Title: Is individual smoking behaviour influenced by area level ethnic density? A cross-sectional electronic health database study of inner south east London

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Abstract

Tobacco smoking remains one of the greatest public health problems facing the UK today. It varies significantly by ethnic group. This study aimed to determine whether ethnic differences in smoking behaviour are related to neighbourhood level own-group ethnic density across south and east London.

The association between ethnic density and individual smoking behaviour was assessed by multilevel logistic regression using the electronic health records of 688,397 GP registered patients. Restricted cubic splines were created to explore whether the effect of ethnic density on smoking behaviour was non-linear.

Increasing own-group ethnic density was found to be associated with a significant reduction in the odds of being a current smoker in all ethnic groups, except for Caribbean women. The relationship between ethnic density and current smoking was found to be non-linear, with the strength of association varying significantly by gender and ethnic group.

These novel findings point to a complex relationship between culture, neighbourhood level experience of adversity or social support and smoking behaviour, and will allow us to target smoking cessation services differentially to individuals/groups living in relative ethnic isolation, who do not benefit from the potential cultural/social factors associated with reduced tobacco consumption.

Introduction

Tobacco smoking remains one of the greatest public health problems facing the UK today. Though smoking rates have decreased by over half since the 1970s, from 46% in 1974, to 16.9% in 2015 smoking is still a leading preventable cause of morbidity and mortality in the UK. (1) Smoking is a key risk factor for cardiovascular disease (CVD), respiratory disease, cancer, and a range of other conditions. In 2014, 1.7 million hospital admissions, and 78,000 deaths in Great Britain were attributable to smoking. (2)

Patterns of smoking have been shown to differ significantly between genders, by socioeconomic status and by ethnic group.(3–6) Smoking rates tend to be higher for men compared to women, with the gender difference most pronounced for South Asian groups.(4) In the UK, higher levels of deprivation have been associated with higher rates of smoking.(6) In 2016, the smoking prevalence was found to be more than a third higher for people living in the most deprived decile of local authorities compared to those living in the most affluent decile of local authorities in England (20.4% compared to 14.3%). (1)

A number of studies have linked ethnic minority health status to area level ethnic density. This concept has been fruitfully explored in the field of mental health. In this case, the ethnic density hypothesis posits that members of ethnic minority groups may have better mental health when they live in areas with a higher density of people with the same ethnicity. A narrative review in 2012 suggested there was good evidence to support this proposition for the prevalence of psychotic disorders,(7–10) with more recent studies suggesting a similar pattern for common mental disorders.(11,12) In Utah in the USA Hispanic immigrants were at greater risk of obesity the more isolated they were from their own ethnic group.(22).(13) The explanatory mechanisms for these differences in prevalence of mental health problems and health risks are hypothesised to be related to the experience of reduced discrimination and enhanced social support in areas of higher own ethnic density – although it is challenging to demonstrate this empirically.(14)

Whether the beneficial health effects of higher own-group ethnic density extend from disease prevalence and risk to health behaviours, such as smoking, remains to be

explored.(15) Although the UK National Institute for Health and Clinical Excellence has highlighted the need to target smoking cessation services at ethnic minority groups(16), studies from across the UK indicate that smoking rates are already low amongst ethnic minority groups, and thus the greatest need for smoking cessation services may be amongst the white majority population.(3,5,17–20) Acculturation towards the norms of the majority social group can change smoking behaviour amongst ethnic minority groups. When moving from a country with low smoking prevalence, acculturation tends to be associated with increased smoking behaviour, though this pattern may be offset by higher education levels amongst second generation migrants, which is associated with reduced smoking rates.(21,22),

In addition to ethnic differences in the prevalence of current smoking, evidence also exists for ethnic differences in smoking intensity(23). Ethnic differences in smoking intensity have been linked to genetic differences in the cytochrome P450 (CYP2A6), which modulates nicotine metabolism, and ultimately, aspects of smoking behaviour.(24–27)

Several studies have highlighted both the importance of developing culturally sensitive health promotion programmes, and also a lack of evidence on how best to deliver these programmes to ethnic minority populations.(28,29) Key considerations include lack of cultural acceptability, language differences, and lack of time and resources amongst healthcare practitioners.(30)

The aims of this study are to determine whether ethnic differences in smoking behaviour are related to neighbourhood level own-group ethnic density across south and east London, and whether these effects vary by gender and age group after accounting for deprivation and geographical location. This study will firstly explore geographical variation in ethnic density in south and east London and, secondly, assess the association between ethnic density and smoking prevalence and intensity.

Methods

This was a cross-sectional observational study using routinely collected primary care data of the association between ethnic density and smoking behaviour in ethnic groups in four inner city boroughs of south and east London.

Data Source

Routinely collected GP health records for all patients registered in Hackney, Lambeth, Newham, and Tower Hamlets were combined to conduct a cross-sectional study. The study population comprised all adults aged 18 and over registered with 47/48 practices in Lambeth in October 2013 and 140/142 practices in Hackney, Newham and Tower Hamlets in June 2015. Patients were eligible for inclusion in the study if they were resident in the London boroughs of interest (Hackney, Lambeth, Newham, and Tower Hamlets).

Individuals with an existing Read coded diagnosis of COPD or lung cancer at the time of data capture were excluded from the analysis in order to identify a population of individuals free from established smoking related respiratory disease (see supplementary files for code list).(31) We excluded these individuals to capture a population suitable for targeting by smoking cessation services in primary care.

Individual-level variables

Individual data were anonymised prior to collection. Data collected included age, gender, self-reported ethnicity, smoking status, smoking intensity (cigarettes smoked per day), census derived lower super-output area based on postal code, Index of Multiple Deprivation (IMD) score, and general practice with which registered. Individual self-reported ethnicity recorded at registration or consultation was reduced to 16 ethnic groups as defined in the 2011 UK census.(32) The main analysis was restricted to the majority ethnic group of white British/Irish, and six ethnic minority groups of other white, Indian, Pakistani, Bangladeshi, black African, and black Caribbean as they represented the main ethnic minority groups resident across South and East London.(32,33) South Asian and Black ethnic sub-groups were considered separately throughout the analysis to account for known differences in migration

history, geographic dispersion, cultural and religious influences on smoking, and established differences in smoking prevalence.(4,5,34)

To identify current smokers, Read codes for tobacco consumption were reduced to two groups of current smoker and current non-smoker (including ex-smoker and never smoker). For the purpose of analysis, we summarised smoking intensity into low intensity (up to 20 cigarettes per day) and high intensity (more than 20 cigarettes per day) (see supplementary files for code list).

Area-level variables

Area-level ethnic density for each ethnic group was defined as the percentage of people from that ethnic group living within each lower super output area (LSOA – an administrative area with an average population of 1,614 individuals), based on the 2011 Census.(35) As a measure of socio-economic deprivation we used the Index of Multiple Deprivation score (IMD) from 2010, with a score assigned to each patient based on home postcode. (36)

Mapping

Mapping of ethnic densities was carried out to demonstrate their distribution in the geographical areas of investigation. To facilitate easier visualisation of this distribution, individuals were aggregated in the larger Middle Super Output Areas (MSOA – an administrative area with an average population of 7,787). The mapping was restricted to four ethnic groups: white, Bangladeshi, African, and Caribbean, because of the low densities of the others.(33) Area level ethnic density estimates were compiled from the current patient data, rather than relying on 2011 Census data, to ensure that they were up to date and as closely related as possible to the population under investigation. (37)

Statistical Analysis

All analyses were stratified by gender to account for established differences in smoking patterns between men and women. Firstly, a three level logistic regression model, which nested patients within LSOAs within boroughs, was conducted separately for each ethnic group. A difference in ethnic density of 10% of the total population was set as the threshold

interval above which an association with a change in the odds of being a current smoker was sought. A priori confounders included age, general practice, borough and IMD score.

Secondly, to assess whether the relationship between change in ethnic density and smoking status differed by age group, we further stratified the analysis by those aged 18-35 and those over 35. We hypothesized that younger adults may be more acculturated to the majority ethnic group and thus show a different relationship between their smoking behaviour and own-group ethnic density, with the association between ethnic density and smoking behaviour being greater in older adults than in younger adults.

Thirdly, to explore whether the association between ethnic density and smoking behaviour was non-linear, we repeated the analysis using restricted cubic splines which modelled the non-linear change in the odds of being a current smoker for every 10% increase (10% of the total population) in own-group ethnic density.(38) A secondary analysis restricted to current smokers was conducted to examine the relationship between own-group ethnic density and smoking intensity, with high smoking intensity defined as smoking more than 20 cigarettes per day. All analyses were carried out using Stata v.14.(39)

Ethical Approval

All data were anonymised and managed according to the UK NHS information governance requirements. Ethical approval was not required for this observational study as it relied solely on the use of Read coded, non-identifiable data with results published in aggregate form.

Results

From a total GP registered population of 1,000,388 adults aged 18 and over across Lambeth and east London, 917,173 patients were resident within the study area of interest and were free from COPD and lung cancer. From this population, 688,397 patients belonged to the pre-specified ethnic groups of interest (see supplementary files for population derivation flowchart). Figure 1 illustrates the wide geographical variation in neighbourhood level ethnic density for Bangladeshi, white British & Irish, black Caribbean, and black African.

(Insert Figure 1 about here)

Mean ethnic density was highest for the white British & Irish group and lowest for the black Caribbean group (Table 1). Large ethnic and gender differences in the proportion of current smokers and heavy smokers are apparent in the study population. The proportion of both current and heavy smokers is uniformly lower for women compared to men, with the difference most pronounced for South Asian groups, where the proportion of current smokers is up to up to 6 times higher for men compared to women.

Table 1. Ethnic breakdown of age, gender, IMD[1] score, ethnic density, current smokers and smoking intensity in south and east London.

	white British & Irish	other white	Indian	Pakistani	Bangladeshi	black Caribbean	black African
Male							
Frequency (n)	113,298	76,031	30,159	19,785	50,871	18,138	33,472
Mean age (SD)	42.7 (15.8)	37.2 (12.0)	37.8 (13.9)	36.3 (13.4)	35.9 (12.9)	48.3 (17.6)	41.3 (13.5)
Median IMD[1] score (IQR)	36.6 (15.3)	37.9 (14.5)	38.8 (9.5)	40.4 (9.6)	43.8 (13.6)	38.7 (12.9)	41.5 (13.7)
Median ethnic density % (IQR)	38.2 (20.0)	15.4 (6.7)	17.9 (42.3)	13.0 (13.2)	28.5 (30.7)	8.6 (5.2)	13.6 (10.2)
Current smokers (%)	36.0	39.2	21.5	27.8	43.8	41.8	18.4
>20 cigarettes/day[2](%)	12.1	7.6	2.4	3.7	4.0	3.6	2.8
Female							
Frequency (n)	115,654	90,531	23,801	12,673	42,513	24,039	37,432
Mean age (SD)	42.3 (17.7)	36.0 (12.8)	39.6 (15.6)	38.2 (14.5)	36.9 (14.5)	48.3 (17.7)	40.8 (14.0)
Median IMD[1] score (IQR)	36.6 (15.2)	38.1 (14.3)	38.7 (9.7)	40.1 (9.0)	43.9 (13.5)	38.8 (12.6)	41.8 (13.5)
Median ethnic density % (IQR)	38.4 (20.4)	15.2 (6.6)	15.1 (24.5)	12.3 (13.4)	28.9 (30.6)	8.7 (5.9)	13.7 (10.2)
Current smokers (%)	31.8	31.4	5.0	5.3	7.2	24.2	6.2
>20 cigs/day[2] (%)	8.8	3.2	1.9	2.7	2.1	2.5	1.4

1 IMD: Index of multiple deprivation

2 High intensity smoking >20 cigarettes per day

The association between ethnic density and smoking status

The association between ethnic density and smoking status stratified by gender is presented in table 2. Each 10% increase in own-group ethnic density was associated with a 2-20% reduction in the odds of being a current smoker for all ethnic groups except for black Caribbean women. For men, the largest association was found in the black African group, for whom each 10% increase in own-group ethnic density was associated with an 18% reduction in the odds of being a current smoker (p<0.001). For women, the largest association was found in the Pakistani group, for whom, each 10% increase in own-group ethnic density was associated with a 43% reduction in the odds of being a current smoker. For black Caribbean women, no association between ethnic density and smoking status was evident (Table 2).

Table 2. Association between an increase of 10% in area ethnic density and the prevalence of current smoking by ethnic group

	Male			*Female*		
Ethnic Group	OR	95% CI	p.value	OR	95%	p.value
white British & Irish	0.94	(0.92-0.97)	<0.001	0.96	(0.93-0.98)	<0.001
other white	0.92	(0.87-0.97)	0.003	0.93	(0.88-0.97)	0.002
Indian	0.93	(0.90-0.96)	<0.001	0.62	(0.57-0.69)	<0.001
Pakistani	0.88	(0.83-0.93)	<0.001	0.57	(0.48-0.67)	<0.001
Bangladeshi	0.98	(0.95-1.00)	0.056	0.92	(0.87-0.96)	<0.001
black African	0.82	(0.77-0.86)	<0.001	0.80	(0.73-0.88)	<0.001
black Caribbean	0.88	(0.79-0.99)	0.034	0.97	(0.86-1.08)	0.555

*Odds ratio adjusted for age, area deprivation, and borough

The relationship between ethnic density and smoking status stratified by gender and age group is presented in table 3, A significant reduction in odds of being a current smoker was evident in all male ethnic groups except for black Caribbean after stratifying by age. The size of the reduction was comparable between those under 35 and those over 35. Amongst women, the association between ethnic density and being a current smoker was larger for those under 35 compared to those over 35 in the other white and Bangladeshi ethnic groups (Table 3).

Table 3. Association between 10% increase in area ethnic density and change in prevalence of current smoking stratified by age group

Male	Effect of a 10% in area ethnic density on being a current smoker					
	Male <=35			Male >35		
Ethnic Group	OR	95% CI	p value	OR	95%	p value
white British & Irish	0.96	(0.93-0.98)	0.003	0.93	(0.91-0.95)	<0.001
other white	0.90	(0.84-0.96)	0.002	0.95	(0.89-1.01)	0.110
Indian	0.93	(0.78-0.98)	0.006	0.94	(0.89-0.98)	0.003
Pakistani	0.87	(0.80-0.94)	<0.001	0.91	(0.84-0.99)	0.028
Bangladeshi	0.97	(0.94-1.00)	0.070	0.99	(0.96-1.02)	0.548
black African	0.77	(0.70-0.86)	<0.001	0.85	(0.80-0.91)	<0.001
black Caribbean	0.95	(0.76-1.18)	0.642	0.90	(0.78-1.02)	0.104

Female	Effect of a 10% in area ethnic density on being a current smoker					
	Female <=35			Female >35		
Ethnic Group	OR	95% CI	p value	OR	95%	p value
white British & Irish	0.97	(0.94-1.00)	0.042	0.94	(0.92-0.97)	<0.001
other white	0.90	(0.85-0.96)	0.001	0.96	(0.90-1.03)	0.261
Indian	0.67	(0.60-0.78)	<0.001	0.57	(0.49-0.66)	<0.001
Pakistani	0.58	(0.47-0.71)	<0.001	0.56	(0.42-0.73)	<0.001
Bangladeshi	0.90	(0.85-0.95)	<0.001	0.94	(0.88-1.02)	0.133
black African	0.83	(0.73-0.94)	0.001	0.77	(0.69-0.87)	<0.001
black Caribbean	0.95	(0.79-1.14)	0.580	0.98	(0.85-1.12)	0.732

*Odds ratio adjusted for age, area deprivation, and borough

Ethnic density as a non-linear effect

Restricted cubic splines were used to examine the non-linear relationship between ethnic density and smoking status. Non-linear relationships were apparent for all ethnic groups, for both men and women (Figure 2). The shape of the relationship differed noticeably between men and women in all South Asian ethnic groups, but was comparable between genders for white British & Irish and black African and black Caribbean groups.

Amongst white British & Irish men and women, the odds of being a current smoker increased until own-group ethnic density reached 30% of the total population and then decreased thereafter. For Bangladeshi, Indian and Pakistani women, the association between smoking status and ethnic density fell steeply with each 10% rise in ethnic density until ethnic density rose above 20% of the total population at which point changes in ethnic density were not associated with changes in smoking status

(Insert Figure 2 about here)

The association between ethnic density and smoking intensity in current smokers

A secondary analysis examining the relationship between own group ethnic density and the odds of being a high intensity smoker (defined as smoking more than 20 cigarettes per day) was conducted for current smokers (Table 4). Due to the small proportion of high intensity smokers amongst women, the analysis of smoking intensity was restricted to men. There was no evidence of a relationship between own-group ethnic density and smoking intensity in six of the ethnic groups. The exception was Bangladeshi men, in whom a 10% increase in own-group ethnic density was associated with a 12% decrease in the odds of being a heavy smoker (OR 0.88; 95% CI 0.82-0.95).

Table 4. Association between 10% increase in area ethnic density and high intensity smoking

	Male				
Ethnic Group	Current smokers (n)	Heavy smokers (%)	OR	95%	p. val
white British & Irish	40,725	10.4	0.99	(0.96-1.04)	0.799
other white	29,783	6.2	0.90	(0.79-1.01)	0.074
Indian	6,481	2.1	0.84	(0.70-1.01)	0.060
Pakistani	5,504	3.3	1.08	(0.83-1.40)	0.560
Bangladeshi	22,262	3.8	0.88	(0.82-0.95)	0.001
African	6,173	2.4	0.94	(0.68-1.03)	0.706
Caribbean	7,580	3.0	0.67	(0.41-1.10)	0.115

After stratifying by age, the odds of being a high intensity smoker were comparable between Bangladeshi males <=35 and Bangladeshi males >35 (results in supplementary files). Restricted cubic splines did not provide any evidence of a non-linear relationship between ethnic density and high intensity smoking (results in supplementary on-line files).

Discussion

This study highlights significant neighbourhood variation in ethnic density of key minority groups in south and east London, and identifies a highly significant relationship between area-level ethnic density and smoking behaviour in both men and women across most of these ethnic groups.

This study found strong evidence that higher own-group ethnic density is associated with a lower prevalence of current smoking across all ethnic and gender groups, with the exception of black Caribbean women. This effect persisted after accounting for social deprivation, age, and geographic location. The relationship was also found for the white British/Irish, the ethnic majority population in the UK. The effect size was greatest in the black African population for men, and in the Pakistani population for women. The relationship between ethnic density and the odds of being a current smoker was non-linear, with the shape of the pattern and strength of association varying significantly between genders and ethnic groups.

The absence of association between ethnic density and smoking status among the black Caribbean population may be due to a small sample size of this ethnic group, and its greater geographic dispersal. In our study - as in others, the median ethnic density – at 8.6%, was lowest for the black Caribbean population among the ethnic groups studied. (see Table 1).(10)

With the exception of Bangladeshi men, the study found no evidence of a relationship between own-group ethnic density and high intensity of smoking behaviour. This may firstly be because the analysis of smoking intensity was restricted to current smokers, few of whom self-reported as being high intensity smokers. Low numbers may have resulted in low statistical power to detect a relationship between ethnic density and smoking intensity in our study population. This was particularly the case in ethnic minority groups where 4% or less were high intensity smokers. Secondly, the use of cigarettes per day as a measure of smoking intensity may be unreliable. Self-report of CPD is prone to digit bias (rounding to multiples of 10 due to standard pack-sizes) and under-reporting.(40) Under-reporting may be particularly prevalent amongst high intensity smokers due to social desirability bias.

We found no differences in the odds of being a current smoker between age groups. We hypothesized that younger adults may be more acculturated and thus show a different relationship between their smoking behaviour and own-group ethnic density. It is possible that young people are more likely to smoke using methods such as cannabis, water pipes, and electronic cigarettes, the latter being perceived as healthier alternatives to traditional cigarettes, and currently not well captured in the primary care record.(41–43)

The lower prevalence of current and heavy smoking in South Asian groups compared to white and Black groups is likely to be determined by a combination of cultural, behavioural and genetic determinants. Studies have identified numerous genetic variants in nicotinic receptors, with a variation in frequencies between ethnic groups, which may reflect a differing propensity to make the transition from smoking to nicotine dependency.(44,45)

Gender differences in smoking behaviour are reflective of wide cultural disparities between men and women in different ethnic groups.(46) Women may under-report tobacco use to a greater extent than men due to social and cultural factors. This has been observed in British Bangladeshi and Pakistani populations, where smoking amongst men is a social activity, while smoking amongst women is associated with stigma and shame (47)

Strengths

Routine electronic health record databases provide up to date information on the current population makeup not available from national Census records.(48) Furthermore, routinely recorded smoking data in a UK primary care database similar to our own (The Health Improvement Network database) has been validated against the Health Survey for England, confirming that GP recorded data are of high enough quality to produce robust research findings.(49)

The East and South London populations that are the subject of this study come from unselected and contiguous general practice lists of more than 1 million people that include

97% of the resident population in these areas.(50) The findings are relevant to other urban areas with high ethnic and social diversity.

Limitations

This study was unable to account for factors likely to influence smoking behaviour but not captured in the electronic patient record. These include education and employment status. These factors were to some extent represented in the Index of Multiple Deprivation which includes domains on employment and education.(51)

Though self-reported religion and country of birth are captured in the primary record, these variables were not complete enough to be used without considerably reducing the number of complete cases available for analysis. These indicators would have allowed for better analysis of the role of migration and generational status in smoking behaviour.

We did not account for the influence of GP practice on the relationship between ethnic density and smoking behaviour. This was because patients in the same LSOAs do not all register with the same general practices. LSOAs, could not be used therefore as a reliable indicator of general practice registration. GP interventions in smoking cessation may vary significantly between practices and this may lead to important differences in smoking behaviours between patient populations. Statistical methods such as cross-classified analysis would be well suited to exploring this relationship further.(52,53)

Recommendations

These novel findings of an association between higher own-group ethnic density and lower odds of current smoking point to a complex relationship between culture, neighbourhood level experience of adversity or social support and smoking behaviour.

Recognizing firstly, that smoking prevalence is lower amongst ethnic minority groups, and secondly, that the odds of smoking are reduced further as ethnic density increases, findings from this study will allow us to consider whether smoking cessation services should be tailored differentially to individuals/groups living in relative ethnic isolation. It is possible that

such individuals do not benefit from the potential cultural/social factors and support mechanisms characteristic of areas with high levels of own-group ethnic density, which may act to reduce tobacco consumption. At the same time, the influence of higher ethnic density on the likelihood of under-reporting smoking behaviour, particularly for women, should also be taken into consideration when designing these services.

Future work elucidating the relationship between ethnicity, ethnic density and smoking will benefit greatly from the linkage of primary care data with genetic and biological data, as in the UK Biobank and other similar studies. This will allow for studies that better characterise ethnic differences in propensity to smoke, as well as responses to smoking cessation strategies and medications, utilizing a combination of genetic, biological and lifestyle information.

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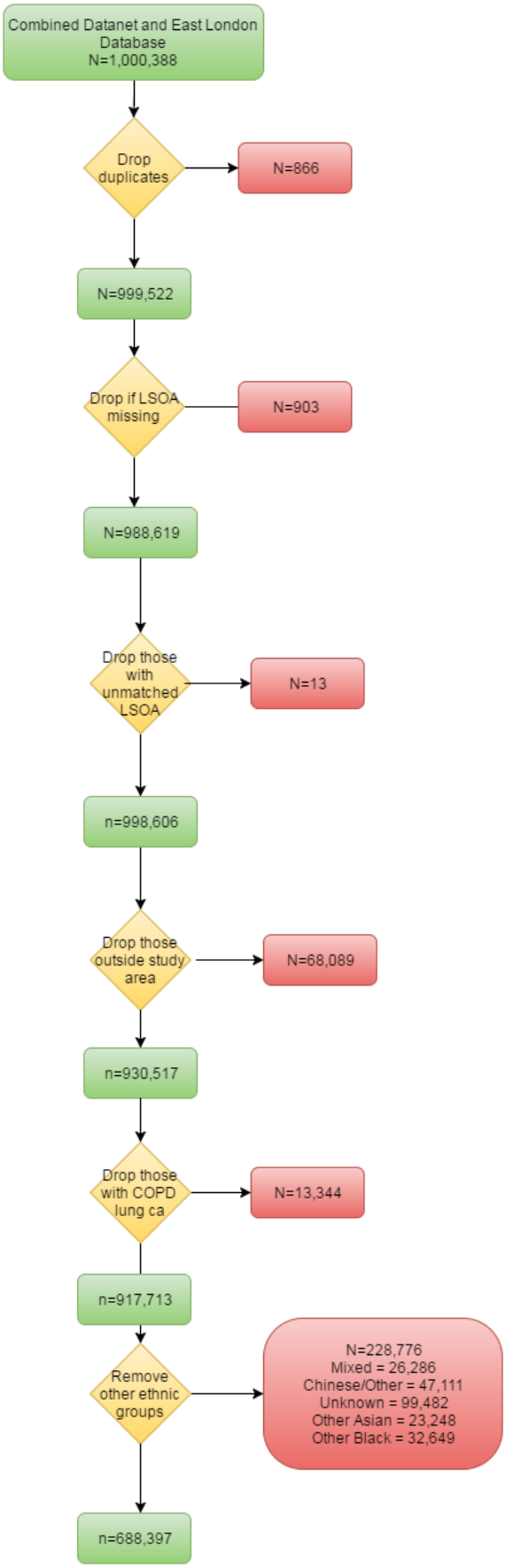
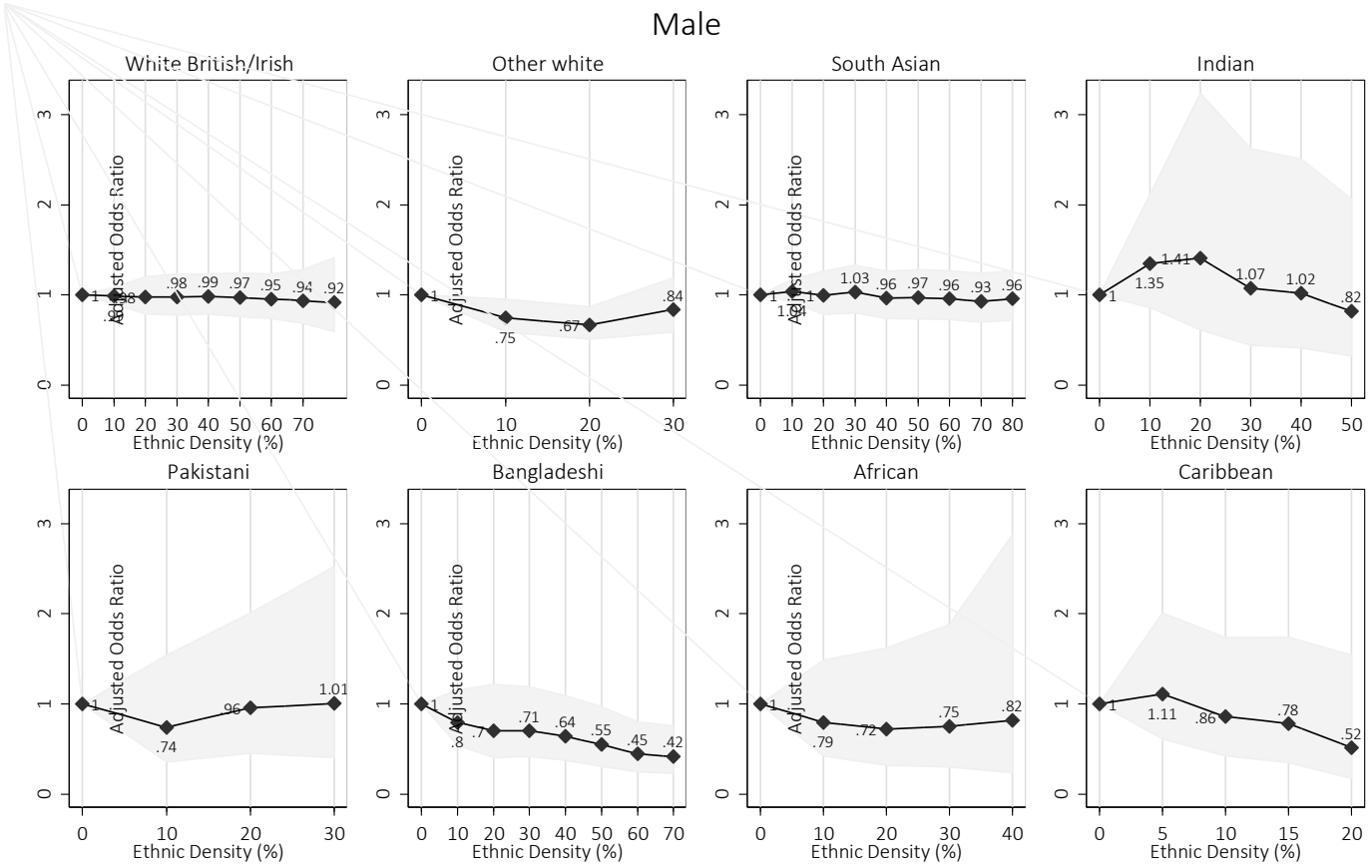
Supplementary files



Supplementary Figure 1: Population Flowchart

Supplementary Table 1. Effect of a 10% in area ethnic density on being a heavy smoker stratified by age group for men

	Male <=35			*Male >35*		
Ethnic Group	OR	95% CI	p. val	OR	95%	p. val
white British & Irish	1.01	(0.89-1.14)	0.100	1.00	(0.95-1.04)	0.889
other white	0.79	(0.92-1.01)	0.056	0.94	(0.82-1.08)	0.373
Indian	0.85	(0.57-1.26)	0.429	0.84	(0.68-1.03)	0.096
Pakistani	0.10	(0.65-1.53)	0.992	1.11	(0.82-1.51)	0.492
Bangladeshi	0.87	(0.78-0.96)	0.009	0.90	(0.52-0.98)	0.018
African	1.03	(0.44-2.40)	0.949	0.92	(0.65-1.31)	0.655
Caribbean	0.78	(0.22-2.80)	0.706	0.68	(0.40-1.16)	0.155



Supplementary Figure 2. Non-linear relationship between own-group ethnic density and the odds of being a high intensity smoker, by ethnic group for males only.

Supplementary Table 2. Read codes for smoking status

Read clinical term	Category	Read clinical code
Exposed to tobacco smoke at home	Unknown	137I0
Total time smoked	Unknown	137n
Refusal to give smoking status	Unknown	137k
Tobacco consumption unknown	Unknown	137E
Current non-smoker	Unknown	137L
Passive smoker	Unknown	137I
Cigarette pack-years	Unknown	137g
Not a passive smoker	Unknown	137U
Admitted tobacco cons untrue?	Unknown	137D
Ex-tobacco chewer	Unknown	137i
Waterpipe tobacco consumption	Unknown	137o
Chews tobacco	Unknown	137W
Very heavy smoker - 40+cigs/d	Current Smoker	1376
Thinking about stop smoking	Current Smoker	137c
Tobacco consumption	Current Smoker	137
Smoking started	Current Smoker	137Q
Rolls own cigarettes	Current Smoker	137M
Smoking reduced	Current Smoker	137V
Cigar consumption	Current Smoker	137Y
Reason for restarting smoking	Current Smoker	137f
Cigarette smoker	Current Smoker	137P
Cigar smoker	Current Smoker	137J
Tobacco consumption NOS	Current Smoker	137Z
Trying to give up smoking	Current Smoker	137G
Light smoker - 1-9 cigs/day	Current Smoker	1373
Heavy smoker - 20-39 cigs/day	Current Smoker	1375
Min from wake to 1st tobac con	Current Smoker	137h
Smoking restarted	Current Smoker	137e
Not interested in stop smoking	Current Smoker	137d
Pipe tobacco consumption	Current Smoker	137a
Current smoker	Current Smoker	137R
Ready to stop smoking	Current Smoker	137b
Pipe smoker	Current Smoker	137H
Trivial smoker - < 1 cig/day	Current Smoker	1372
Failed attempt to stop smoking	Current Smoker	137m
Keeps trying to stop smoking	Current Smoker	137C
Cigarette consumption	Current Smoker	137X
Moderate smoker - 10-19 cigs/d	Current Smoker	1374
Ex-heavy smoker (20-39/day)	Ex-smoker	137A
Date ceased smoking	Ex-smoker	137T
Ex-smoker	Ex-smoker	137S
Stopped smoking	Ex-smoker	137K
Ex cigar smoker	Ex-smoker	137O

Ex-trivial smoker (<1/day)	Ex-smoker	1377
Ex-smoker - amount unknown	Ex-smoker	137F
Ex-moderate smoker (10-19/day)	Ex-smoker	1379
Ex-very heavy smoker (40+/day)	Ex-smoker	137B
Ex roll-up cigarette smoker	Ex-smoker	137l
Recently stopped smoking	Ex-smoker	137K0
Ex-light smoker (1-9/day)	Ex-smoker	1378
Ex pipe smoker	Ex-smoker	137N
Ex-cigarette smoker	Ex-smoker	137j
Never smoked tobacco	Never Smoked	1371

Supplementary Table 3. Read codes for COPD and lung cancer

Read clinical term	Read clinical code
COPD	
Chronic obstr.airway dis.NOS	H3z..
Other emphysema NOS	H32yz
Other chronic bronchitis	H31y.
Giant bullous emphysema	H3202
Emphysematous bronchitis	H3121
Chronic obstr.airway dis.OS	H3y..
Chronic asthmatic bronchitis	H3120
Mild chron obstr pulm disease	H36..
Emphysema NOS	H32z.
Chronic bronchitis	H31..
Centrilobular emphysema	H322.
MacLeod's unilateral emphysema	H32y2
Obstructive chr.bronchitis NOS	H312z
Obstructive chronic bronchitis	H312.
Chronic catarrhal bronchitis	H3100
Segmental bullous emphysema	H3200
Chronic bullous emphysema NOS	H320z
Chr obs pulm dis+ac exac,unspc	H3y1.
Emphysema	H32..
Zonal bullous emphysema	H3201
Mucopurulent chr.bronchitis	H311.
Chronic bronchitis NOS	H31z.
Bullous emphysema + collapse	H3203
Very severe COPD	H39..
Chronic bullous emphysema	H320.
Sev chron obstr pulm disease	H38..
Simple chronic bronchitis	H310.
Other emphysema	H32y.
Chr obs pulm dis+ac l resp inf	H3y0.
Mod chron obstr pulm disease	H37..
Chronic obstructive pulm.dis.	H3...
Lung cancer	
Mesothelioma of pleura	B232.
2-malig neop lung	B570.
Malig neop upper lobe of lung	B2221
Malig neop main bronchus	B221.
Malig neop upp lobe bronc/lung	B222.
Malig neop ovlap resp/thc org	B26..
Malig neop low lobe bronc/lung	B224.
Malig neop low lobe bronc/lung	B224z
Malig neop trachea/bronch/lung	B22..
Malig neop bronchus/lung NOS	B22z.

Malig neop upper lobe bronchus	B2220
Malig neop lower lobe of lung	B2241
Mesothelioma	B226.

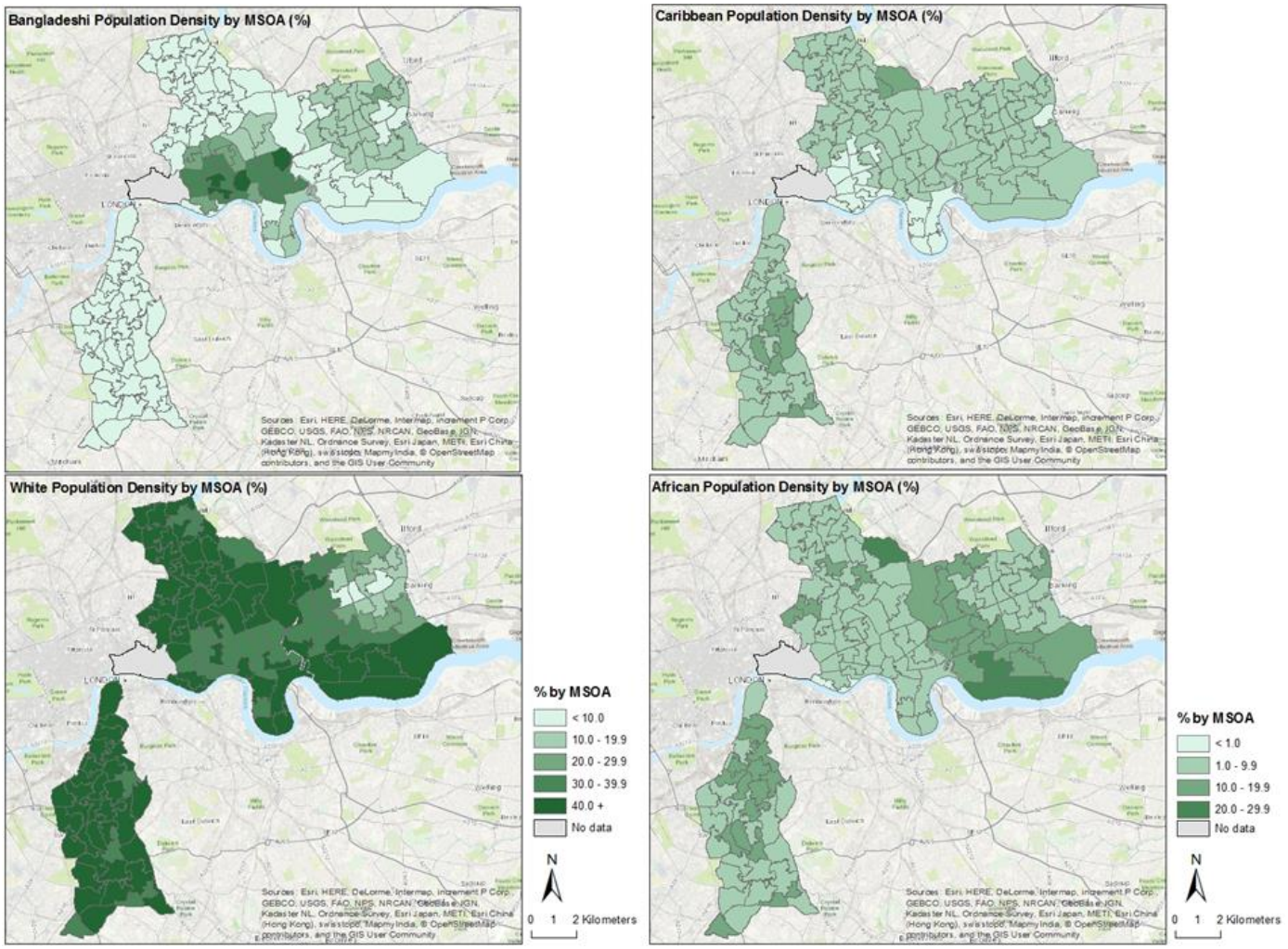


Figure 1. Ethnic density distributions mapped across south and east London for Bangladeshi, white, black Caribbean, and black African GP-registered populations