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RESEARCH ARTICLE

Inequality in Diabetes-Related Hospital Admissions in England by Socioeconomic Deprivation and Ethnicity: Facility-Based Cross-Sectional Analysis

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Abstract

Objective

To investigate the effect of social deprivation and ethnicity on inpatient admissions due to diabetes in England.

Design

Facility-based cross-sectional analysis.

Setting

National Health Service (NHS) trusts in England reporting inpatient admissions with better than 80% data reporting quality from 2010–2011 (355 facilities).

Participants

Non-obstetric patients over 16 years old in all NHS facilities in England. The sample size after exclusions was 5,147,859 all-cause admissions.

Main Outcome Measures

The relative risk of inpatient admissions and readmissions due to diabetes adjusted for confounders.

Results

There were 445,504 diabetes-related hospital admissions in England in 2010, giving a directly (age-sex) standardized rate of 1049.0 per 100,000 population (95% confidence interval (CI): 1046.0–1052.1). The relative risk of inpatient admission in the most deprived quintile was 2.08 times higher than that of the least deprived quintile (95% CI: 2.02–2.14), and the effect of deprivation varied across ethnicities. About 30.1% of patients admitted due to diabetes were readmitted at least once due to diabetes. South Asians showed 2.62 times

(95% CI: 2.51 – 2.74) higher admission risk. Readmission risk increased with IMD among white British but not other ethnicities. South Asians showed slightly lower risk of readmission than white British (0.86, 95% CI: 0.80 – 0.94).

Conclusions

More deprived areas had higher rates of inpatient admissions and readmissions due to diabetes. South Asian British showed higher admission risk and lower readmission risk than white British. However, there was almost no difference by ethnicity in readmission due to diabetes. Higher rates of admission among deprived people may not necessarily reflect higher prevalence, but higher admission rates in south Asian British may be explained by their higher prevalence because their lower readmission risk suggests no inequality in primary care to prevent readmission. Better interventions in poorer areas, are needed to reduce these inequalities.

Introduction

It is well known that socioeconomic deprivation is associated with excess hospital admissions. For example, people in unskilled employment[1], people from a household whose head is in an unskilled-labour social class, or with an adult member of the family who cannot work due to illness, experience higher rates of emergency admission[2]. In the United States, people in highly deprived socioeconomic conditions or from certain ethnic minorities have a higher risk of diabetes-related hospitalization[3]. To the extent that these inequalities in admission rates are preventable, they represent a burden of potentially avoidable hospital admissions which, if addressed, may lead to health service efficiencies.

Diabetes is a typical example of a chronic non-communicable disease. Diabetes patients need continuous careful management in primary care by a general practitioner (GP) to prevent complications that may lead to hospitalization. In Type 1 diabetes, failure of primary care management can lead to acute ketoacidosis, which requires immediate emergency department admission; acute sequelae of untreated or poorly-managed type 2 diabetes can also lead to preventable hospital admissions. In the context of a growing diabetes epidemic in the UK, prevalence of type 1 and type 2 diabetes are expected to increase from approximately 0.6% and 5.4% of the whole population respectively in 2010/2011 to 0.9% and 7.7%, respectively by 2035/2036[4], for assumed population projections at 2035[5]. The annual cost of emergency calls for severe hypoglycaemia is £13.6m for England alone[6], and the total cost of diabetes is estimated to increase from £23.7bn in 2010/2011 to £39.8bn by 2035/2036[4]. Reducing excess inpatient admissions, especially in high-prevalence groups, is important to both reduce unnecessary expenditure on medical services and to reduce demand on NHS hospitals.

In the UK the prevalence of diabetes is estimated to be almost equal across socioeconomic status in men and at most double in women between the highest and lowest social classes[7]. Thus, a socioeconomic gradient in excess hospital admissions due to diabetes in the UK may reflect poorer management of chronic diabetes in this group. Some research also suggests inequality in diabetes primary care by ethnicity[8]. British of black Caribbean or south Asian descent are known to have a higher prevalence of diabetes[9–11] and without good quality management in primary care it is likely that this higher prevalence will be represented in higher rates of emergency admissions.

Excess rates of admission for diabetes represent a health system burden that can be reduced through targeting better quality primary care management of diabetes[12] such as controlling blood glucose concentration and blood pressure[13]. In a period of straitened finances in the UK and significant cuts to both social welfare and health services[14], it is important to understand the role that socioeconomic inequality can play in increasing the burden on health systems, to better prepare for and manage its health system effects. Furthermore, the current agenda for NHS reform in the UK focuses on increasing the role of GPs in clinical commissioning and health service planning[15], suggesting that GPs will be playing a greater future role in public health than has previously been the case, with the risk that flaws in primary care service will have a greater impact on the health system in the future. In this study, we investigate the relationship between socioeconomic deprivation, ethnicity and inpatient admission for diabetes using data for all of England.

Methods

Data sources

Data on individual inpatient hospital admissions was obtained from the inpatient components of the UK Hospital Episode Statistics (HES) data set. This data contains individual records of all attendances occurring in England from 2010–11, and was obtained from the National Health Service (NHS) Information Centre[16]. The population data for Lower Super Output Areas (LSOAs), the key geographical variable on which data on socioeconomic deprivation is available for 2011, was obtained from the website of the Office for National Statistics[17]. This data set contained 8,696,242 all-cause admissions in 498 hospitals.

Patients with obstetric-related diagnostic codes were excluded because gestational diabetes has very different etiology, management and epidemiological patterns than adult diabetes. In the inpatient data, only patients admitted through elective and emergency admission pathways were analyzed and other admission methods (maternity, psychiatric etc.) were excluded.

To avoid duplication of patient data due to follow-up admission, between- or within-facility referral for the same admission period, only the initial admission record for any hospital stay (the first episode of a "spell" in HES terminology) was analyzed This exclusion criterion is standard practice for analysis of admission data in the inpatient dataset[16]. Patients under 16 years old were also excluded from this analysis. Admissions from postcodes in Wales, Scotland, Northern Ireland, the Channel Islands, the Isle of Man, and any "pseudopostcodes" were excluded because these postcodes lack information about the Index of Multiple Deprivation (IMD), and only data for England were analyzed.

Missing data

Before analysis, records were excluded on a facility-wise basis depending on the rate of missing data in key variables. Hospitals with less than 80% valid data on diagnosis were excluded from the data set. Because ethnicity is relatively poorly recorded in the data, analysis of the relationship between hospital admission and ethnicity was restricted to only those hospitals with at least 80% valid data on both diagnosis and ethnicity.

Age-sex standardization of emergency admission rate

Directly standardized inpatient admission rates per 100,000 population were calculated as the age- and sex-standardized mean of the admission rates of each IMD quintile using the whole of England as the reference population. All statistical analysis was conducted on crude admission counts in order to adjust for age and sex.

Covariates

Admission due to diabetes was defined as a hospital admission with primary or secondary diagnosis from the ICD 10 codes E10—E14. IMD was used to express the degree of socioeconomic deprivation. This index is given at the level of small districts called Lower Super Output Areas, each consisting of about 672 households on average[18], and aggregates indices measuring income, employment, health, education, housing services, crime, and the living environment [19]. We adjusted all analyses for the confounding effect of patients' sex, ethnicity, age on the day of admission, and rural-urban indicator. In the HES data, rural-urban indicator is classified into nine categories[20] representing degree of urbanization. For this analysis, we collapsed them into three: urban, town, and village/hamlet. The admission method, elective or emergency, was also adjusted for.

HES data classifies ethnicity into 18 categories[20], but we grouped data into six categories: white, mixed, south Asian, black, Asian, and others.

Statistical analysis

The relationship between regional deprivation and inpatient admission was analyzed using a multiple Poisson regression model with random effects for region (the LSOA) and IMD treated as a region-level variable. Population by broad age groups (16–29, 30–44, 45–64, over 65) at the LSOA level was used as an offset in the regression model. All results from the multiple regression models are presented as relative risks with confidence intervals and p-values. We categorized IMD into quintiles and age into the same broad age groups as were present in the population data. An interaction term between IMD and ethnicity was included in the model to identify effect modification due to ethnicity.

Analysis of high-impact users

Using the same set of inpatient admission data, patients readmitted to hospital for diabetes were identified and their total number of readmissions calculated. To adjust for varying dates of initial admission, the time at risk was calculated in person-years from the first admission to the end of the data collection period (31st March 2011). A small number of patients whose record of observation period exceeded one year were excluded (20,352 patients). After exclusion, 230,535 patients remained. The number of readmissions was analyzed using multi-level Poisson regression. However, a small number of extreme outliers (more than 11 readmissions: 0.05% of the whole dataset) were excluded due to computational problems. The natural log of the person-year was used as the offset in the Poisson regression, and LSOA-level population was excluded because the analysis was only being conducted on the subset of those admitted from each area. Admission method of the initial admission due to diabetes for each patient was included as a covariate in this model, to test the relative risk of readmission of emergency compared to elective patients.

Ethics Considerations

Approval was given for the use of the data by the NHS Information Centre. Because the data is anonymous, routine monitoring data open to the public, further ethics approval is not required.

Results

A flowchart describing the application of exclusion criteria and removal of missing data is summarized in Fig. 1. There were a total of 8,696,242 all-cause admissions in 498 hospitals. After

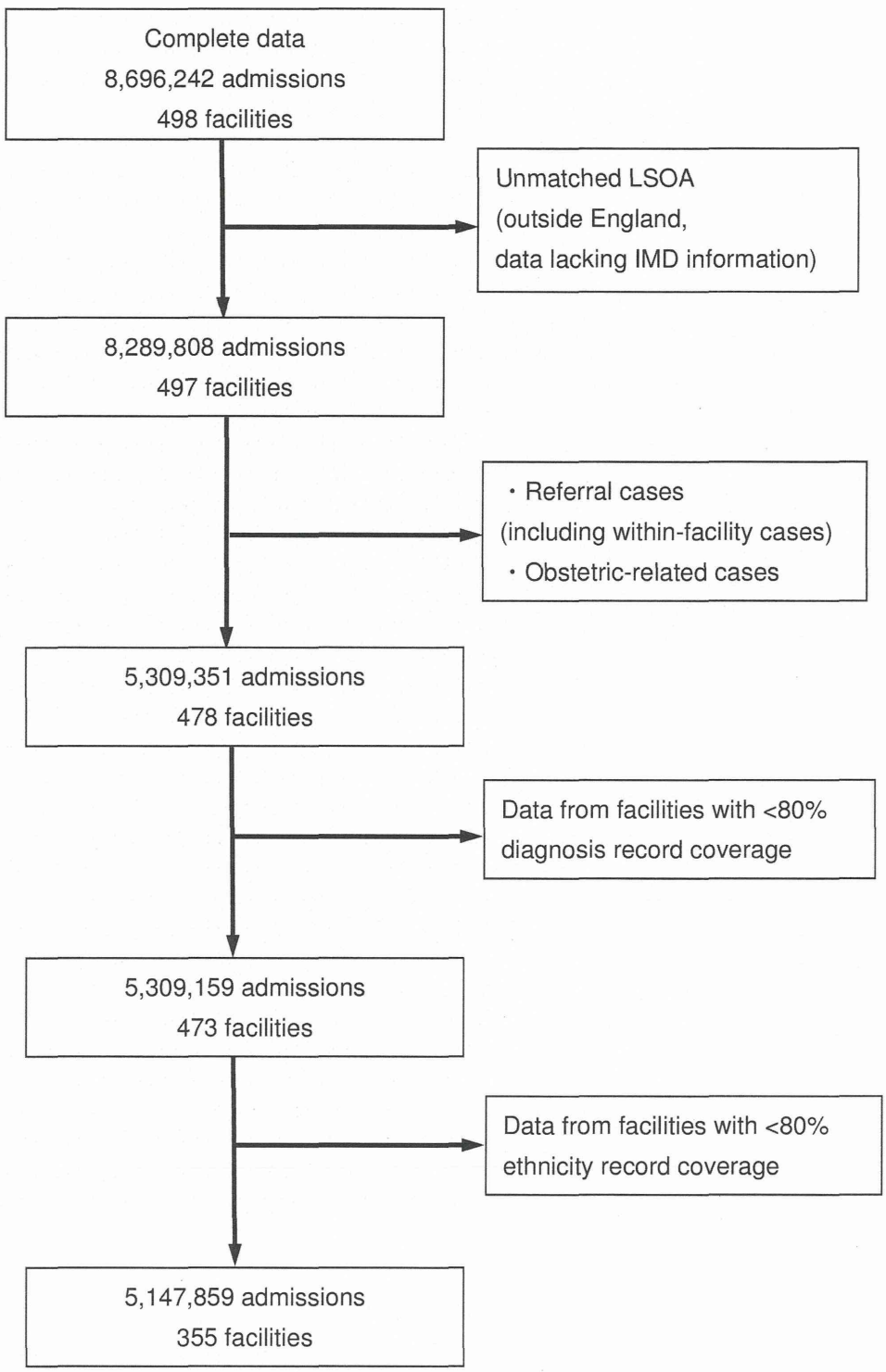

Fig 1. Data exclusion flowchart.

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applying the exclusion criteria, 5,309,351 admissions remained, spread across 478 hospitals. After excluding data with insufficient diagnostic codes and ethnicity data, 5,147,859 records remained in the data set, spread over 355 NHS hospitals. This is 97.0% of all valid attendances and 74.3% of all valid NHS hospitals.

In the whole of England, there were a total of 445,504 diabetes admissions, giving a crude rate of 1049.0 (95% CI: 1046.0–1052.1) admissions per 100,000 population.

Fig. 2 shows IMD quintile-specific directly standardized admission rates. The age-sex standardized admission rate increases with increasing deprivation.

Table 1 shows the result of multiple regression analysis of diabetes admissions by IMD quintile adjusting for ethnicity. Likelihood ratio tests comparing the multi-level model with a simple Poisson regression without random effects in the model showed the random effects were significant. The relative risk of diabetes-related admission increases with IMD quintile. The poorest quintile of white British had a 2.08 times (95% CI 2.02–2.14) higher admission risk than the richest quintile. The risk of diabetes-related admission among south Asian British was 2.62 (95% CI 2.51–2.74) times higher than white British. Although statistically significant, the risk increase among other non-white British was not large. Other risk factors for hospital admission were age, sex and living in an urban area.

The chi square value of the Wald likelihood test of overall interaction terms (185.25, p-value <0.001) shows that there was a statistically significant interaction between ethnicity and deprivation. Fig. 3 shows the relationship between diabetes-related hospital admission risk and IMD quintile, for selected ethnicities calculated from linear combinations of the coefficients shown in Table 1. The effect modifier for south Asian ethnicity showed lower sensitivity to IMD (1.68 times higher risk in the most deprived quintile than the least deprived quintile) than black British (2.28 times higher risk) or white British (2.08 times higher risk). This is suggestive of an attenuated effect of deprivation in south Asian British relative to white and black British.

A total of 174,932 patients were admitted due to diabetes at least once and 73,684 patients were admitted more than once. Table 2 shows the result of Poisson regression of readmission in these patients. For this model the random effect was also significant. The relative risk of diabetes-related readmission also increases with IMD quintile but the association was much weaker than that of admission. The poorest quintile of white British had a 1.18 times (95% CI 1.15–1.22) higher readmission risk than the richest quintile. The relative risk of readmission in south Asian British was 0.86 (95% CI 0.80–0.94) times that of white British. Other ethnic groups did not show significant difference from white British except the "other" ethnic group. Readmission risk was slightly higher in patients whose index admission was elective than those who were admitted through the emergency department. Women showed slightly lower risk of readmission than men. Almost all other covariates showed no significant difference.

Fig. 4 shows the relationship between readmission and IMD by selected ethnicities, calculated from linear combinations of the coefficients shown in the Poisson regression. Black and white British show almost no difference by IMD quintiles, while hospital readmission in more deprived groups was higher in white British though the relationship is attenuated.

Discussion

This is the first study to analyze the effect of socioeconomic deprivation and ethnicity on inpatient hospital admission and readmission due to diabetes using inpatient admission data for all of England, by deprivation quintiles and by ethnic groups. Our study is the first analysis of HES data for the whole of England to use multi-level modeling in the statistical analysis. We used IMD as a second level effect, because IMD is calculated at the level of LSOA rather than

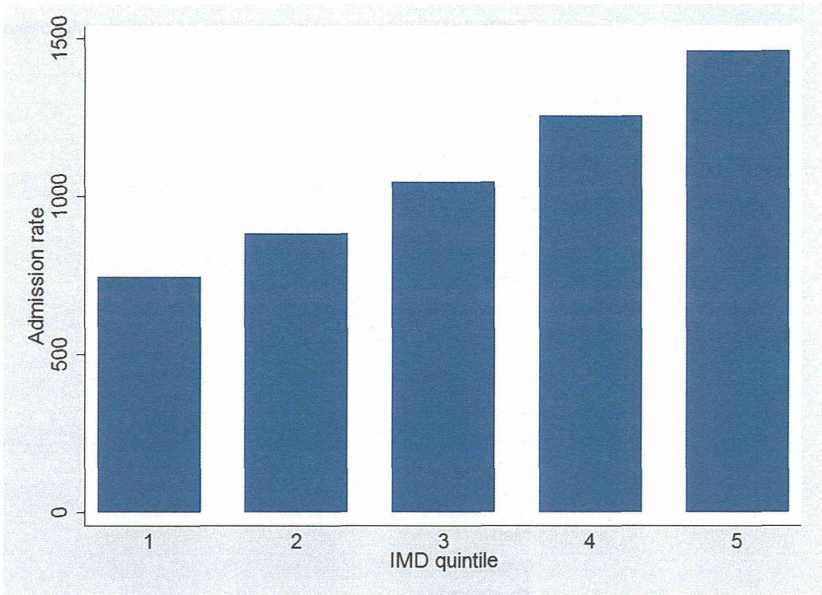

Fig 2. IMD quintile-specific directly standardized admission rate due to diabetes.

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for individuals[19]. This enables our study to incorporate the effect of unmeasured community-level influences on hospital admission risk.

In this study we found that risk of inpatient admission for diabetes increases with increasing socioeconomic deprivation measured by IMD quintile, and that although the relationship exists across all ethnicities it is strongest in white and black British. The relative risk of hospital admission in the most deprived quintile among white British was 2.08 (95% CI 2.02–2.14) times higher than the least deprived quintile. The relative risk in the most deprived quintile was 1.68 (95% CI: 1.58–1.77) times and 2.28 (95% CI: 2.02–2.57) times higher than the least deprived quintile among south Asian and black British, respectively. Admission risk was 1.61 times (95% CI: 1.60–1.62) higher for transfer from emergency departments than through elective or planned admission pathways.

This research also found that ethnic minority groups are at higher risk of hospital admission for diabetes compared to white British people even after adjusting for socioeconomic deprivation. For diabetes, this may reflect the known differences in prevalence between South Asian, white and black British[9–11]. We found readmission rates in most non-white groups were not significantly different from the white group, though the smaller number of observations gave wider confidence intervals. This suggests that the relationship between ethnicity and inpatient admission may reflect racially-specific higher prevalence, but may also be a function of differences in primary care management or health-seeking behavior[21]. By contrast, this study found that people from poorer areas had higher rates of readmission, even after adjusting for ethnicity. Even though they were admitted once, after discharge the same people in these socioeconomic groups were more likely to be admitted to hospital again. This suggests that prevalence alone does not account for the differences in admission risk by IMD.

The two main possible causes of the increased risk of hospital admissions and readmissions in poorer areas are excess prevalence of individual risk factors in poorer individuals, or poorer management of diabetes in primary care in poorer areas[22]. One of the most important risk factors for diabetes is obesity, and the prevalence of obesity is inversely associated with

Table 1. Multiple regression model of relationship between hospital admission due to diabetes, IMD quintile and ethnicity.

Variables	Relative Risk	95% Confidence Interval	P-value
IMD quintile			
Quintile 1 (Least Deprived)	1	N.A.	
Quintile 2	1.16	1.13–1.19	<0.001
Quintile 3	1.35	1.32–1.39	<0.001
Quintile 4	1.68	1.63–1.73	<0.001
Quintile 5 (Most Deprived)	2.08	2.02–2.14	<0.001
Age			
16–29 years	1	N.A.	
30–44 years	2.28	2.22–2.34	<0.001
45–64 years	5.88	5.74–6.02	<0.001
65 + years	14.17	13.83–14.51	<0.001
Sex			
Men	1	N.A.	
Women	0.64	0.63–0.64	<0.001
Region type			
Urban	1	N.A.	
Town	0.89	0.87–0.91	<0.001
Village	0.81	0.80–0.83	<0.001
Ethnicity			
White	1	N.A.	
Mixed	1.49	1.29–1.72	<0.001
South Asian	2.62	2.51–2.74	<0.001
Black	1.22	1.09–1.37	0.001
Asian	1.02	0.87–1.21	0.783
Others	1.32	1.21–1.43	<0.001
IMD/ethnicity interaction			
IMD Quintile 1: all	1	N.A.	
IMD Quintile 2:			
Mixed	0.83	0.68–1.01	0.061
South Asian	0.91	0.86–0.97	0.004
Black	1.23	1.07–1.42	0.004
Asian	1.22	0.95–1.57	0.111
Others	1.03	0.92–1.16	0.585
IMD Quintile 3:			
Mixed	1.15	0.97–1.37	0.10
South Asian	0.85	0.81–0.91	<0.001
Black	1.20	1.05–1.36	0.006
Asian	0.83	0.65–1.06	0.135
Others	1	0.90–1.11	0.946
IMD Quintile 4:			
Mixed	0.73	0.61–0.86	<0.001
South Asian	0.81	0.77–0.86	<0.001
Black	1.12	0.99–1.26	0.068
Asian	1.10	0.89–1.36	0.371
Others	0.89	0.80–0.98	0.019

(*Continued*)

Table 1. (*Continued*)

Variables	Relative Risk	95% Confidence Interval	P-value
IMD Quintile 5:			
Mixed	0.86	0.73–1.01	0.074
South Asian	0.81	0.77–0.85	<0.001
Black	1.10	0.97–1.24	0.127
Asian	1.07	0.87–1.32	0.538
Others	0.86	0.78–0.95	0.003
Admission method			
Elective	1	N.A.	
Emergency	1.61	1.60–1.62	<0.001
Likelihood ratio statistic against without random effect mode (p-value)		129728.94(<0.001)	

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socioeconomic status in developed nations[23]. Type 2 diabetes prevalence increased in the UK between 1994 and 2006 and the increase was associated with socioeconomic inequality measured by social class categories[7], though there was no consistent pattern in individual risk factors[24].

In the UK, the poor and ethnic minorities are more likely to consult their GP than secondary care[25] and people from more deprived socioeconomic backgrounds use all forms of medical services less frequently[8]. Although historical socioeconomic disparities in diabetes care [26] seem to have reduced[24], it has been suggested that there is still poorer control of risk factors such as HbA_{1c} in more deprived white British[27]. In the context of the pathway of care through Britain's health system, this result suggests a failure of the primary care gate-keeping role, leading to increased need for secondary care for diabetic patients in highly deprived areas. In the most deprived areas and the areas with the worst health and deprivation indicators (so-

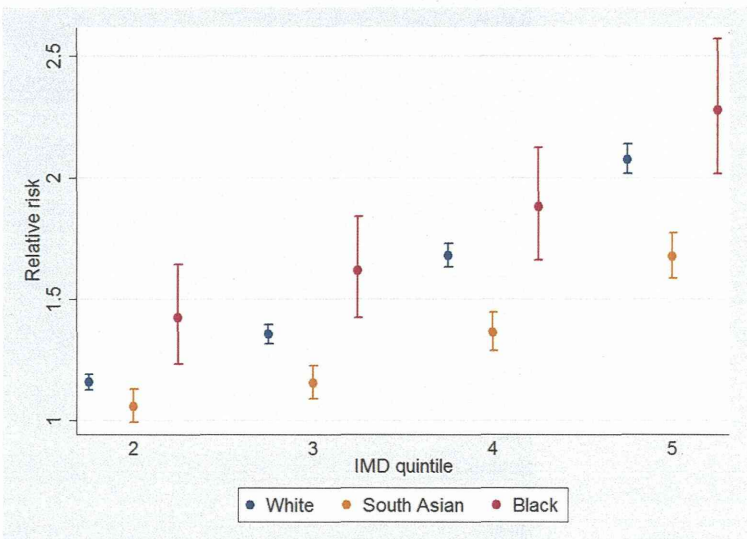

Fig 3. Sensitivity of relative risk of admission to IMD quintiles by ethnicity.

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