expected\_cost_{age,sex,imd} = survival_{age,sex,imd} \times average\_cost_{age,sex,imd}$$

$$expected\_lifetime\_cost_{sex,imd} = \sum^{age} expected\_cost_{age,sex,imd}$$

We repeated this analysis for emergency and elective hospitalisations and compared rates of outpatient hospital use among the different groups.

Results

Social patterning of hospital episodes

In 2011/12 there were 11,477,435 elective episodes and 7,914,736 emergency episodes to hospitals in England (19,392,171 total episodes). Numbers of episodes decrease between the ages of 0 and 10 in both sexes, then for men increase up to the age of 70 before declining in the oldest age groups, and for women spike sharply between adolescence and the age of 40 – reflecting admissions relating to reproduction – before gradually increasing up to the oldest age groups (**Figure 1a**). For ages 0 to 60, there was a clear social gradient in both sexes, with episodes increasing with area deprivation. After the age of 60 this trend begins to reverse until in the over 75 age groups the most deprived areas have the fewest episodes. The greatest gap between social groups occurs in women during the peak reproductive years.

Figure 1b shows the rate of episodes after adjusting for the different demographic structures of population groups. After early childhood, rates of hospital episodes generally increase with age, and are higher in women than in men between the ages of 20 and 40 and higher in men after the age of 70. A social gradient is again evident with a higher rate of episodes in more deprived areas, but in the case of episode rates the gradient persists across the entire age range. This indicates that the relative fall in the number of episodes for older age groups in more deprived areas is due to a relative decline in population, with fewer people in deprived areas surviving into old age (**Figure 2a**).

The trends for average annual costs per head of population (**Figure 1c**) closely mirrored the patterns for hospital episode rates, suggesting that costs associated with different population groups are primarily driven by volumes of hospital usage rather than differences in types of hospital usage across the life course.

The social gradient in hospital episodes is evident for both elective and emergency admissions, but the gaps are greater for emergency admissions (**Table 1).** Compared with residents in the most affluent fifth of areas, residents of the most deprived fifth of areas have a 20% higher rate of elective episodes, a 71% higher rate of emergency episodes, and a 39% higher rate of episodes overall. Detailed age, sex and deprivation breakdowns of the different types of admissions are given in the supplementary appendix (**Figure A1**).

The potential savings for the NHS if the costs associated with the age and sex specific episode rates in the most affluent quintile in 2011/12 were achieved in the other deprivation groups are given in **Table 2**. The total cost associated with socioeconomic inequality is £4.8 billion per year, and there is a clear social gradient across the entire deprivation spectrum, with the largest cost observed in the most deprived group (£2.2 billion). Costs are broadly similar in men and women.

Estimates of lifetime costs

Survival curves for men and women by deprivation quintile are shown in **Figure 2a**. People who live in more affluent areas are expected to live longer than those who live in more deprived areas and women are expected to live longer than men at any given deprivation level.

Combining data on survival and average costs, we calculated expected costs of hospital admission over the life course for each deprivation group, assuming survival and costs remained constant at 2011/12 levels. Cumulative lifetime costs are shown in **Figure 2b**. Average lifetime costs for men range from £43,358 for the most affluent group to £50,163 for the most deprived, and the respective costs for women range from £48,409 to £59,255. Overall, women have 14% higher expected lifetime hospital costs than men, largely due to the increased costs associated with the reproductive years, but also due to their longer life expectancy. Despite having longer life expectancy, people living in the most affluent fifth of areas have lower lifetime hospital costs than those living in more deprived areas.

Analyses for emergency and elective admissions are presented in the supplementary appendix (**Figures A1** and **A2**). Results are broadly similar to those for all admissions, but expected cumulative lifetime costs for elective episodes in men converge and are highest for people living in the most affluent fifth of areas. Results for outpatient appointments are also given in the supplementary appendix (**Figure A3**). Very similar trends are apparent to those for inpatient admissions, with outpatient hospital use increasing with greater deprivation level and age and spiking for women between the ages of 20 and 40.

Discussion

Summary of key findings

In this study we aimed to quantify the hospital care costs to the NHS of socio-economic inequality. As expected, we found that hospital admission rates generally increase with age, and are higher in women during the reproductive years and higher in men at most other ages. For all ages there is a clear socio-economic gradient, particularly for emergency admissions, with the rate of admissions increasing with neighbourhood deprivation. The costs to the NHS associated with this inequality are partially off-set by lower life expectancy in more deprived groups, but remain substantial: £4.8 billion per year at 2011/12 levels.

Strengths and Limitations

This is the first study based on comprehensive whole-population data in England to explore the relationship between lifetime hospital costs to the NHS and socio-economic inequality. We utilised data at small area level to minimise the risk of ecological fallacy that may have masked inequality at

larger and coarser geographical levels. Mortality data were used to extrapolate the results of the analysis across the patient lifetime to allow conclusions to be drawn on both cross sectional and lifetime costs of inequality to the NHS.

The study is subject to several limitations. First, we did not control for differing need for healthcare amongst the different groups, and so do not make any judgements on whether the different levels of utilisation are "fair" or appropriate given differences in need. Second, the focus of our analysis was inpatient care, but health care costs are also incurred through outpatient appointments and in primary care. In 2011/12 inpatient costs and primary care costs each constituted 22% of the total NHS budget of £101.42 billion.[12] In our supplementary analyses we found that outpatient utilisation followed similar trends to those for inpatient use. This suggests that our estimates represent a lower bound on the total cost of inequality to the NHS. Third, our lifetime extrapolation assumes that hospitalisation rates and costs observed in 2011/12 will remain constant into the future and that mortality rates in 2011/12 can be used to predict survival rates in future years. The extrapolation also assumes that deprivation levels are fixed over individuals' lifetimes. While these assumptions may not hold in practice we feel they give a reasonable indication of the relative magnitudes and directions of future trends. Finally, the underlying population and mortality data breakdowns that we use in this study are truncated at 85 years of age, so mortality and hospitalisation rates for older age groups are assumed to be constant and not to increase further with age.

Comparison with other studies

As far as we know, this is the first published analysis of the inpatient costs of socio-economic inequality. The 2010 Strategic Review of Health Inequalities (the Marmot Review) estimated the cost of inequality to the NHS to be £5.5 billion per year,[13] but the basis for this calculation and the detailed findings were not described. The Office for National Statistics estimated that overall NHS spending in 2011/12 was 8.4% higher for households in the lowest income quintile compared with households in the highest (spending of £3,345 and £3,096 respectively).[14] However, this is a cross-sectional estimate based on the age and sex of respondents from neighbourhoods with different levels of deprivation to the Living Costs and Food Survey. In contrast, we used comprehensive national data to calculate the actual variation in healthcare costs by social group and to model lifetime costs. Our approach found that hospital costs in 2011/12 were 31% higher for people living in the most deprived quintile of neighbourhoods compared with people living in the least deprived quintile (average annual hospital costs per resident of £597 and £455 respectively). Forget et al modelled lifetime healthcare costs based on the population of Manitoba, finding costs for women were 40% higher than for men.[15] As with our study, this gap between the sexes developed during the peak childbearing years and widened at the end of life. However, whilst the authors described wide variations in healthcare costs between individuals, the contribution of socioeconomic factors was not assessed.

Policy / clinical implications

Socioeconomic inequalities in the determinants of health result in both increased morbidity and decreased life expectancy. We found that the substantially higher health care costs accrued by residents of deprived areas throughout their lives are only slightly offset by their lower life expectancy. Evidence suggests that even in a country with universal access to health care, more affluent groups benefit more [6,16,17] and health care is not entirely equitable. If health care provision were to adequately meet need, the cost disparities we describe could be even greater, although better prevention and early intervention could also result in a net reduction in the costs associated with inequality, as has been found in social and educational interventions.[18,19]

Rising health care costs in older age are largely driven by the onset of chronic disease, and the earlier onset of these diseases in poorer populations shifts the health care costs to younger age groups. Better primary and secondary prevention, progressively weighted towards more deprived populations, is an obvious response, but one that has proved hard to achieve. Anticipatory interventions to tackle the onset of chronic conditions in deprived neighbourhoods can result in significant patient benefit,[20] potentially generating net savings for the health system in any given year as well as across the lifetimes of these patients. However, whilst there is scope for health professionals to do more to tackle health inequalities as both providers and commissioners,[21,22] the root causes of these inequalities are socio-economic and the health care system – however equitable – can only partially alleviate their impact.[23,24] A range of recent national social and health system programmes (for example, Health Action Zones, the Quality and the Outcomes Framework) have been associated with more equitable access to high quality care [24,25] and in some cases with improvements in educational and health outcomes,[26] but for the most part inequalities in health outcomes have persisted – or have actually worsened.[27–29] More radical social and economic solutions, the effectiveness of which remain largely untested, have been proposed.[30–32] Our results provide vital context when assessing the cost-effectiveness of such interventions, in terms of the potential gains to the health service.

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Figures and Tables

Figure 1: All hospital inpatient admissions split by age, sex and deprivation

Notes to figure 1: Graphs are based on hospital episode statistics for year 2011/12 and are broken down by sex (female on the left male on the right), deprivation (different line colours) and are plotted against age. **Panel a** shows the total number of hospital episodes. **Panel b** shows the hospitalisation rate i.e. adjusts for the demographic structure of the population. **Panel c** translates from hospital episodes to average annual costs due to these hospitalisation.

Figure 2: Survival curves and cumulative lifetime costs split by age, sex and deprivation

Notes to figure 2: Graphs are based on and mortality data and hospital episode statistics for year 2011/12 and are broken down by sex (female on the left male on the right), deprivation (different line colours) and are plotted against age. **Panel a** shows the probability of surviving against age. **Panel b** shows the cumulative expected hospital costs calculated by adjusting hospital costs by the probability of being alive at any given age and cumulating these adjusted costs over all previous years.

Table 1. Number and rate of hospital episodes by admission type

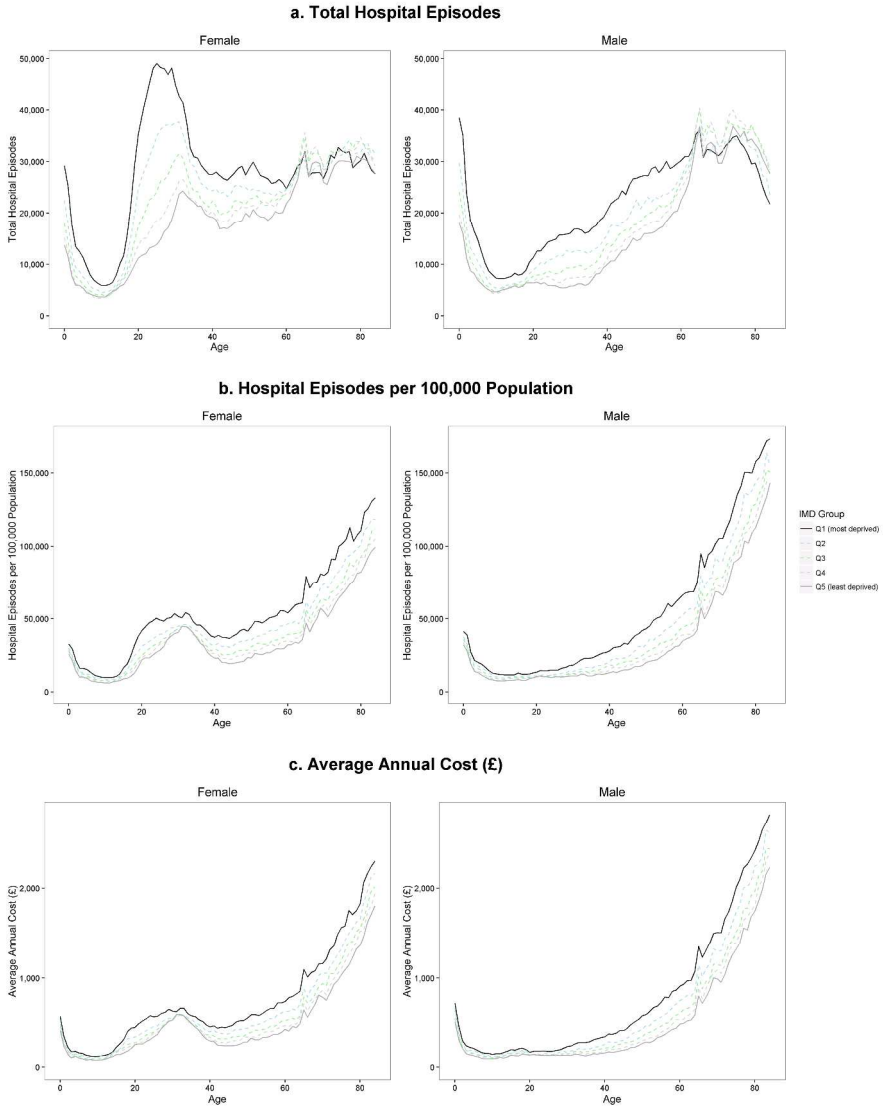
IMD Quintile	Elective		Emergency		All	
	Total	Rate *	Total	Rate *	Total	Rate *
Q1 (most deprived)	2,481,014	23,727	2,055,481	19,658	4,536,495	43,385
Q2	2,355,297	22,338	1,706,833	16,188	4,062,130	38,526
Q3	2,310,208	21,811	1,546,013	14,596	3,856,220	36,408
Q4	2,235,779	21,254	1,390,347	13,217	3,626,126	34,472
Q5 (most affluent)	2,095,137	19,804	1,216,063	11,495	3,311,200	31,298
Overall	11,477,435	21,783	7,914,736	15,021	19,392,171	36,804

Notes to table 1: This table shows the total numbers and rates of hospital episodes split by type of hospital admission and deprivation group. All data are based on hospital episode statistics for year 2011/12. * Rate per 100,000 population

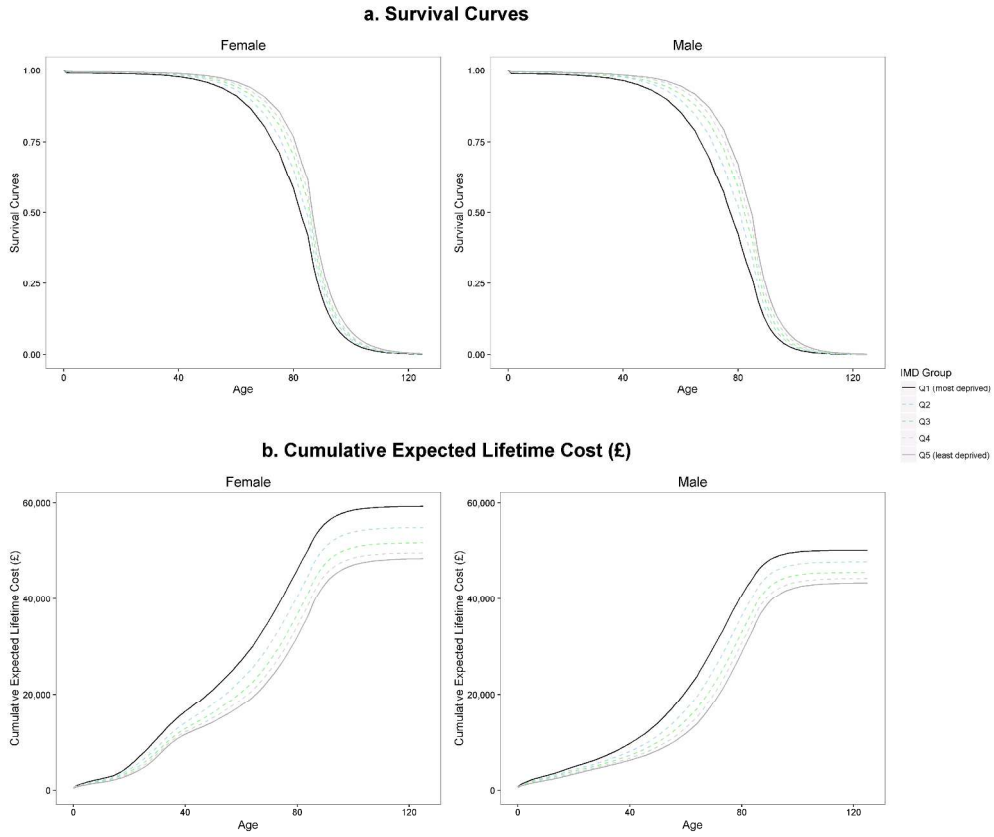
Table 2. Estimated cost of social inequality

IMD Quintile	Female (£)	Male (£)	Total (£)
Q1 (most deprived)	1,127,006,663	1,065,236,932	2,192,243,595
Q2	706,629,004	671,287,893	1,377,916,897
Q3	410,841,645	405,654,922	816,496,567
Q4	198,794,943	190,121,699	388,916,642
Q5 (most affluent) *	-	-	-
Overall	2,443,272,255	2,332,301,446	4,775,573,701

Notes to table 2: This table shows the difference in inpatient hospital costs between those in the most affluent group and each of the other deprivation groups assuming everybody in the other groups would have the same average hospital costs as those in the most affluent groups adjusted for the different demographic profiles of the groups. All data are based on hospital episode statistics for year 2011/12. * Comparator group – costs in this group are £2,608,800,295, £2,208,982,887 and £4,817,783,181 for female, male and total respectively.



Graphs are based on hospital episode statistics for year 2011/12 and are broken down by sex (female on the left male on the right), deprivation (different line colours) and are plotted against age. Panel a shows the total number of hospital episodes. Panel b shows the hospitalisation rate i.e. adjusts for the demographic structure of the population. Panel c translates from hospital episodes to average annual costs due to these hospitalisation.



Graphs are based on and mortality data and hospital episode statistics for year 2011/12 and are broken down by sex (female on the left male on the right), deprivation (different line colours) and are plotted against age. Panel a shows the probability of surviving against age. Panel b shows the cumulative expected hospital costs calculated by adjusting hospital costs by the probability of being alive at any given age and cumulating these adjusted costs over all previous years.

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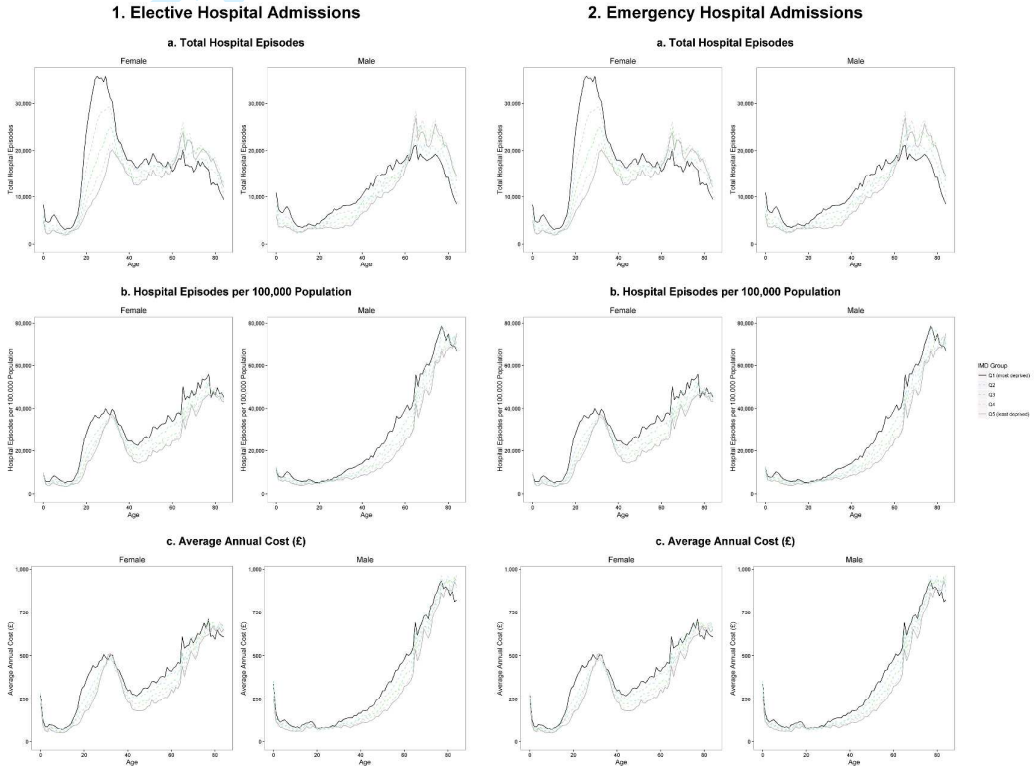
Supplementary Appendix

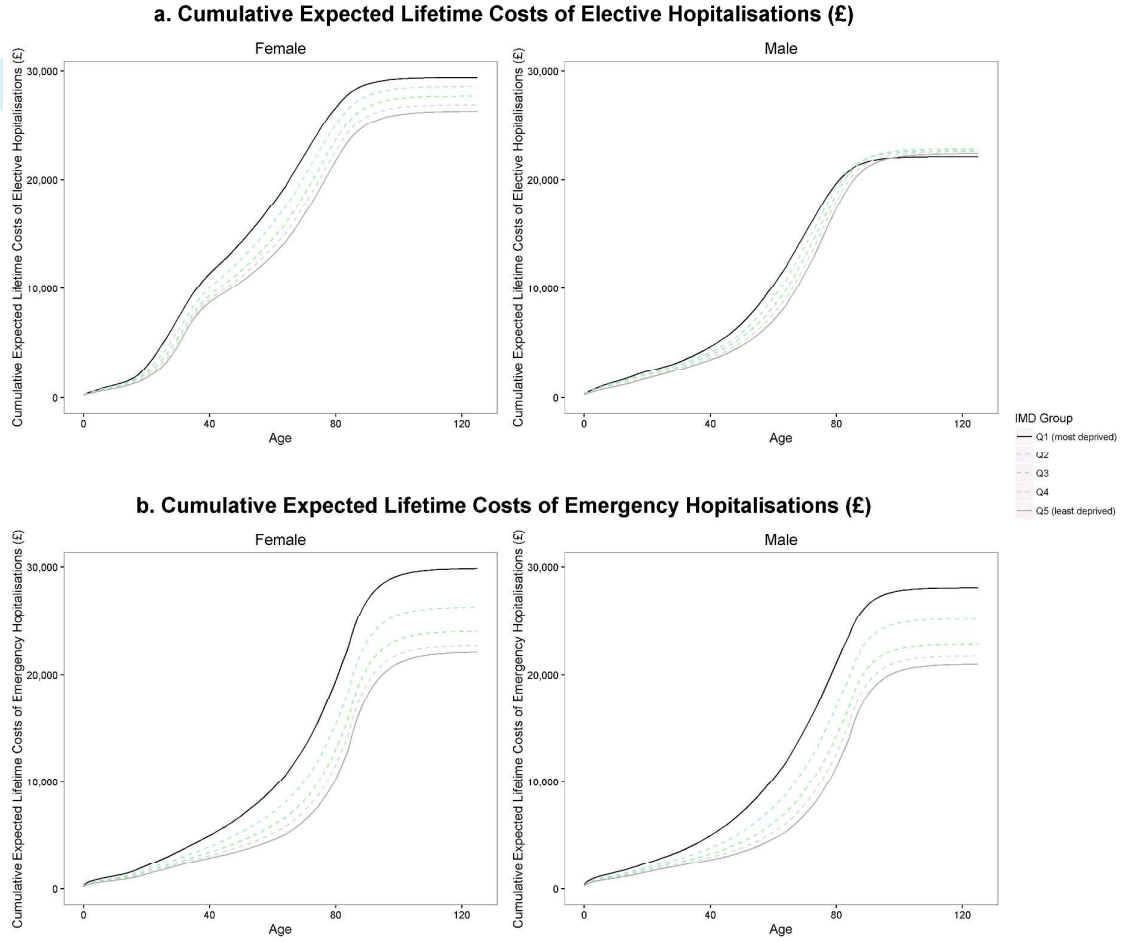
This supplementary appendix provides additional details about the social gradient in hospital utilisation and associated costs in terms of type of inpatient appointments (elective versus emergency) as described in **Figures A1** and **A2** as well as describing the social gradient in use of outpatient care as described in **Figure A3**.

Figure A1: Hospital inpatient admissions split by admission type, age, sex and deprivation



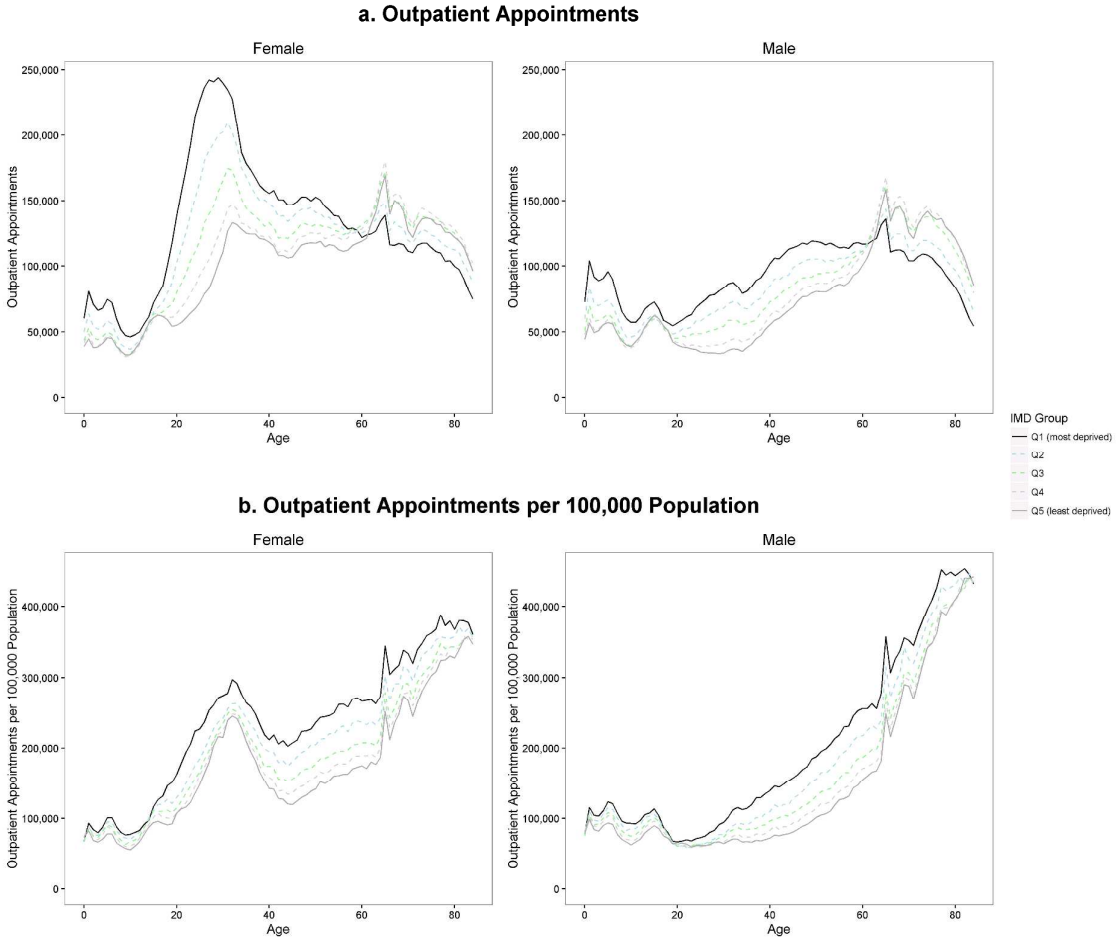
Notes to figure A1: Graphs are based on hospital episode statistics for year 2011/12 and are broken down by admission type (set of graphs on the left show elective admission while those on the right show emergency admissions), sex (female on the left within each admission type and male on the right), deprivation (different line colours) and are plotted against age. **Panel a** shows the total number of hospital episodes. **Panel b** shows the hospitalisation rate i.e. adjusts for the demographic structure of the population. **Panel c** translates from hospital episodes to average annual costs due to these hospitalisation.

Figure A2: Hospital inpatient costs broken down by admission type age, sex and deprivation



Notes to figure A2: Graphs are based on and mortality data and hospital episode statistics for year 2011/12 and are broken down by sex (female on the left male on the right), deprivation (different line colours) and are plotted against age. **Panel a** shows cumulative expected hospital costs due to elective hospital episode and **Panel b** shows the cumulative expected hospital costs due to emergency hospital episodes. These costs are calculated by adjusting hospital costs by survival probabilities and cumulating these adjusted costs over all previous years.

Figure A3: Outpatient appointments split by age, sex and deprivation



Notes to figure A3: Graphs are based on hospital episode statistics for year 2011/12 and are broken down by sex (female on the left male on the right), deprivation (different line colours) and are plotted against age. **Panel a** shows the total number of outpatient appointments. **Panel b** shows the appointment rate i.e. adjusts for the demographic structure of the population.