Influence of practices' ethnicity and deprivation on access to angiography: an ecological study

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SUMMARY

Background: *Coronary heart disease is more common among some ethnic minority groups (particularly people from the Indian subcontinent living in Europe and North America) and in socially deprived populations. Hospital studies in the United Kingdom (UK) suggest that these groups have less access to treatment for coronary heart disease. Studies from primary care have found reduced access to angiography for lower social class groups, but there are no studies on the ethnicity of primary care populations in relation to angiography.*

Aims: *To determine the influence of ethnicity and social deprivation in primary care on access to coronary angiography.*

Design of study: *Ecological study measuring general practices' ethnicity, socioeconomic status, and nitrate prescribing rates with angiography rates.*

Setting: *General practices (n = 143) in East London, UK.*

Method: *Ecological study measuring the proportion of general practice populations with South Asian ethnicity and high social deprivation score (Carstairs). Nitrate prescriptions and admissions for myocardial infarction per 1000 population per year were used as measures of need. Distance from the tertiary centre was used as a measure of supply. The outcome measure was coronary angiography procedures data (n = 869) collected in the context of the appropriateness of coronary revascularisation study.*

Results: *Practices with a higher proportion of South Asian patients had higher rates of angiography after adjustment for age, distance, deprivation, nitrate prescribing and myocardial infarction admissions (regression coefficient B = 0.02, 95% confidence interval [CI] = 0.01 to 0.03, P<0.001). There was no association between deprivation and angiography (regression coefficient B = -0.41, 95% CI = -0.13 to 0.05, P = 0.393).*

Conclusion: *General practices with a higher proportion of South Asian patients had higher rates of angiography, challenging the widely held belief that access may be inequitable. Deprivation shows no relationship with angiography in this study.*

Keywords: *access to health care; coronary angiography; epidemiology; ethnic groups; primary health care; social class.*

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Introduction

ALTHOUGH primary care consultations for coronary heart disease are increasing,[1] the majority of patients are not referred to secondary care,[2] nor are they investigated with coronary angiography. Guidelines[3] and United Kingdom (UK) government policy[4] aim to improve access to hospital services equitably among all sections of the community.[5] It is well established that people of South Asian origin have a higher prevalence of coronary disease than people of European origin.[6] There is evidence to suggest that people of South Asian origin, despite the higher risk of coronary disease, may experience increased delays in investigation, less aggressive treatment[7] and receive less invasive management.[8] Among hospital patients in whom coronary artery bypass grafting was deemed appropriate, South Asian patients were less likely to receive this procedure than white patients.[9]

However, a key question remains unanswered; how does ethnicity and social deprivation in primary care influence access to coronary angiography? One study in the UK found that general practices with high deprivation scores had a lower rate of angiography, but ethnicity data was not collected.[10] The aim of this study, therefore, is to examine whether ethnicity and social deprivation in primary care populations influence access to coronary angiography.

Method

In the absence of primary care cohorts of individually characterised patients, we used an ecological design, based on practice level characteristics. The study received ethical approval from the former East London and the City Health Authority for the appropriateness of coronary revascularisation (ACRE) study and use of the East London general practice database. Patients in the ACRE study gave written consent. The East London general practice database uses anonymised patient data and is overseen by an advisory group.

The former East London and the City Health Authority has among the highest levels (ranked fifth in England from 2000–2001 data) of age standardised rates of coronary bypass surgery and angioplasties at 1307 per million, compared with the all-England rate of 905 per million (range = 504–1885 per million).[11]

General practices

Individual practices in the East London general practice database were the unit of analysis in this ecological study. The database contains information on age, ethnicity, deprivation, and nitrate prescriptions for the registered population of each of the 163 practices (total registered population = 725 342)

HOW THIS FITS IN

What do we know?

Coronary disease is more common among some ethnic minority groups and socially deprived populations. Hospital-based studies suggest that patients from ethnic minorities and those with lower socioeconomic status may have less access to tertiary care than patients from the majority white community.

What does this paper add?

General practices with a higher proportion of South Asian patients had higher rates of angiography, consistent with equitable access to specialist cardiac services from primary care. General practices with more deprived populations had neither more admissions for myocardial infarction nor angiography.

in contract with the former East London and the City Health Authority. The database has been used previously in studies of factors influencing use of secondary care services.[12,13] Distance in kilometres between each practice and the tertiary centre performing coronary angiography was calculated using multimap software.[14]

South Asian ethnicity

The proportion of each practice population identified as of South Asian origin was determined by checking the names of practices' registered patients with a validated database of names of people from Bangladesh, India, Pakistan, and Sri Lanka.[15] Similar methods for measuring ethnicity have been used in the UK[16] and Canada.[17]

Social deprivation

We used the Carstairs' measure of deprivation,[18] based on 1991 census data. This score combines overcrowding, male unemployment, low social class, and not having a car. Negative scores denote affluent and positive scores more deprived populations; Carstairs scores were standardised to England and Wales. The Jarman score[19] is often used to describe deprivation in primary care studies, but is not appropriate for our analysis because it already includes a measure of ethnicity.

Nitrate prescriptions

We obtained nitrate prescribing data from prescribing analysis and cost data collected by the Prescription Pricing Authority.[20] The British National Formulary code for nitrates (2.6.1) includes sublingual (for example, glyceryl trinitrate tablets), transdermal (patches), and oral forms (short- and long-acting; for example, isosorbide mononitrate).

Myocardial infarction admissions

We obtained hospital admission data for acute myocardial infarction (ICD 10 code 121) for each practice from the patient administration system via the health authority information department. We collected data from the same time period as the ACRE study, during which time there were 540 admissions for myocardial infarction.

Coronary angiography procedures and findings

Over 90% of coronary angiography procedures performed on patients resident in the health authority are carried out at Barts and the London NHS Trust, the only tertiary cardiac centre within the former East London and the City Health Authority. Angiographies were identified from the ACRE study, a prospective cohort study of all patients who underwent coronary angiography during a 12-month period at this centre.[21] There were 917 study patients resident or registered within the boundaries of the health authority. Coronary artery disease was defined as the presence of one or more diseased vessels according to previously described criteria.[22] The appropriateness of angiography was defined by nine-member expert-panel ratings, described in detail elsewhere.[23]

Statistical analysis

In order to validate ecological associations between our practice level data and use of coronary angiography, we postulated positive correlations between coronary angiography and measures that reflect need: age, nitrate prescriptions[2] and admissions for myocardial infarction. We also predicted a negative correlation with distance from the practice to the cardiac centre (as a measure of supply).[10] For each practice we expressed the numbers of nitrate prescriptions, acute myocardial infarction admissions, unique admissions for angiography, and unique admissions for angiography in which coronary artery disease was confirmed per year, per 1000 registered population aged 35 years or over. The relationship of ethnicity and deprivation with angiography rate, coronary artery disease and appropriate angiography were described initially by a comparison of crude mean rates and their 95% confidence intervals (CIs). In order to identify the independent effects, if any, of ethnicity and socioeconomic position, we fitted linear regression models, adjusting for the other factors; age, distance to tertiary centre, nitrate prescribing, and admissions for myocardial infarction. These effects were expressed as the slope (regression coefficient), both unstandardised and standardised (the increase in outcome variable for one standard deviation increase in explanatory variable), to facilitate comparison between variable measured on different scales. Relations between explanatory variables were expressed as Pearson correlation coefficients (*r*). All analyses were performed in SPSS.

Results

The angiography procedures were successfully linked to 869/917 (95%) of the practices ($n = 143$). Practice list size ranged from 749 to 12 825 (median = 3929). There was a wide variation between practices in the rate of nitrate items prescribed (interquartile range = 148–288), and proportion of South Asian patients (7–34%, UK mean = 4%). Carstairs deprivation scores (-2.89 to 15.18, UK mean = 0) showed a predominantly deprived population.

Practice level need and use of coronary angiography

Practices with a higher proportion of older people, a higher volume of nitrate prescribing, and more admissions for myocardial infarction had more patients who received

Table 1. Mean rates (per 1000 target list population) by exposure variables below and above median values.

Variable	Median	Interquartile range	Cut-off (*n* practices)	Angiography procedures Mean	Angiography procedures 95% CI	Coronary disease found at angiography Mean	Coronary disease found at angiography 95% CI	Appropriate angiography Mean	Appropriate angiography 95% CI
Percentage aged ≥65 years	10.3	7.7 to 13.3	≤10.3 (80)	2.44	2.06 to 2.82	1.81	1.47 to 2.15	1.32	0.33 to 1.57
			>10.3 (79)	2.97	2.54 to 3.38	2.13	1.81 to 2.45	1.48	0.39 to 1.74
Distance to tertiary centre in km	4.9	3.2 to 6.0	≤4.9 (72)	3.26	2.88 to 3.63	2.33	2.00 to 2.65	1.70	0.45 to 1.97
			>4.9 (71)	2.76	2.36 to 3.16	2.04	1.70 to 2.37	1.41	0.37 to 1.67
Percentage with a South Asian name	17.0	7.0 to 34.0	≤17 (80)	2.45	2.06 to 2.84	1.79	1.48 to 2.10	1.31	0.31 to 1.54
			>17 (79)	2.95	2.53 to 3.36	2.16	1.80 to 2.51	1.49	0.40 to 1.76
Carstairs deprivation score	5.2	-2.9 to 15.2	≤5.2 (80)	2.50	2.09 to 2.91	1.82	1.47 to 2.16	1.38	0.38 to 1.65
			>5.2 (79)	2.86	2.46 to 3.25	2.09	1.77 to 2.40	1.39	0.35 to 1.64
Nitrate prescribing in primary care	216	148 to 288	≤216 (75)	2.14	1.82 to 2.46	1.46	1.20 to 1.72	1.02	0.22 to 1.23
			>216 (74)	3.42	2.96 to 3.87	2.55	2.17 to 2.92	1.80	0.53 to 2.09
Myocardial infarction admissions	1.6	0.8 to 2.3	≤1.6 (80)	2.08	1.73 to 2.43	1.49	1.21 to 1.76	1.07	0.24 to 1.30
			>1.6 (80)	3.30	2.89 to 3.71	2.43	2.07 to 2.78	1.73	0.47 to 2.00

angiography, and appropriate angiography, as well as more patients with coronary disease at angiography (Table 1). Age (regression coefficient $B = 0.07$, $P = 0.026$), and nitrate prescriptions ($B = 0.004$, $P = 0.001$) were independently associated with use of angiography in the hypothesised directions (Table 2). There was an inverse relationship with distance from practice to the angiography centre and angiography rates ($B = -0.22$, $P = 0.002$). There was no relationship with hospital admission rates for myocardial infarction and coronary angiography rates ($B = 0.10$, $P = 0.37$). Nitrates and myocardial infarction admission rates were not related (age adjusted $r = 0.07$, $P = 0.41$).

Effects of ethnicity

Practices with a higher proportion of South Asian patients had more patients receiving angiography (Figure 1), appropriate angiography, and more patients with coronary disease at angiography (Table 1). Practices with a higher proportion of South Asian patients were more socially deprived (age adjusted $r = 0.27$, $P = 0.001$), had higher rates of nitrate prescribing (age adjusted $r = 0.16$, $P = 0.052$) and admissions for acute myocardial infarction (age adjusted $r = 0.23$, $P = 0.003$). The association between ethnicity and higher rates of angiography was independent of these associations ($B = 0.02$, $P<0.001$) (Table 2).

Effects of social deprivation

Practices with a higher Carstairs deprivation score had no independent association with angiography rate ($B = -0.41$, $P = 0.393$) (Table 2 and Figure 2).

Discussion

Main findings

Practices with a higher proportion of South Asian patients have higher rates of age-adjusted nitrate prescription and age-adjusted hospital admission rates for myocardial infarction, suggesting an increased coronary heart disease prevalence. In both crude and adjusted analyses, practices with a higher proportion of South Asian patients had higher

Table 2. Standardised betas (β) and unstandardised regression coefficients (B, 95% CI, P-value) for practice-level angiography rate, confirmed coronary artery disease and appropriate angiography rate, adjusted for all need and supply factors.[a]

	β	B	95% CI	P
Angiography procedures				
Percentage aged ≥65 years	0.21	0.07	0.01 to 0.14	0.026
Distance to tertiary centre in km	-0.26	-0.22	-0.34 to -0.08	0.002
Percentage with a South Asian name	0.34	0.02	0.01 to 0.03	<0.001
Carstairs deprivation score	-0.07	-0.41	-0.13 to 0.05	0.393
Nitrate prescribing in primary care	0.30	0.004	0.002 to 0.006	0.001
Myocardial infarction admissions	0.07	0.10	-0.11 to 0.31	0.370
Coronary disease found at angiography				
Percentage aged ≥65 years	0.18	0.05	0.02 to 0.11	0.041
Distance to tertiary centre in km	-0.27	-0.19	-0.31 to -0.17	0.001
Percentage with a South Asian name	0.40	0.02	0.01 to 0.03	<0.001
Carstairs deprivation score	-0.14	-0.07	-0.15 to 0.01	0.086
Nitrate prescribing in primary care	0.31	0.004	0.02 to 0.05	<0.001
Myocardial infarction admissions	0.10	0.12	-0.06 to 0.30	0.185
Appropriate angiography				
Percentage aged ≥65 years	0.07	0.02	-0.03 to 0.06	0.472
Distance to tertiary centre in km	-0.29	-0.17	-0.27 to -0.07	0.002
Percentage with a South Asian name	0.25	0.12	0.003 to 0.02	0.008
Carstairs deprivation score	-0.11	-0.04	-0.11 to 0.03	0.206
Nitrate prescribing in primary care	0.31	0.003	0.001 to 0.004	0.001
Myocardial infarction admissions	0.04	0.04	-0.12 to 0.20	0.643

[a]Medians and interquartile ranges are as for Table 1.

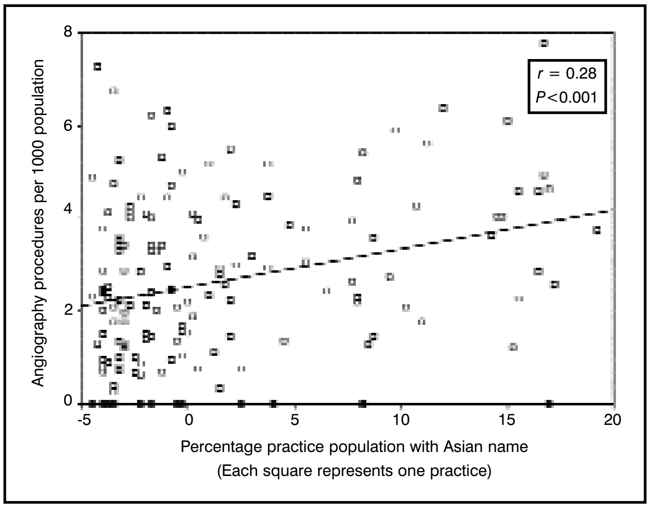

Figure 1. Scatterplot of angiography rate versus proportion of patients on general practice list with a South Asian name.

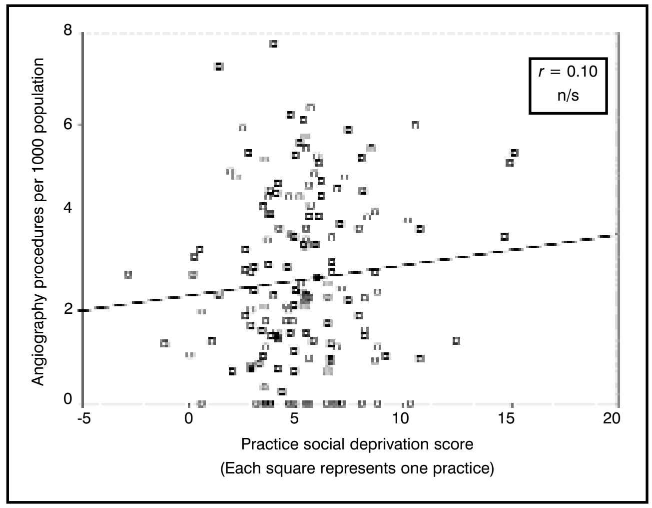

Figure 2. Scatterplot of angiography rate versus general practice list social deprivation score.

rates of angiography. There was no association between deprivation and indicators of coronary heart disease morbidity (nitrate prescription rates, myocardial infarction rates), and there was no association between deprivation and angiography (either crude or when adjusted). The study therefore offers cautious reassurance that general practice is not grossly inequitable with respect to South Asian ethnicity and access to coronary angiography. However, we have not seen the expected relationship with deprivation and angiography in this study.

Strengths and limitations of the study

The main methodological weakness of this study is inherent in all ecological studies; the individual patients who were South Asian, or lived in deprived areas, may not be the individuals undergoing angiography; the so-called ecological fallacy. Further, the small number of angiographies occurring in each practice will tend to underestimate true associations. Although our analysis, using individual general practices as the level of aggregation, is less subject to ecological confounding than using whole primary care trusts, there remains a need for adequately powered individual patient cohort studies in primary care.

Comparison with existing literature

Validity of approach. Practices with higher nitrate prescribing rates had higher angiography rates, demonstrating that need measured in primary care relates to supply in secondary care. Our findings are consistent with practices with a higher prevalence of angina, or patients with more severe angina, being more likely to be treated with nitrates, and in turn being more likely to undergo angiography. This observation supports the validity of nitrate prescribing as an objective marker of coronary disease in populations,[2] even though it may systematically underestimate angina prevalence.[24] Acute myocardial infarction admissions were not associated with nitrate prescribing. This may be owing to the fact that many myocardial infarctions are 'unheralded', so patients may not previously have been receiving treatment from their general practitioner.[25,26]

Ethnicity. We have shown, for the first time, that practices with more South Asian patients, who have a higher prevalence of heart disease,[27] also have greater use of coronary angiography. The naming database used to assign ethnicity is based on the actual population registered with a practice, and is therefore likely to be more accurate than electoral ward estimates. However, the naming program cannot distinguish between different South Asian communities; for example, between people from Bangladesh, Punjab, and Gujarat, among whom coronary disease rates vary.[28] A previous study by our group[9] found that South Asian patients undergoing angiography are equally likely as white patients to be judged appropriate for revascularisation, and referred for revascularisation. Our findings here concern the earlier stage of referral for angiography and are consistent in showing no ethnic disadvantage.

Social deprivation. East London is among the most socially deprived areas in the UK,[29] and this lack of social variation may explain why we found no relation between practices' socioeconomic status and cardiovascular morbidity or angiography use. This lack of association contrasts with two other studies. Firstly, a general practice-based study in Nottingham found an inverse relationship between deprivation and angiography rate.[10] Secondly, a population-based study in Sheffield found that, among those with symptoms there was an inverse relationship between revascularisation and deprivation (Townsend) score.[30]

Implications for future research

It is increasingly recognised that many patients who have symptoms of angina do not have a diagnosis, and this 'submerged clinical iceberg' may be prognostically important.[25,26,31] It is not known how ethnicity or social position influence the chances of consultation or diagnosis among people with symptoms of angina. There is an inverse relationship between angiography rates and the distance of practices from the centres performing the procedure. Although we were surprised to detect an effect of distance in an urban area with reasonable public transport links, this is

Commentary

Ecological studies investigate associations between exposure and outcome at some aggregate level, such as general practice, health authority or country, rather than at the individual level. They can often be done relatively quickly and cheaply using information that is routinely available. Most epidemiology texts warn that ecological studies are limited to hypothesis generation rather than hypothesis testing. The main reasons for this lowly ranking in the hierarchy of evidence are that ecological studies cannot link exposure with outcome among individuals and often have a reduced ability to control for potential confounding factors. These inherent design weaknesses can give rise to what is known as the 'ecological fallacy'. This is where we infer, potentially incorrectly, that associations observed at the aggregate level also hold true for individuals.

A good example is that of alcohol consumption and coronary heart disease death rates among middle-aged men. Ecological data from the early 1970s reported a strong inverse association between per capita alcohol consumption and coronary heart disease mortality in developed countries.[1] Countries such as Italy and France, with the highest alcohol consumption, had the lowest coronary heart disease mortality rates. However, later studies that collected individual information on alcohol consumption found that the association may be better represented by a J-shaped curve.[2] Individuals who drink the most have the highest risks, and those who drink a moderate amount have a lower risk than both heavy drinkers and non-drinkers. This illustration of the ecological fallacy is likely to owe in large part to the inability of group-level data to properly control for confounding factors such as diet, physical activity, smoking, and alcohol type and consumption patterns.

Other examples of group-level associations have been later borne-out by individual-level analyses. Local authorities in England and Wales with the highest infant mortality rates in the 1920s (infant mortality was taken as a proxy for poor fetal growth) had the highest heart disease mortality rates 50 years later.[3] Although not universally true, studies of individual fetal growth indicators and cardiovascular disease in later life have generally supported the association observed at the ecological level.[4]

Some risk factors for disease may genuinely operate at a population level, either directly or as an effect modifier; for example, average economic status of a neighbourhood or country may exert influences on health over and above individual economic status. So, although it may be misleading to infer individual risk factors from ecological associations, ignoring group-level effects may also lead to biased estimates of association. Increased interest and methodological developments in multi-level analysis means that if the data are available, studies can estimate both group-level and individual effects.

As Jones and colleagues point out in their paper,[5] practices with higher proportions of South Asian patients had higher angiography rates, but it may not be the South Asians within these practices who have the angiographies. Without individual data, this question cannot be answered. However, given the hierarchical nature of the data involved in this area (patients within practices, practices within trusts), even a study that collects information on individual patients with angina should take appropriate account of group-level data in a multi-level analysis.

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consistent with findings from Nottingham[10] and warrants further exploration.

Clinical implications

Patients may see a cardiologist via referral from secondary care or emergency admission, therefore referral for angiography can occur independently of the general practitioner. Thus we have studied the aggregate effect of decisions about referral to angiography across primary and secondary care. The National Health Service and other healthcare systems with similar datasets could replicate these analyses as a means of exploring equity of access to cardiovascular procedures. By themselves, these results have no direct implications for clinical practice. We need prospective studies based on individual patients with angina to investigate the appropriateness of investigation and referral decisions at each step in the pathway in relation to clinical outcomes. These studies will directly inform guidance to general practitioners.

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