An investigation of the longitudinal relationship between neighbourhood income inequality and individual self-rated health in England.

Abstract

There are mixed findings on whether neighbourhood income inequality leads to better self-rated health (SRH) or not. This study considers two hypotheses: individuals living in more unequal neighbourhoods have better SRH and the level of neighbourhood income inequality and its impact on SRH is moderated by household income and neighbourhood income and deprivation. Data from Waves 8-10 of the UK Household Longitudinal Study for respondents living in England at wave 8 were used. Neighbourhood income inequality was measured using Gini coefficients of household income from the Pay As You Earn and benefits systems for Lower Super Output Areas. Longitudinal ordinal multilevel models predicted self-rated health in 2016-18, 2017-19 and 2019-20 by income inequality and its interaction with household income, neighbourhood median income and neighbourhood deprivation, conditional on individual educational attainment, age, sex, ethnic group, years lived in current residence, region of residence and study wave. There were 24,889 respondents analysed over three waves. SRH was worse for those living in more income equal neighbourhoods. There was no indication that neighbourhood inequality was moderated by household income, neighbourhood median income or neighbourhood deprivation. These findings are in line with the balance of existing evidence and support policy interventions that aim to create mixed communities for the purpose of improving population health.

Introduction

Whether socioeconomic status is measured by occupation, education or income, there is a social gradient in mortality and morbidity (Yngwe et al., 2001). Moreover, the number of studies that have looked at the correlation between income (and more broadly wealth) inequality and poor health are innumerable and have been increasing rapidly particularly in the last 20 years (Kondo et al., 2009). This is because many developed and emerging countries are experiencing a growing gap between wealthy and poor people which may lead to a considerable population burden from the possible negative impacts of income inequality (commonly measured using the Gini coefficient) on health (Prado, 2009).

However, there have been mixed findings, often within the same study, on the relationship between neighbourhood income inequality and health, especially since the degree to which health is tied to the characteristics of the immediate places that people reside in remains unclear (Weich et al., 2002). Wilkinson (1999) argues that in large geographical areas, the impacts of inequality on health become more apparent compared to more localised areas because it is easier to compare social strata at this geographical scale. This finding is supported by Kawachi (2000) who suggests studies that find a clear link between income inequality and health are primarily the ones that looked at larger units of aggregation such as states in the U.S.

One way in which neighbourhood income inequality may affect health is because of the income inequality hypothesis, which suggests that the distribution of income in society is one of the main determinants of health in addition to the absolute living standard amongst the poor. This means that communities with a greater gap between rich and poor people are more likely to have a greater mortality risk and health problems compared to more equal communities (regardless of individuals' own income) (Wilkinson, 2002). Kawachi and Kennedy (1997) state that this is because the social capital and social cohesion that lead to healthy populations may not be generated by highly unequal communities. Moreover, neighbourhoods with wide economic disparities may amplify social comparisons, incite distrust and cause feelings of injustice amongst underprivileged people which results in poor health (Bjornstrom, 2011; Haithcoat et al., 2019; Kennedy et al., 1998; Tibber et al., 2022).

An opposing theory for how neighbourhood income inequality affects health is the mixed neighbourhood hypothesis. This hypothesis suggests that better health outcomes are found in

neighbourhoods with some degree of inequality because socio-economic mixing can mitigate issues such as depression (Marshall et al., 2014; Musterd and Andersson, 2005). High neighbourhood income inequality could benefit individuals' health because it reflects the greater probability of communal resources being shared, high economic integration and low levels of social isolation (Staley, 1989; Wen et al., 2003). This hypothesis, amongst broader benefits of mixed communities, underpins government strategies in Europe and North America to create mixed communities through a variety of means (Friedrichs et al., 2003; Kearns and Mason, 2007; Tibber et al., 2022). In the UK, the planning system has been designed to create socially mixed communities since its creation in 1947 (Fée, 2021). For example, Section 106 of the Town and Country Planning Act 1990 requires housing developers to include a provision for affordable housing (Morrison and Burgess, 2014). The degree to which UK governments have intervened to ensure mixed communities has varied over time but it has never been completely absent in policy (Fée, 2021).

This paper will focus on the association between neighbourhood income inequality and poor self-rated health (SRH). SRH is one of the most widely used and validated indicators of general health across scientific research and it can independently predict morbidity and mortality (Idler and Benyamini, 1997). There are suggestions that the strength of association between SRH and mortality varies between regions in the UK (O'Reilly et al., 2005). O'Reilly et al (2005) suggest that this could be due to the sensitivity of a measure such as SRH to pick up graduations of poor health rather than measurement invariance between regions. The current paper starts with a review of the existing evidence describing the empirical support, or lack of, for opposing theories of how neighbourhood income inequality affects SRH.

Rostila et al (2012) used the Gini coefficient to investigate the relationship between income inequality and SRH in 22 municipalities and 709 neighbourhoods in the county of Stockholm, Sweden. Poor SRH was dichotomised as worse than good health derived from a five-category variable (very good, good, fair, bad or very bad) collected as part of a Public Health Questionnaire in 2002. In a mutually adjusted model for municipal and neighbourhood inequality as well as individual age, gender, marital status and family income they find no association between greater municipal inequality and SRH but a lower probability of poor SRH in gradually more unequal neighbourhoods. The magnitude and statistical significance of the association altered once municipal and neighbourhood-level

average income was added to the model. In the average area income adjusted models, neighbourhood inequality was no longer associated with SRH. The authors find some suggestion that SRH of those with the lowest individual income is more adversely impacted by greater municipality income inequality than those with the highest income (Rostila et al., 2012). There was no moderating effect of individual income on the neighbourhood income inequality and SRH association. The reason for this geographical sensitivity is thought to be inequality decreases spending on social goods in large and politically important areas like municipalities but not as much in smaller areas like neighbourhoods (Subramanian and Kawachi, 2004). This is a finding that is supported by Erdem et al (2019) when analysing the association between income inequality and mental health in the Netherlands. This suggests that the spatial scale of analysis is important (Haithcoat et al., 2019). Haithcoat et al (2019) come to a similar conclusion from a county level analysis of the American Community Survey linked to a health examination survey collected in 2014, 2015 and 2016 where SRH was dichotomised as worse than good health from excellent, very good, good, fair or poor. A more nuanced measurement of inequality using the Gini coefficient was calculated for spatial uniformity across each US state. The authors do not find a significant association between income inequality and SRH when using a standard Gini coefficient but a statistically significant association with uniformly high inequality within the state. Control variables include health behaviours as well as the same controls as Rostila et al (2012).

Ichida et al (2009) find support for increased Gini coefficient at municipal level linked to worse SRH using a 2003 sample survey of people aged 65 and over in the Chita peninsula, Japan. SRH was dichotomised as worse than good from very good, good, fair or poor. Control variables included age, sex, income, marital status, education, type of housing and average income. The association was not significant when controlling for social capital. Bjorstrom (2011) drew the same conclusion at a finer spatial scale using the Los Angeles Family and Neighborhood Survey, 2000-2001 linked to census tract Gini coefficient, median income and crime rate. There was no Gini coefficient association to worse SRH (measured as worse than good from very good, good, fair or poor) when adjusting for similar covariates as Ichida et al (2009) as well as body-mass index, smoking, health insurance, relative income position and distrust.

Wen et al (2003) analysed an ordinal measurement of SRH (excellent, good, fair or poor) using a Chicago based survey linked to the 1990 US Census and other contextual data. They

find a higher probability of worse SRH in more income unequal census tracts, measured using the Gini coefficient, when controlling for gender, age, marital status, smoking, blood pressure, race, income and education. The income inequality association was not statistically significant once neighbourhood affluence was added to the model. Wong et al (2009) found evidence of an unadjusted association between the Gini coefficient in the most income unequal quartile of neighbourhoods and worse than good SRH. The SRH measure was derived from a five-point instrument (excellent, very good, good, fair or poor) using the Thematic Household Surveys, Hong Kong in 2002 and 2005. Once controls were added to the model for sex, age, marital status, education, household income and economic activity, the income inequality association with SRH was not statistically significant. The association was not sensitive to neighbourhood median income. Wong et al (2009) hypothesise that the detrimental impacts of income inequality are counteracted in neighbourhoods in Hong Kong through a high degree of social integration.

McLeod et al (2003) measured income inequality using median share of total area income in 53 metropolitan areas using the 1991 Canadian Census linked to individual data from the National Population Health Surveys in 1994, 1996 and 1998. SRH was measured on an ordinal scale of excellent, very good, good, fair or poor. There was no association between income inequality and SRH in 1994 and 1996, but a statistically significant negative association in 1998 when controlling for age, age squared, sex, marital status, smoking, alcohol consumption, physical activity, social support, social involvement, household income and average area income. McLeod et al (2003) found people in lower income households reported poorer SRH when living in areas with lower income inequality compared with those living in areas with higher income inequality. They suggest unequal areas may demand a high standard on the quality and quantity of communal services like transportation and medical services which can be health-promoting particularly for poorer people.

There is further evidence from Canada supporting the mixed neighbourhood hypothesis. Hou and Chen (2003) used the 1996/97 National Population Health Survey linked to 1996 Census data for census tracts in Toronto to show that the most unequal quartile of neighbourhoods score poorer health compared with the most equal quartile of neighbourhoods. SRH was modelled on a continuous five-point (excellent, very good, good, fair or poor) scale. The findings were robust to a dichotomous version of worse than good SRH. Income inequality was measured using the coefficient of variation, a ratio of standard deviation to the mean.

Control variables were neighbourhood mean income, individual low-income status, age, sex, education, alcohol dependence, smoking, physical inactivity and emotional support.

Hou and Myles (2004) used the same data for Canada's 25 Census Metropolitan Areas to compare the association between a reverse coded SRH measure and six measures of income inequality for census tracts, including the Gini coefficient. Once neighbourhood median income was controlled for in addition to age, sex, immigrant status, minority status, education and household income, a significant positive association was found between living in the most unequal quintile of neighbourhoods compared with the most equal quintile and better SRH. The results were consistent across inequality measures. Hou and Myles (2004) suggest the mechanism for smaller geographical areas with greater income inequalities leading to better SRH is due to socialisation processes such as living near people that have healthier lifestyles and are better educated which influences those who are not (Wilson, 2012)

In summary, the weight of evidence appears to suggest that greater neighbourhood income inequality is either not associated with SRH or associated with better SRH. Moreover, although there is no empirical support at the neighbourhood level, the mixed neighbourhood hypothesis suggests that lower income individuals will be affected the most by income inequality.

Study hypotheses

This study tested two hypotheses in support of the mixed neighbourhood hypothesis:

1. Individuals living in more unequal neighbourhoods will have better SRH.
2. The level of neighbourhood income inequality and its impact on SRH is moderated by household income, neighbourhood median income and neighbourhood deprivation. Poorer households and more deprived neighbourhoods will benefit more from neighbourhood inequality compared with affluent households and less deprived neighbourhoods.

This study contributes to the existing literature by taking a longitudinal study design and links administrative small area data to the UK's largest nationally representative panel study, UK Household Longitudinal Study. Longitudinal analysis of neighbourhood effects remains rare because the data required to test these effects often are not available, difficult to link or not yet mature enough to do meaningful analysis. In the UK, the specific test of association

between neighbourhood income inequality and health is constrained by the lack of small area data on individual or household income. This is largely because the UK Censuses have not asked a question about income and nationally representative surveys that do cannot provide estimates at fine spatial scales. Administrative data on income estimates at small area level have been slow to emerge and continue to be published on a largely ad-hoc basis. Existing evidence on income inequality and SRH could be compromised by over adjustment for individual and area variables that might be caused by income inequality rather than being a confounder of the relationship. For example, trust in neighbours is likely to be caused by income inequality rather than cause income inequality. This study will limit the inclusion in the analysis of control varibles that could be considered as colliders rather than confounders.

Methodology

Data source

This study used data from Waves 8-10 (2017-2018 to 2019-2020) of the UK Household Longitudinal Study (UKHLS) – a nationally representative household panel study hosted at the Institute for Social and Economic Research, University of Essex. The UKHLS began in 2009 (where around 40,000 households were interviewed) following on from the successful British Household Panel Study (University of Essex, Institute for Social and Economic Research 2019). The UKHLS follows its participants of different ages, backgrounds, educational levels and in different locations across the UK over time to try to understand changes over the life course of the UK's population. The data were collected via a combination of face-to-face, web and telephone interviewing. Permission to use small area geographic identifiers for UKHLS study members was obtained via submission of an application to the UKHLS with declaration of compliance procedures for a special licence (University of Essex, 2021). The UKHLS data were linked for 24,889 study members aged 16 and over who were living in England when interviewed at wave 8. All variables were measured at wave 8 with the exception of the dependent variable. Study respondents resident in Wales, Scotland and Northern Ireland were excluded because either or both neighbourhood median income and neighbourhood deprivation were not available.

Measures

Dependent variable

SRH was the dependent variable. SRH refers to how individuals perceive their own general health. In the UKHLS, it was measured using the question: "In general, would you say your

health is: excellent, very good, good, fair, or poor?". The measure was available at UKHLS waves 8, 9 and 10.

Exposure variable

Neighbourhood income inequality was operationalised using Gini coefficients based on household income from the Pay As You Earn (PAYE) and benefits systems (which include tax credits) data for 2016. These data, although from the Office for National Statistics, are not official statistics and are described as experimental (Office for National Statistics, 2020). Income from self-employment, investments, maintenance payments and educational grants, scholarships and loans are excluded. The data were measured at the 2011 Lower Super Output Area (LSOA) level. LSOAs are a census output geography created to have even population sized boundaries in England and Wales. English LSOAs had a mean population of 1,614 and a standard deviation of 301.29 in 2011. LSOAs have been widely used as a neighbourhood level spatial scale in health research (Jivraj et al., 2019). There was no income information for, on average, 2.67% of households across all LSOAs. There were a small number of LSOAs (less than 0.3%) where there was missing information for more than 20% of households. These were typically LSOAs containing large student residences.

The neighbourhood income data comprise the proportion of households in income bands (£0.00, £0.01-5,000, £5,000.01-10,000, £10,000.01-15,000, £15,000.01-20,000, £20,000.01-30,000, £30,000.01-40,000.00, £40,000.01-60,000.00, and £60,000.01 and above). The mid-point of each band was used to derive the proportion of total income in an LSOA in each band which were used to calculate Gini coefficient values ranging from 0 (complete equality) to 100 (complete inequality). To do this, the cumulative proportions of population for each income band and the cumulative proportions of total income for the bands were calculated. These cumulative proportions were used to derive points on a Lorenz curve which were then used to calculate the Gini coefficient by dividing the area beneath a line of equality by the difference between the Lorenz curve and the line of equality. The code to source and derive these values is available here. The values at the regional level are similar to those calculated using nationally representative data for Government Office Regions (Wishart et al., 2018). The Gini coefficients for LSOAs were categorised into four quantiles according to the national distribution where a higher value indicated a more unequal neighbourhood quantile. Cauvai et al (2022) suggest that the Gini coefficient is well suited to measuring social mix at the neighbourhood level in the UK.

Moderator variables

Three effect modifiers were tested: household income, neighbourhood median income and neighbourhood deprivation. These measures were used to test their moderating effect on the neighbourhood inequality and SRH association. UKHLS collects data on various aspects of individuals' income including total personal income and sources of individuals' income (including main and second job earnings). For this paper, we use data on gross monthly household income from all sources. The household income measure was equivalised using the OECD scale to assign weights to the number and age of persons in the household. Household equivalised gross income was categorised according to the distribution of national household equivalised income in 2016. The categories were coded as < £12,922, £12,922 to £22,698, £22,698 to £35,152, and > £35,152 where a higher quantile indicated an individual is from a poorer household.

Neighbourhood median income was measured from individual PAYE, Self-Assessment and benefits data from HM Revenue and Customs (Office for National Statistics, 2021). These experimental statistics were produced at LSOA level for annual income in pounds. They are missing information from, on average, an estimated 10% of individuals within each LSOA. The neighbourhood median income values were categorised into four quantiles according to the national distribution where a higher quantile indicates a poorer neighbourhood.

Neighbourhood deprivation was measured using the 2019 Index of Multiple Deprivation (IMD). IMD is a government commissioned measure of multiple deprivation of residents in a neighbourhood and is calculated for LSOAs in England. An overall deprivation weighted score (scaled to between 0 and 100) was calculated using indicators within domains of income, employment, education, health, crime, barriers to housing and services, and living environment (Godhwani et al., 2019). Most of the IMD indicators were measured between 2014 and 2017. The IMD values were categorised into four quantiles according to the national distribution where a higher quantile indicates a more deprived neighbourhood.

Control variables

The number of years lived in a current residence for UKHLS study members was measured by subtracting the year of interview by the year moved into current accommodation. Education was measured by highest qualification level (no qualification, General Certificate

of Secondary Education or GCSE, A Level, university degree and other qualifications). Demographic variables used in the analysis were age (years), sex (male or female), and ethnic group (White British, Other White, Mixed, Indian, Pakistani, Bangladeshi, Caribbean, African and Other). The region of residence was measured using Government Office Regions in England.

Statistical analysis

Analyses were conducted using Stata 16. Three-level ordinal longitudinal models were fitted where SRH responses on a five-point scale (excellent, very good, good, fair or poor) at waves 8, 9 and 10 were nested within study members and study members at wave 8 were nested within LSOAs. The model is equivalent to a random intercept model in multilevel modelling terminology. The complete case sample contained 19,185 study members with an average of 2.6 waves of responses. The study members resided in 8,840 LSOAs with an average of 1.9 in each LSOA. The percentage of LSOAs with only one study member was 10.8%.

The proportional odds assumption for ordinal regression that the relationship between each pair of outcome categories is the same did not hold. Appendix 1 provides the results of a likelihood ratio test of proportional odds using a single level ordinal model and a comparable multinomial logistic model. The comparison of these models demonstrates how the findings are substantively similar when the proportional odds assumption is ignored and that the graduated stronger neighbourhood income inequality relationship to better SRH is present in both model specifications.

Five models are reported in the main results. The first model predicts SRH on neighbourhood inequality while controlling for variables described above (see Table 2). The rest of the models contain the same variables as well as an interaction term between neighbourhood inequality and one of household income, neighbourhood median income or neighbourhood deprivation (see Table 3).

Almost 4% of study members had missing information on SRH at wave 8 and longitudinal attrition meant 22% of study members from wave 8 were missing by wave 10 (see Table 1). Multiple imputation by chained equations using 10 imputed datasets was used to adjust for potential non-response bias and increase the sample size at each wave to the 24,889 sample members who responded at wave 8. It increased the number of LSOAs (level 3 units) in the

analysis to 10,003 and the average number of study members per LSOA to 2.5. The substantive results did not change when using and not using imputed data. Non-imputed regression results are available in Appendix 2. All analyses were weighted using cross-sectional sample weights from wave 8 that aim to correct for unequal selection probability, non-response at wave 8, and include a slight correction for sampling error.

Results

Table 1 shows the weighted sample characteristics. Most respondents had at least good SRH at waves 8, 9 and 10. The percentage with fair or poor health was 20% at wave 8, rose to 21% by wave 9 and rose to 22% by wave 10. The distribution of respondents across the four Gini coefficient quantiles was fairly even with almost a fifth in each.

Table 1. Sample description for the variables used in the analysis

	N=24,889	
	Mean (SD) or %	Missing (%)
Outcome variable		
SRH wave 8		3.73%
Excellent	12.58%	
Very good	34.12%	
Good	33.18%	
Fair	14.74%	
Poor	5.37%	
SRH wave 9		18.01%
Excellent	10.32%	
Very good	33.69%	
Good	34.73%	
Fair	15.70%	
Poor	5.56%	
SRH wave 10		22.04%
Excellent	9.46%	
Very good	34.49%	
Good	33.57%	
Fair	16.65%	
Poor	5.84%	
Exposure variable		
Gini coefficient		0.00%
22.06-31.33	23.87%	
31.33-33.95	25.94%	

	N=24,889	
	Mean (SD) or %	Missing (%)
33.95-37.35	26.00%	
37.35-58.23	24.19%	
Moderator variables		
Neighbourhood deprivation		0.00%
0.54-9.91	26.67%	
9.91-17.65	26.30%	
17.65-29.58	24.05%	
29.58-92.74	22.98%	
Neighbourhood median income		0.00%
£17,233-£47,902	25.93%	
£15,494-£17,233	25.31%	
£14,112-£15494	26.08%	
£2,237-£14,112	22.68%	
Household income		0.18%
> £35,152	22.40%	
£22,698-£35,152	27.73%	
£12,922-£22,698	33.34%	
<£12,922	16.53%	
Control variables		
Age in years	48.69 (19.04)	0.03%
Years lived at accommodation	17.49 (11.83)	19.31%
Education		2.56%
Degree	38.02%	
A-level etc	21.78%	
GCSE etc	20.52%	
Other qualification	9.42%	
No qualification	10.27%	
Sex		
Male	47.90%	0.00%
Female	52.10%	
Ethnic group		
White British	87.07%	0.71%
Other White	4.09%	
Mixed	1.22%	
Indian	2.07%	
Pakistani	1.24%	
Bangladeshi	0.55%	
Caribbean	0.78%	

	N=24,889	
	Mean (SD) or %	Missing (%)
African	1.23%	
Other	1.74%	
Region		0.00%
London	5.22%	
North East	13.08%	
North West	10.81%	
Yorkshire and the Humber	9.05%	
East Midlands	10.37%	
West Midlands	11.38%	
East	13.13%	
South East	16.32%	
South West	10.66%	

Figure 1 shows the spatial distribution of Gini coefficient quantiles across neighbourhoods in England in 2016. There are concentrations of the most unequal neighbourhoods (i.e. higher Gini coefficients), shown by the darkest shading of blue, in parts of Greater London, the home counties, for example, parts of Buckinghamshire, Berkshire and Surrey. The large swathes of the darkest shade of blue outside of the London, South East and East regions are typically collections of a small number of geographically large LSOAs. The most equal neighbourhoods (i.e. lower Gini coefficients), shown by the darkest shade of red, are concentrated in post-industrial urban areas, including parts of the West Midlands County, Staffordshire, Merseyside, Greater Manchester, West Yorkshire, South Yorkshire, Derbyshire, Nottinghamshire, Tyne and Wear, Teesside and a number of coastal towns.

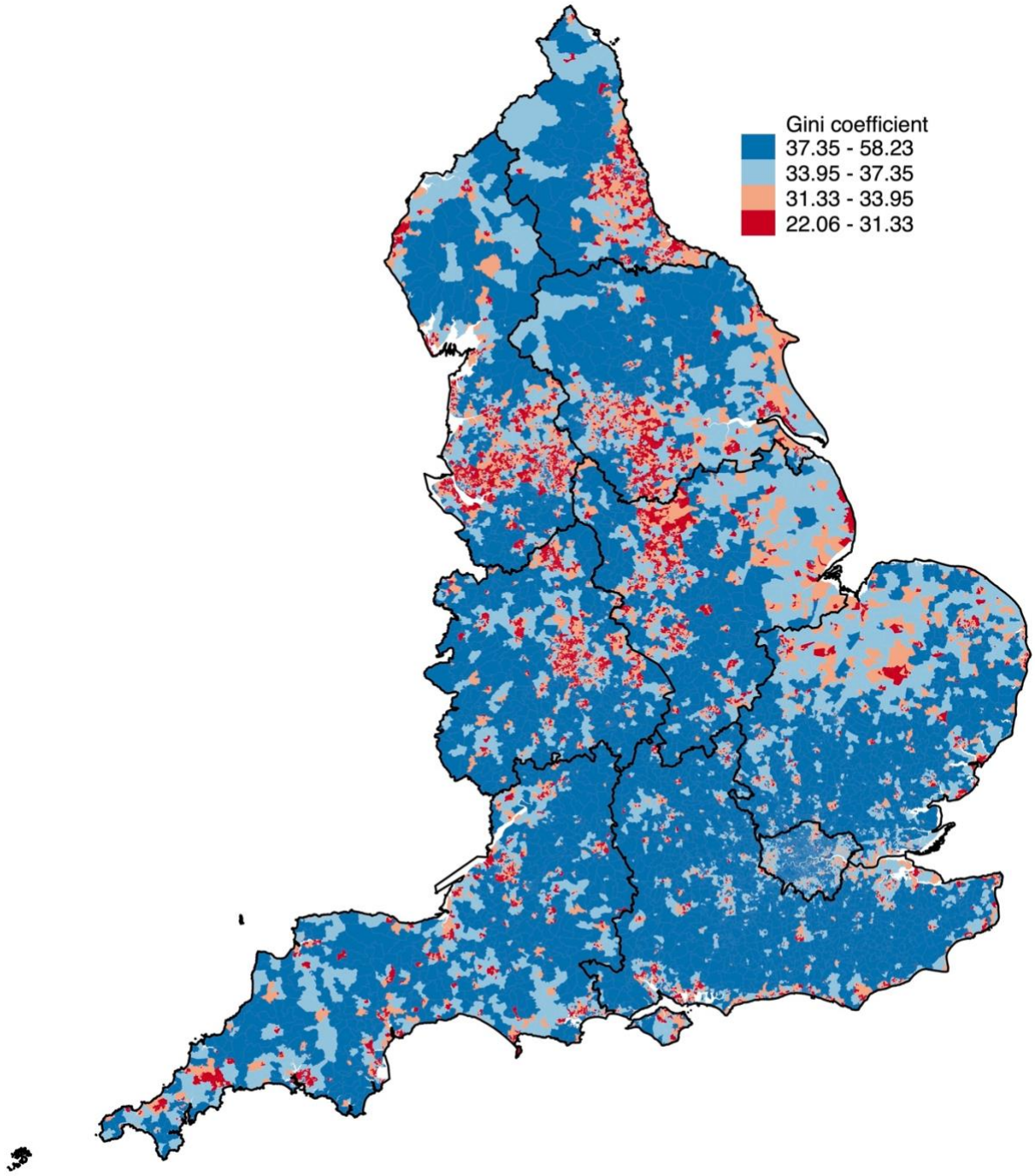

Figure 1. Spatial distribution of neighbourhood household income inequality across LSOAs in England in 2016. Note: black lines mark Government Office Regions.

Table 2 provides the multiple imputed longitudinal model results. The random estimates show that a little over 10% of the variance at the individual and neighbourhood levels is attributable to between neighbourhood differences in SRH. The fixed estimates from the same adjusted model show for each more unequal quantile of neighbourhood inequality there

was a lower log odds of a worse category of SRH. The most unequal quantile is estimated to have a -0.583 lower log odds compared with the most equal quantile. This means respondents living in more unequal neighbourhoods are less likely to report worse SRH while holding constant neighbourhood deprivation, neighbourhood median income, household income, and individual educational attainment, age, sex, ethnicity, years lived at current residence, region of residence and wave of observation. The magnitude of the neighbourhood inequality estimates can be seen more clearly in Figure 2, which shows the predicted probability of each SRH category over the quantile of neighbourhood inequality with all other variables set at their means. It shows higher predicted probabilities of excellent and very good categories of SRH in more unequal quantiles of neighbourhoods and lower predicted probabilities of good, fair and poor categories of SRH in quantiles of more unequal neighbourhoods. This suggest that the nature of the SRH and neighbourhood inequality relationship is more complicated than one in which good health is more common in more unequal neighbourhood and bad health is less common in more unequal neighbourhoods.

Table 2 also shows that those living in more deprived neighbourhoods and poorer households are more likely to report worse SRH while holding constant other variables in the model. There was no significant adjusted association between neighbourhood median income and SRH. Lower educational attainment, higher age, being female and identifying as Mixed or Caribbean compared with White British was associated with worse SRH. Identifying as African compared with White British, living longer at current residence and living in the Yorkshire, Midlands or South West regions compared with London was associated with a lower likelihood of worse SRH.

Table 3 shows the results of interaction terms in separate models between neighbourhood inequality and household income, neighbourhood median income and neighbourhood deprivation. All of the interaction terms were not statistically significant suggesting there is no evidence of a moderating effect of these variables on the neighbourhood inequality and SRH relationship.

Table 2. Multilevel ordinal regression log odds of worse self-rated health

	Estimate	P-value	95% CI	
Fixed effects				
Neighbourhood level				
Gini coefficient (ref. 22.06-31.33)				
31.33-33.95	-0.148	0.072	-0.309	0.013
33.95-37.35	-0.316	0.000	-0.480	-0.151
37.35-58.23	-0.583	0.000	-0.764	-0.401
Deprivation score (ref. 0.54-9.91)				
9.91-17.65	0.353	0.000	0.206	0.500
17.65-29.58	0.562	0.000	0.389	0.736
29.58-92.74	1.011	0.000	0.797	1.225
Median income (ref. £17,233-£47,902)				
£15,494-£17,233	0.022	0.785	-0.134	0.177
£14,112-£15494	0.082	0.371	-0.097	0.260
£2,237-£14,112	0.100	0.353	-0.112	0.312
Individual level				
HH income (ref. > £35,152)				
£22,698-£35,152	0.693	0.000	0.555	0.831
£12,922-£22,698	1.262	0.000	1.114	1.410
<£12,922	1.290	0.000	1.107	1.473
Education (ref. degree)				
A-levels	0.446	0.000	0.319	0.574
GCSEs	0.744	0.000	0.611	0.877
Other	0.955	0.000	0.763	1.148
None	1.273	0.000	1.076	1.470

	Estimate	P-value	95% CI	
Age	0.055	0.000	0.051	0.059
Sex (ref. male)				
Female	0.170	0.000	0.080	0.260
Ethnic group (ref. White British)				
Other White	-0.181	0.175	-0.443	0.081
Mixed	0.526	0.003	0.179	0.873
Indian	0.263	0.051	-0.002	0.528
Pakistani	-0.068	0.697	-0.410	0.274
Bangladeshi	-0.025	0.906	-0.433	0.383
Caribbean	0.626	0.000	0.278	0.974
African	-1.146	0.000	-1.517	-0.776
Other	0.116	0.483	-0.208	0.440
Year lived at residence	-0.013	0.000	-0.018	-0.007
Region (ref. London)				
North East	-0.048	0.757	-0.352	0.256
North West	-0.231	0.054	-0.465	0.004
Yorkshire and the Humber	-0.349	0.005	-0.594	-0.104
East Midlands	-0.313	0.012	-0.557	-0.070
West Midlands	-0.251	0.034	-0.483	-0.019
East	-0.151	0.201	-0.383	0.081
South East	-0.111	0.299	-0.321	0.099
South West	-0.427	0.001	-0.672	-0.181
Wave	0.182	0.000	0.153	0.212
Random effects				
Neighbourhood level	1.233		1.029	1.477
Individual level	9.550		9.131	9.988

Table 3. Interaction terms between neighbourhood inequality and household income, neighbourhood median income and neighbourhood deprivation

	Gini * household income				Gini * neighbourhood income				Gini * neighbourhood deprivation			
	Estimate	P-value	95% CI		Estimate	P-value	95% CI		Estimate	P-value	95% CI	
Main effects												
Neighbourhood level												
Gini coefficient (ref. 22.06-31.33)												
[2] 31.33-33.95	-0.048	0.786	-0.394	0.298	-0.281	0.243	-0.753	0.191	-0.226	0.246	-0.608	0.156
[3] 33.95-37.35	-0.130	0.437	-0.457	0.197	-0.408	0.074	-0.855	0.039	-0.376	0.046	-0.745	-0.006
[4] 37.35-58.23	-0.504	0.002	-0.825	-0.182	-0.511	0.023	-0.954	-0.069	-0.555	0.004	-0.932	-0.178
Deprivation score (ref. 0.54-9.91)												
[2] 9.91-17.65	0.356	0.000	0.209	0.504	0.349	0.000	0.201	0.496	0.168	0.445	-0.263	0.599
[3] 17.65-29.58	0.565	0.000	0.391	0.739	0.555	0.000	0.380	0.729	0.459	0.026	0.055	0.863
[4] 29.58-92.74	1.011	0.000	0.797	1.225	0.984	0.000	0.765	1.203	1.074	0.000	0.683	1.464
Median income (ref. £17,233-£47,902)												
[2] £15,494-£17,233	0.022	0.778	-0.133	0.178	-0.035	0.889	-0.527	0.457	0.030	0.707	-0.126	0.186
[3] £14,112-£15494	0.082	0.366	-0.096	0.261	0.007	0.978	-0.460	0.473	0.089	0.329	-0.090	0.268
[4] £2,237-£14,112	0.101	0.348	-0.111	0.313	0.163	0.505	-0.317	0.643	0.095	0.382	-0.118	0.308
HH income (ref. > £35,152)												
[2] £22,698-£35,152	0.805	0.000	0.470	1.141	0.696	0.000	0.558	0.834	0.693	0.000	0.555	0.831
[3] £12,922-£22,698	1.289	0.000	0.953	1.624	1.262	0.000	1.114	1.410	1.262	0.000	1.114	1.410
[4] <£12,922	1.589	0.000	1.200	1.979	1.291	0.000	1.108	1.474	1.288	0.000	1.105	1.471
Interaction terms												
Gini interaction												
2*2	-0.098	0.656	-0.531	0.334	0.204	0.485	-0.368	0.775	0.291	0.265	-0.221	0.804
2*3	0.049	0.824	-0.382	0.480	0.283	0.306	-0.259	0.826	0.238	0.336	-0.247	0.724

2*4	-0.467	0.069	-0.971	0.037	-0.037	0.894	-0.589	0.514	-0.125	0.600	-0.593	0.343
3*2	-0.221	0.299	-0.637	0.196	0.142	0.612	-0.408	0.692	0.264	0.297	-0.232	0.760
3*3	-0.122	0.560	-0.534	0.289	0.155	0.568	-0.378	0.689	0.059	0.804	-0.409	0.528
3*4	-0.437	0.083	-0.931	0.057	0.102	0.704	-0.426	0.631	0.026	0.915	-0.450	0.502
4*2	-0.079	0.712	-0.495	0.338	-0.072	0.798	-0.621	0.478	0.095	0.704	-0.395	0.585
4*3	0.013	0.952	-0.412	0.438	-0.091	0.747	-0.641	0.459	0.081	0.744	-0.405	0.567
4*4	-0.265	0.302	-0.767	0.238	-0.276	0.326	-0.827	0.275	-0.353	0.197	-0.889	0.183

Notes: models are fitted with one interaction term each between neighbourhood inequality and one of household income, neighbourhood median income or neighbourhood deprivation. All models include controls for educational attainment, age, sex, ethnic group, years lived at residence, region and wave of observation.

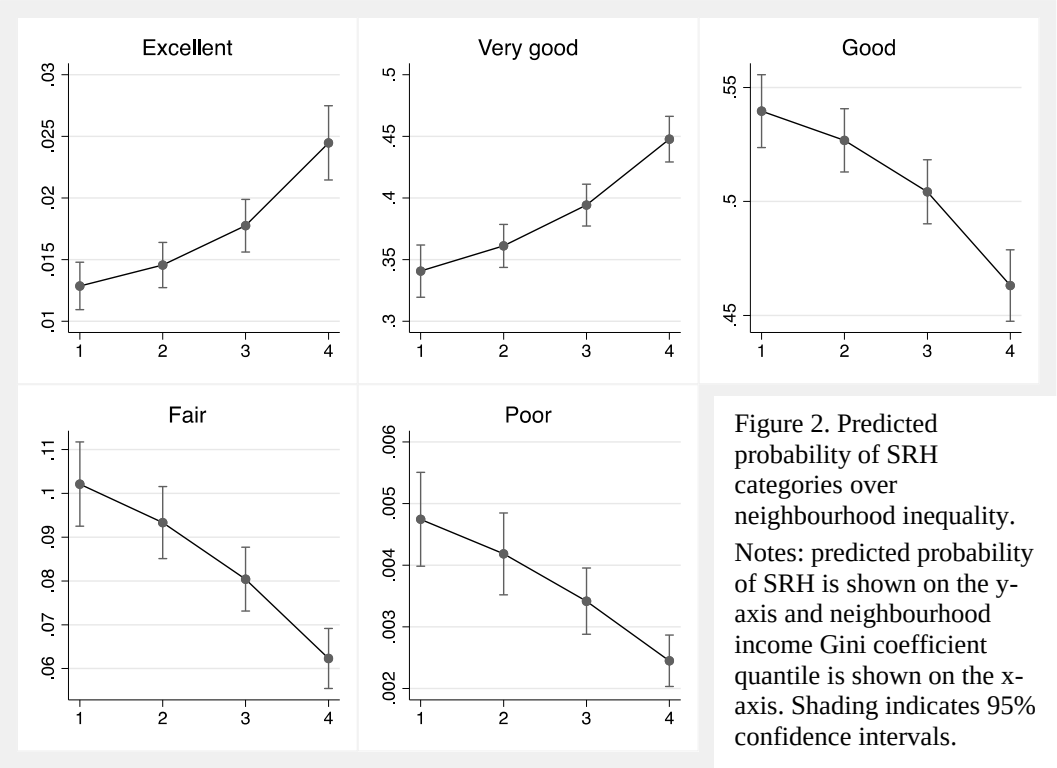

Figure 2. Predicted probability of SRH categories over neighbourhood inequality.

Notes: predicted probability of SRH is shown on the y-axis and neighbourhood income Gini coefficient quantile is shown on the x-axis. Shading indicates 95% confidence intervals.

Discussion

The results of this study support the balance of existing evidence that suggests there is an inverse association between living in more unequal neighbourhoods and worse SRH (Hou and Chen, 2003; Hou and Myles, 2004; Rostila et al., 2012). This provides support for the mixed neighbourhood theory which suggests socio-economic mixing can increase access to resources and services beneficial to health and decrease access to sources detrimental to health, which is particularly beneficial for poorer people's health (Marshall et al., 2014; Musterd and Andersson, 2005). This could come about through socialisation with people who might encourage better health behaviours or through those with more agency, demanding services which bring about better health (e.g. healthcare, education, employment, transport and retail). The current study provides no support for a moderating effect of household income, neighbourhood median income or neighbourhood deprivation on the neighbourhood inequality and SRH relationship. In support of Marshall et al (2014), the study finds the association is equally strong across the individual and neighbourhood income spectrum. This does not mean that mechanisms operate in the same way for more affluent groups compared with poorer groups. It could be, as suggested by Marshall et al (2014), that there are different

stressors for more affluent people of having to ‘keep up with the Jones’ in homogenously affluent neighbourhoods.

In this study, there is a somewhat surprising deviation in the neighbourhood inequality and SRH relationship between the SRH categories of very good and good. There is increased probability of excellent and very good categories of SRH at higher levels of neighbourhood inequality compared with decreased probability of good, fair and poor categories at higher levels of neighbourhood deprivation. This suggests that the SRH of people living in the most equal areas is typically at least good. It could be the case that the measurement of SRH using a five-point scale does not measure the graduation of health or that there is measurement invariance in certain places in England. It has been noted by O’Reilly (2005) that places where neighbourhood inequality is lower are places where people are less likely to report better SRH. There is some suggestion that the findings here are robust to the categorisation of SRH because alternative logistic modelling specifications using every possible combination showed that, however SRH is coded, higher neighbourhood inequality is related to worse SRH.

It is important to set the findings from this study against policies that aim to create mixed neighbourhoods. In the UK, mixed communities policies have aimed to restore and create neighbourhoods that have cohesion and integration through mixed tenure (such as affordable house building) (Lupton et al., 2009). The principles behind this are that improving services, facilities, and creating more affordable housing in more sought-after locations will lead to positive changes for existing residents. It also encourages new and wealthier residents to move in who can contribute money to support facilities, improve area reputation and allows poor people to benefit from interacting with individuals from other tenure or income groups (Lupton et al., 2009). Although this initiative is controversial, in part because the evidence supporting a positive effect of mixed communities is relatively weak and because some argue that the money spent on creating mixed neighbourhoods could be spent on tackling the underlying causes of poverty and social exclusion, our findings support policies that create mixed communities (Lupton et al., 2009). The current paper suggests that the benefits of mixed communities are not only experienced by the poorest in society, rather that the positive SRH association is evident across the household and neighbourhood income distribution.

Strengths

This longitudinal study used data from the latest waves of the UK's largest nationally representative household panel study (UKHLS). The effects of neighbourhood income inequality on health are likely to involve processes that occur over numerous years which is why it was important to capture those by using a longitudinal study design rather than a cross-sectional snapshot. This presents a stepchange compared with the vast majority of existing research. Further research should seek to test this relationship over a longer period and, if and when possible, between generations. This study used Gini coefficients to measure income inequality using nationally derived estimates of neighbourhood household income from tax records, which is novel in the UK because small area data on income are rare and direct income estimates are rarer. This is the first study to our knowledge that compares the relationship between SRH and neighbourhood income inequality in the UK using a nationally representative sample. The focus on neighbourhood level income inequality enables the study to be compared against the burgeoning evidence based on mean neighbourhood effects on health, for example measures of relative neighbourhood deprivation (Jivraj et al., 2021). To adjust for potential non-response bias and preserve the statistical power and sample size, multiple imputation was carried out. Attempts to minimise non-response bias and sampling error was also achieved by using UKHLS survey weights at wave 8. The study measured income using equivalised household income and average neighbourhood income to test the sensitivity of the scale of association to SRH and any potential modifying effect on the association between neighbourhood inequality and SRH. It also tested alternative modifiers including area deprivation to see whether different operationalisations of socioeconomic status modify the neighbourhood inequality to SRH relationship.

Limitations

There are limitations that this study should be considered against. The measurement of neighbourhood income inequality using PAYE and tax benefits income is problematic because it excludes income from sources other than a supply of labour or benefits and excludes all people who are self-employed. There is a wide variation in the income of people who are self-employed and therefore the measure of neighbourhood income inequality could misestimate its association with SRH, especially because there are certain places where self-employment is more common (Burke et al., 2009). While not directly comparable, studies using measures of neighbourhood inequality that arguably measure the assets of wealthier individuals, such as house price values, show similar direction of association to depression

(Marshall et al., 2014). There is always a suggestion in social research that there could be residual confounding (i.e. a factor not considered that explains [and is the cause] of why people have better health in more unequal neighbourhoods). Obvious candidates are the affluence or deprivation of individuals or the places they live in. We have taken account of this using a household measure of income and a measure of neighbourhood deprivation. It could be the case that these are measured imperfectly, are not the most appropriate measures of the concepts or there are different characteristics of individuals or areas that cause better health in more unequal places. An obvious suggestion from Figure 1 is that many of the clusters of more unequal neighbourhoods are in affluent localities. Adding a control and moderator for median income at the neighbourhood level in the regression analysis had very little impact on the neighbourhood inequality and SRH association. The period of change in SRH analysed in this study was four years over three measurement occasions. This could be a too short period to provide meaningful exposure to any positive or negative effect of income inequality on SRH and to simply measure cumulative exposure to any neighbourhood effect (Jivraj et al., 2021; Murray et al., 2021) and may explain why there are no statistically significant moderating effects. Therefore, further research should seek to find more historic neighbourhood level income data that could be linked to existing surveys or wait for existing individual survey data, such as UKHLS, to mature. Notwithstanding these limitations, there appears to be a consensus forming that greater neighbourhood income inequality is associated with better SRH. To this end there are ways in which further research could provide stronger confirmation of this finding. For example, quantitative methods that seek to determine causal effects could be used such as structural equation modelling and marginal structure modelling. Moreover, qualitative methods could explore the effects of neighbourhood inequality.

Conclusion

This study sides with the existing balance of the research on the relationship between neighbourhood income equality and health. It finds that the risk of worse SRH is elevated in more equal neighbourhoods when using the Gini coefficient to measure within neighbourhood income inequality. This finding provides support for the mixed neighbourhood theory and has implications for policy plans aiming to increase mixed communities. There is no empirical support for the theory-led hypothesis that the strength of the relationship between neighbourhood inequality and SRH is stronger for those living in households and neighbourhoods with greater exposure to social deprivation. Further research over a longer study period is required to determine the robustness of these findings.

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Appendix 1 – Proportional odds assumption

Ordinal logit estimates of worse self-rated health

	Estimate	P-value	95% CI	
Neighbourhood variables				
Gini coefficient (ref. 22.06-31.33)				
31.33-33.95	-0.088	0.000	-0.133	-0.043
33.95-37.35	-0.185	0.000	-0.232	-0.137
37.35-58.23	-0.280	0.000	-0.333	-0.227
Deprivation score (ref. 0.54-9.91)				
9.91-17.65	0.193	0.000	0.149	0.238
17.65-29.58	0.289	0.000	0.237	0.340
29.58-92.74	0.500	0.000	0.438	0.562
Median income (ref. £17,233-£47,902)				
£15,494-£17,233	-0.015	0.524	-0.061	0.031
£14,112-£15494	0.012	0.662	-0.041	0.064
£2,237-£14,112	0.015	0.645	-0.047	0.076
Individual variables				
HH income (ref. > £35,152)				
£22,698-£35,152	0.283	0.000	0.241	0.326
£12,922-£22,698	0.551	0.000	0.507	0.595
<£12,922	0.592	0.000	0.538	0.645
Education (ref. degree)				
A-levels	0.222	0.000	0.179	0.264
GCSEs	0.363	0.000	0.320	0.406
Other	0.448	0.000	0.391	0.505
None	0.598	0.000	0.537	0.659
Age	0.024	0.000	0.023	0.025
Sex (ref. male)	0.065	0.000	0.034	0.095
Ethnic group (ref. White British)				
Other White	-0.127	0.001	-0.204	-0.049
Mixed	0.168	0.002	0.062	0.274
Indian	0.082	0.031	0.007	0.157
Pakistani	0.053	0.241	-0.036	0.143
Bangladeshi	0.074	0.226	-0.046	0.194
Caribbean	0.153	0.004	0.049	0.258
African	-0.537	0.000	-0.637	-0.437
Other	0.076	0.115	-0.018	0.170
Year lived at residence	-0.005	0.000	-0.007	-0.003
Region				
North East	-0.052	0.254	-0.141	0.037
North West	-0.116	0.001	-0.182	-0.051

Yorkshire and the Humber	-0.198	0.000	-0.267	-0.128
East Midlands	-0.183	0.000	-0.255	-0.111
West Midlands	-0.130	0.000	-0.197	-0.062
East	-0.057	0.092	-0.123	0.009
South East	-0.073	0.019	-0.133	-0.012
South West	-0.195	0.000	-0.266	-0.124
Wave	0.084	0.000	0.066	0.103

Notes: unweighted analysis was used to test proportional odds assumption. Approximate likelihood-ratio test of proportionality of odds across response categories: chi-square = 904.94 (p=0.000).

Multinomial logit estimates of worse self-rated health (ref. excellent)

	Very_good				Good				Fair				Poor			
	Est.	p	95% CI		Est.	p	95% CI		Est.	p	95% CI		Est.	p	95% CI	
Neighbourhood variables																
Gini coefficient (ref. 22.06-31.33)																
31.33-33.95	-0.115	0.015	-0.208	-0.022	-0.106	0.026	-0.199	-0.012	-0.168	0.001	-0.272	-0.065	-0.237	0.000	-0.366	-0.109
33.95-37.35	-0.128	0.009	-0.223	-0.032	-0.191	0.000	-0.287	-0.095	-0.291	0.000	-0.399	-0.183	-0.423	0.000	-0.560	-0.285
37.35-58.23	-0.276	0.000	-0.378	-0.174	-0.415	0.000	-0.519	-0.312	-0.513	0.000	-0.632	-0.395	-0.622	0.000	-0.779	-0.466
Deprivation score (ref. 0.54-9.91)																
9.91-17.65	0.089	0.034	0.007	0.171	0.139	0.001	0.055	0.223	0.372	0.000	0.271	0.473	0.684	0.000	0.529	0.838
17.65-29.58	0.031	0.527	-0.065	0.128	0.160	0.001	0.061	0.258	0.481	0.000	0.365	0.597	0.830	0.000	0.661	1.000
29.58-92.74	0.059	0.336	-0.061	0.179	0.205	0.001	0.084	0.326	0.744	0.000	0.604	0.884	1.290	0.000	1.097	1.483
Median income (ref. £17,233-£47,902)																
£15,494-£17,233	0.098	0.022	0.014	0.183	0.119	0.007	0.033	0.205	-0.021	0.691	-0.125	0.083	0.011	0.893	-0.143	0.164
£14,112-£15494	0.076	0.127	-0.022	0.174	0.118	0.020	0.019	0.218	0.026	0.665	-0.091	0.143	0.036	0.671	-0.130	0.202
£2,237-£14,112	0.059	0.324	-0.058	0.176	0.121	0.046	0.002	0.239	-0.046	0.513	-0.184	0.092	0.110	0.250	-0.078	0.298
Individual variables																
HH income (ref. > £35,152)																
£22,698-£35,152	0.072	0.061	-0.003	0.147	0.315	0.000	0.238	0.393	0.451	0.000	0.352	0.549	0.871	0.000	0.703	1.039
£12,922-£22,698	0.152	0.000	0.070	0.233	0.487	0.000	0.404	0.569	0.895	0.000	0.795	0.995	1.467	0.000	1.304	1.630
<£12,922	0.125	0.018	0.022	0.228	0.441	0.000	0.337	0.545	0.913	0.000	0.793	1.034	1.555	0.000	1.374	1.735
Education (ref. degree)																
A-levels	0.063	0.111	-0.014	0.141	0.263	0.000	0.185	0.342	0.395	0.000	0.302	0.489	0.319	0.000	0.184	0.454
GCSEs	0.073	0.092	-0.012	0.158	0.395	0.000	0.310	0.480	0.571	0.000	0.473	0.668	0.621	0.000	0.490	0.751
Other	0.144	0.034	0.011	0.277	0.465	0.000	0.334	0.596	0.620	0.000	0.478	0.761	0.954	0.000	0.785	1.122
None	-0.004	0.955	-0.148	0.140	0.283	0.000	0.142	0.425	0.674	0.000	0.525	0.823	1.006	0.000	0.833	1.179
Age	0.015	0.000	0.012	0.017	0.026	0.000	0.024	0.029	0.044	0.000	0.041	0.046	0.049	0.000	0.045	0.052

	Very_good				Good				Fair				Poor			
	Est.	p	95% CI		Est.	p	95% CI		Est.	p	95% CI		Est.	p	95% CI	
Sex (ref. male)	0.133	0.000	0.075	0.190	0.108	0.000	0.050	0.167	0.182	0.000	0.115	0.250	0.228	0.000	0.139	0.317
Ethnic group (ref. White British)																
Other White	-0.006	0.929	-0.147	0.134	0.016	0.822	-0.127	0.160	-0.202	0.026	-0.379	-0.024	-0.406	0.002	-0.668	-0.144
Mixed	-0.008	0.931	-0.198	0.181	0.017	0.863	-0.177	0.212	0.123	0.290	-0.105	0.350	0.582	0.000	0.312	0.853
Indian	-0.066	0.352	-0.206	0.073	0.115	0.107	-0.025	0.256	0.072	0.393	-0.093	0.236	-0.023	0.839	-0.247	0.201
Pakistani	-0.408	0.000	-0.569	-0.246	-0.133	0.098	-0.291	0.024	-0.201	0.031	-0.383	-0.019	-0.088	0.434	-0.310	0.133
Bangladeshi	-0.274	0.020	-0.504	-0.044	0.191	0.089	-0.029	0.411	-0.088	0.508	-0.347	0.172	-0.214	0.210	-0.548	0.120
Caribbean	0.016	0.891	-0.210	0.241	0.281	0.013	0.060	0.502	0.154	0.219	-0.092	0.400	0.229	0.128	-0.066	0.525
African	-0.513	0.000	-0.670	-0.356	-0.611	0.000	-0.773	-0.448	-0.854	0.000	-1.060	-0.649	-1.568	0.000	-1.924	-1.212
Other	-0.011	0.900	-0.188	0.166	0.304	0.001	0.128	0.480	-0.049	0.662	-0.269	0.171	-0.044	0.772	-0.345	0.256
Year lived at residence	0.003	0.111	-0.001	0.006	0.003	0.099	-0.001	0.007	-0.003	0.170	-0.007	0.001	-0.012	0.000	-0.017	-0.007
Region (ref. London)																
North East	-0.114	0.197	-0.287	0.059	-0.202	0.024	-0.377	-0.027	-0.209	0.040	-0.408	-0.009	-0.051	0.683	-0.297	0.195
North West	-0.161	0.011	-0.284	-0.038	-0.206	0.001	-0.331	-0.082	-0.232	0.002	-0.377	-0.087	-0.344	0.000	-0.534	-0.154
Yorkshire and the Humber	-0.043	0.523	-0.174	0.088	-0.224	0.001	-0.357	-0.091	-0.302	0.000	-0.457	-0.147	-0.355	0.001	-0.558	-0.152
East Midlands	-0.054	0.441	-0.192	0.084	-0.168	0.019	-0.308	-0.028	-0.167	0.044	-0.328	-0.005	-0.683	0.000	-0.909	-0.456
West Midlands	-0.101	0.121	-0.229	0.027	-0.160	0.015	-0.289	-0.031	-0.184	0.016	-0.334	-0.034	-0.439	0.000	-0.639	-0.239
East	0.013	0.837	-0.112	0.138	-0.014	0.827	-0.141	0.112	-0.026	0.731	-0.174	0.122	-0.252	0.015	-0.456	-0.048
South East	-0.093	0.103	-0.204	0.019	-0.104	0.073	-0.217	0.010	-0.151	0.027	-0.286	-0.017	-0.223	0.018	-0.408	-0.038
South West	-0.018	0.788	-0.153	0.116	-0.184	0.009	-0.320	-0.047	-0.284	0.001	-0.444	-0.124	-0.314	0.004	-0.526	-0.102
Wave	0.126	0.000	0.091	0.161	0.160	0.000	0.124	0.195	0.202	0.000	0.161	0.243	0.187	0.000	0.133	0.241
Constant	-0.871	0.000	-1.236	-0.505	-2.119	0.000	-2.491	-1.748	-4.651	0.000	-5.085	-4.217	-6.548	0.000	-7.135	-5.960

Notes: unweighted analysis.

Appendix 2 – Non-imputed analysis

Multilevel ordinal regression log odds of worse self-rated health

	Estimate	P-value	95% CI	
Fixed effects				
Neighbourhood level				
Gini coefficient (ref. 22.06-31.33)				
31.33-33.95	-0.164	0.081	-0.348	0.020
33.95-37.35	-0.323	0.001	-0.515	-0.132
37.35-58.23	-0.624	0.000	-0.837	-0.412
Deprivation score (ref. 0.54-9.91)				
9.91-17.65	0.430	0.000	0.261	0.599
17.65-29.58	0.623	0.000	0.423	0.822
29.58-92.74	1.152	0.000	0.903	1.401
Median income (ref. £17,233-£47,902)				
£15,494-£17,233	-0.031	0.736	-0.210	0.148
£14,112-£15494	0.063	0.544	-0.141	0.267
£2,237-£14,112	0.101	0.413	-0.140	0.342
Individual level				
HH income (ref. > £35,152)				
£22,698-£35,152	0.712	0.000	0.553	0.872
£12,922-£22,698	1.308	0.000	1.138	1.478
<£12,922	1.374	0.000	1.159	1.589
Education (ref. degree)				
A-levels	0.494	0.000	0.340	0.647
GCSEs	0.824	0.000	0.666	0.981
Other	1.022	0.000	0.805	1.239
None	1.286	0.000	1.052	1.519
Age	0.055	0.000	0.051	0.059
Sex (ref. male)	0.132	0.014	0.027	0.237
Ethnic group (ref. White British)				
Other White	-0.313	0.050	-0.626	0.001
Mixed	0.534	0.013	0.114	0.954
Indian	0.231	0.136	-0.072	0.535
Pakistani	-0.081	0.696	-0.489	0.326
Bangladeshi	-0.078	0.760	-0.577	0.421
Caribbean	0.593	0.005	0.176	1.010
African	-1.333	0.000	-1.754	-0.912
Other	0.023	0.899	-0.337	0.384
Year lived at residence	-0.013	0.000	-0.020	-0.007
Region (ref. London)				
North East	-0.175	0.335	-0.529	0.180

	Estimate	P-value	95% CI	
North West	-0.278	0.043	-0.547	-0.009
Yorkshire and the Humber	-0.456	0.002	-0.739	-0.173
East Midlands	-0.489	0.001	-0.771	-0.206
West Midlands	-0.367	0.007	-0.636	-0.099
East	-0.204	0.132	-0.470	0.061
South East	-0.177	0.156	-0.421	0.067
South West	-0.478	0.001	-0.762	-0.195
Wave	0.175	0.000	0.145	0.204
Random effects				
Neighbourhood level	1.385		1.133	1.694
Individual level	10.428		9.889	10.995

Notes: survey weight adjusted. Excludes imputed data.