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ABSTRACT

Socioeconomic Determinants of COVID-19 Infections and Mortality: Evidence from England and Wales*

I use simple correlations and regression analysis to study how the number of confirmed Covid-19 cases and the number of deaths with Covid-19 per 100,000 people is related with the socioeconomic characteristics of local areas in England and Wales. I find that local areas that have larger households, worse levels of self-reported health and a larger fraction of people using public transport have more Covid-19 infections per 100,000 people. For mortality, household size and use of public transport are less important, but there is a clear relation with age, ethnicity and self-reported health. Local areas with an older population, a larger share of black or Asian population and worse levels of self-reported health have more Covid-19 deaths per 100,000 people. To prevent the spread of infection and reduce mortality, policymakers should introduce measures to improve housing conditions and improve the health of the population. Also, as many countries now begin to relax lockdown measures, they should pay particular attention to reducing the risk of infection in public transport.

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1 Introduction

The Covid-19 pandemic raises many important research questions for economists. This paper combines data on the number of confirmed Covid-19 cases and the number of deaths with Covid-19 per 100,000 people for local areas in England and Wales with socioeconomic data from the 2011 Census to study the socioeconomic determinants of infections and deaths. I examine, in particular, the correlation with population density and household size, ethnicity, health, an index of multiple deprivation and use of public transport.

The first confirmed case of Covid-19 in England was registered in York on January 30th 2020. As of May 6th 2020, there have been 206,715 positive tests and 30,615 deaths (in all settings and not just in hospitals) in the UK. The number of deaths is the highest among European countries.

Behind these overall numbers, there is considerable regional variation. Figure 1 shows the number of confirmed cases per 100,000 people in different local authority districts and Table 1 lists the 10 local authorities with highest infection rates in England and Wales and in England only. These are cumulative cases as of May 5th 2020 in Wales and May 8th 2020 in England. Infection rates depend on two factors: the frequency of testing and the fraction of tests with a positive result.[1] England and Wales have different public health agencies and different policies on testing, which may explain the relatively high infection rates recorded in Wales. When looking at England only, the highest infections rates are in Barrow-in-Furness and nearby Lancaster and South Lakeland. The North East region around Gateshead, Sunderland and South Tyneside is another hot spot. The London borough with the highest infection rate is Brent, with 421 cases per 100,000 people.

[1] It would be interesting to study these two factors separately, as Borjas (2020) does for New York City neighbourhoods. However, data on the number of tests by local authority is not available for England.

Figure 1

Confirmed Covid-19 cases (per 100,000 people)

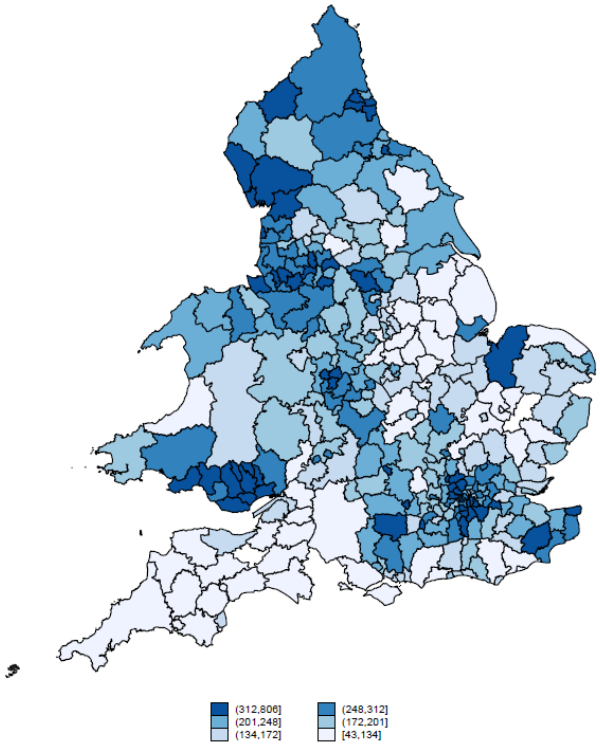


Table 1

Local authorities with the largest number of Covid-19 cases per 100,000 people

England and Wales	Covid-19 cases per 100,000 people	England only	Covid-19 cases per 100,000 people
Barrow-in-Furness	805.8	Barrow-in-Furness	805.8
Lancaster	515.1	Lancaster	515.1
Rhondda Cynon Taf	497.6	South Lakeland	483.1
Cardiff	491.1	Gateshead	466.2
South Lakeland	483.1	Sunderland	460
Newport	480.1	Ashford	450.2
Merthyr Tydfil	478.5	Middlesbrough	437.6
Gateshead	466.2	South Tyneside	427.9
Sunderland	460	Brent	421.4
Swansea	458.1	Knowsley	405.2

Figure 2 and Table 2 show the number of deaths per 100,000 people. The data record the cumulative number of deaths that mention Covid-19 on the death certificate as of April 24th 2020. Importantly, geographic disaggregation is by area of usual residence rather than place of death. Because the vast majority of deaths (70%) occur in hospital, it is important to look at area of

residence rather than place of death when analysing the socioeconomic determinants of mortality. The borough with the highest mortality rate, at 131 deaths per 100,000 people is Hertsmere in Hertfordshire, which borders with the North London boroughs of Harrow, Barnet and Enfield. These London boroughs as well as Brent, Ealing and Croydon also have high mortality rates. Outside London, mortality rates are highest in Epping Forest in Essex, South Lakeland in Cumbria and Middlesbrough in North Yorkshire. The South West counties of Cornwall and Devon and West Wales have low Covid-19 mortality rates.

Figure 2

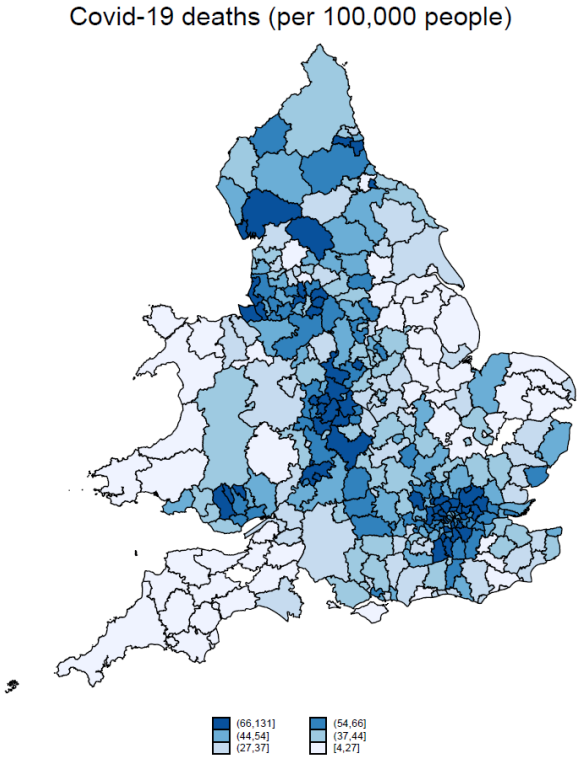


Table 2

Local authorities with the largest number of Covid-19 deaths per 100,000 people

	Covid-19 deaths per 100,000 people
Hertsmere	131.5
Harrow	122.3
Brent	116.4
Epping Forest	107.5
South Lakeland	101.4
Enfield	94.9
Ealing	94.5
Barnet	93.8
Croydon	90.3
Middlesbrough	88.9

To examine which socioeconomic characteristics of local authorities are correlated with Covid-19 infections and mortality, I first look at simple correlations. I then estimate a regression model which examines all factors together. The evidence suggests that infection rates are higher in local areas with larger households, more extensive use of public transport and worse levels of self-reported health. Mortality is higher in local areas that are more densely populated, have an older population, worse levels of self-reported health and a larger share of black or Asian population.

2 Data

Data on the cumulative number of confirmed Covid-19 cases by local authority district are from Public Health England (as of May 8th 2020) and Public Health Wales (as of May 5th 2020). Data on the number of deaths related to Covid-19 are from the ONS and are based on any mention of Covid-19 in the death certificate. For the descriptive evidence, I use the cumulative number of deaths as of April 24th 2020 by local authority district of usual residence. For the regression analysis, I use more disaggregated data by Middle Layer Super Output Area (MSOA) on the number of deaths occurring between March 1st and April 17th 2020. This finer level of disaggregation makes it possible to include local authority fixed effects in the mortality regressions.

I merge these data on infections and mortality with data on socioeconomic characteristics of local authorities. Data on ethnicity, age, household size, health and use of public transport are from the 2011 Census. Data on population and density are from the ONS 2018 population estimates. Data

on deprivation are from the 2019 English and Welsh Indices of Multiple Deprivation (IMD), which combine the following categories of deprivation: income, employment, education, crime, housing and living environment. This index is available by Lower Layer Super Output Area (LSOA). To aggregate the data to local authority or MSOA level, I use the proportion of LSOAs in a given local authority or MSOA that are in the most deprived 10% nationally. Table 3 presents descriptive statistics and lists the data sources. The final dataset contains 337 local authorities and 7,201 MSOAs in England and Wales.

Table 3

	Mean	Standard deviation	Source
Covid-19 cases per 100,000 people	222.749	98.653	Public Health England (updated May 8th 2020) and Public Health Wales (updated May 6th 2020); population from ONS 2018 population estimates
Covid-19 deaths per 100,000 people (by local authority district)	46.946	20.834	ONS weekly deaths dataset up to April 24th 2020
Covid-19 deaths per 100,000 people (by MSOA)	34.362	32.753	ONS weekly deaths dataset covering the period from March 1st to April 17th 2020
Log population density	1.929	1.407	ONS 2018 population estimates
Percent female	50.683	0.745	2011 Census
Percent age 60 and over	25.355	5.583	2011 Census
Percent black/African/Caribbean/black British	2.261	4.351	2011 Census
Percent Asian/Asian British	5.593	7.634	2011 Census
Average household size	2.349	0.120	2011 Census
IMD – proportion of LSOAs in most deprived 10% nationally	7.408	10.336	English Index of Multiple Deprivation and Welsh Index of Multiple deprivation
Percent reporting health as bad or very bad	5.437	1.520	2011 Census
Percent travelling to work by public transport	13.201	13.262	2011 Census (public transport includes underground, metro, light rail or tram; train; and bus, minibus or coach)

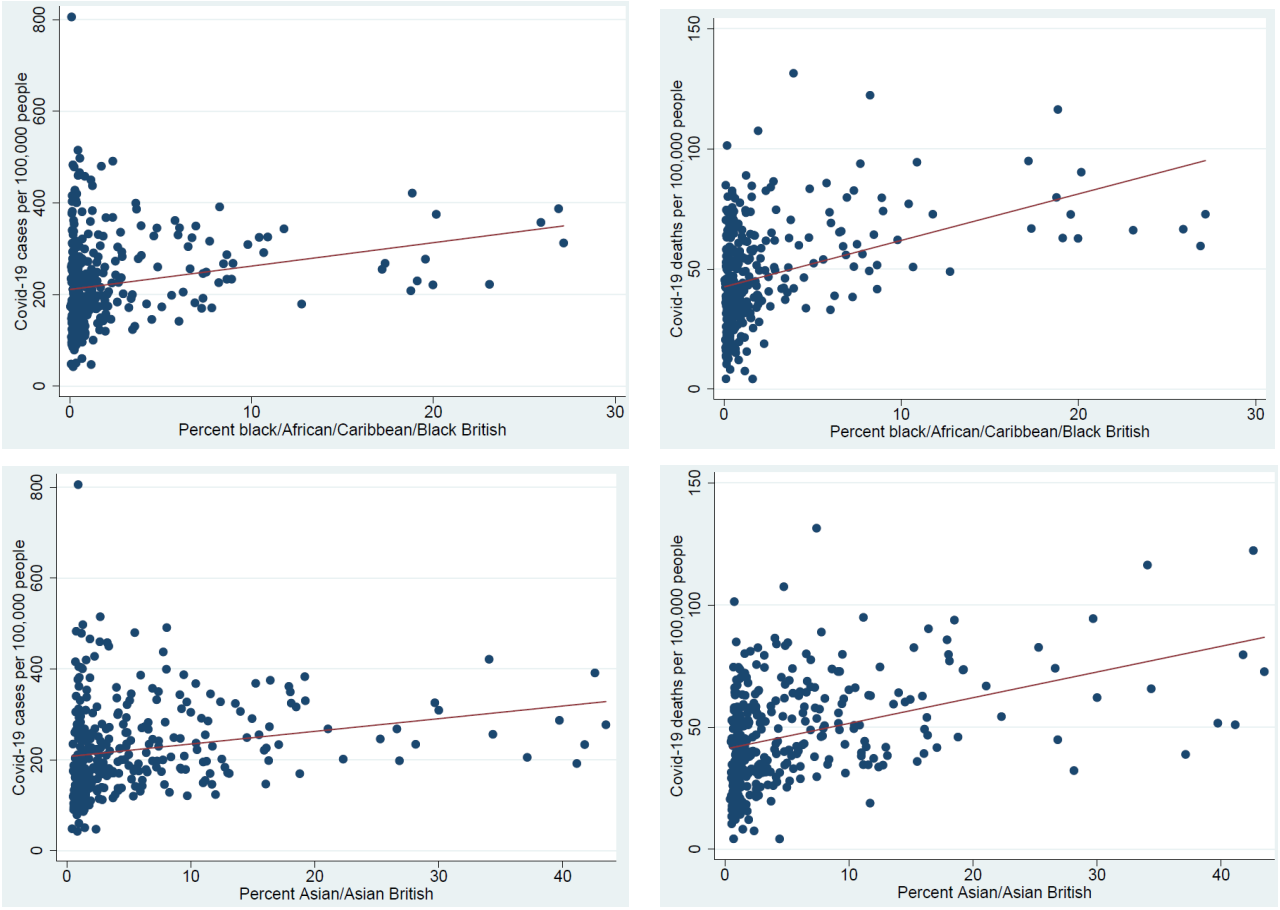
3 Descriptive evidence

Before presenting the regression results, I examine simple correlations between Covid-19 infections and mortality and socioeconomic characteristics of local authorities.

3.1 Ethnicity

There is a positive correlation between both infections and mortality and the percentage of black or Asian population in the local authority. This correlation is larger for mortality than for infections. A similar pattern is found in New York City in Borjas (2020) and Almagro and Orane-Hutchinson (2020). For England and Wales, analysis by the ONS (ONS (2020)) shows that people of black ethnicity are 1.9 times more likely to die with Covid-19 than those of white ethnicity, after controlling for age, measures of self-reported health and disability and sociodemographic characteristics. Their analysis is based on individual level data, obtained by linking information on the death certificate with data from the 2011 Census.

Figure 3

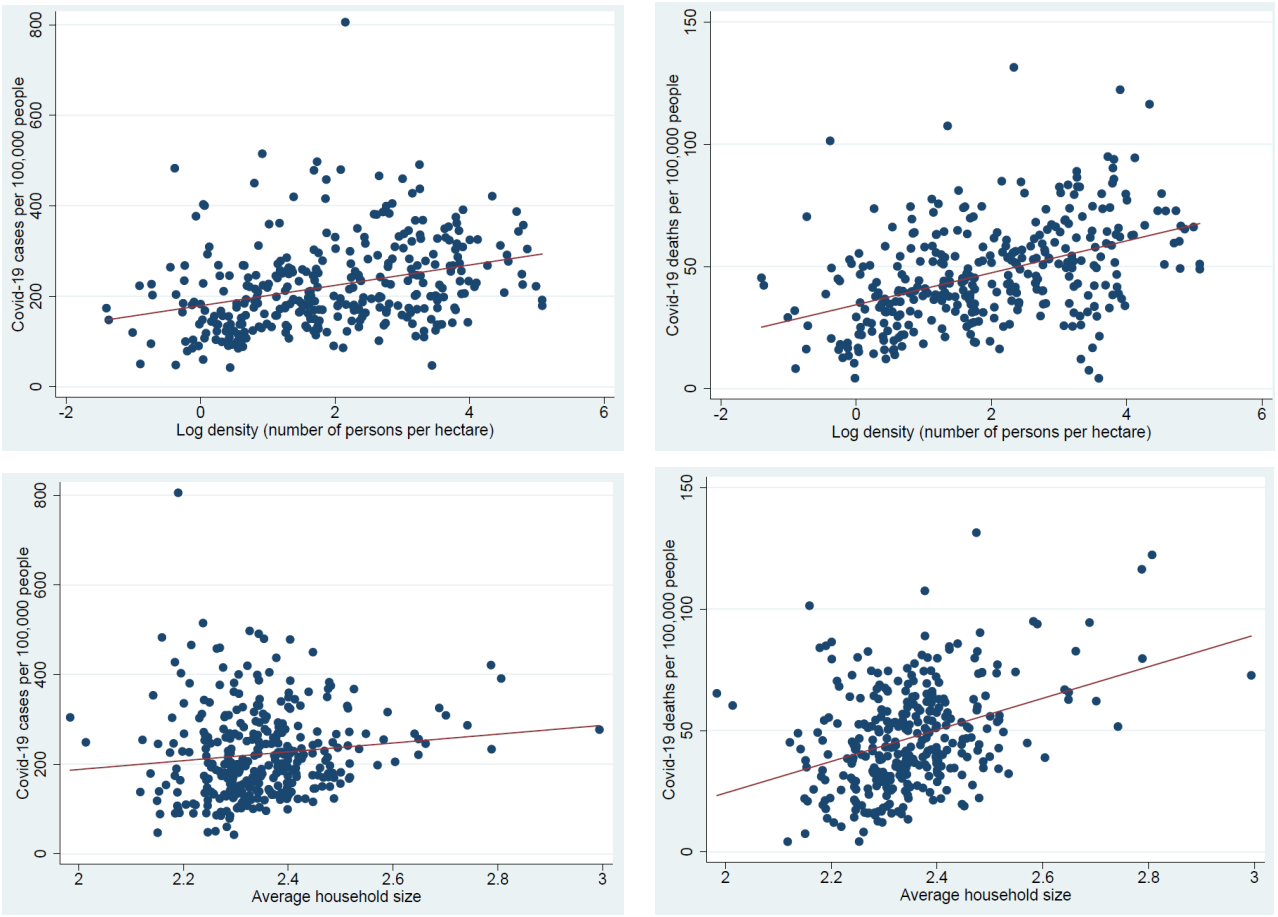


3.2 Population density and household size

Population density and average household size are also positively correlated with infections and mortality. This is again consistent with the findings for New York City reported in Borjas (2020)

and Almagro and Orane-Hutchinson (2020).

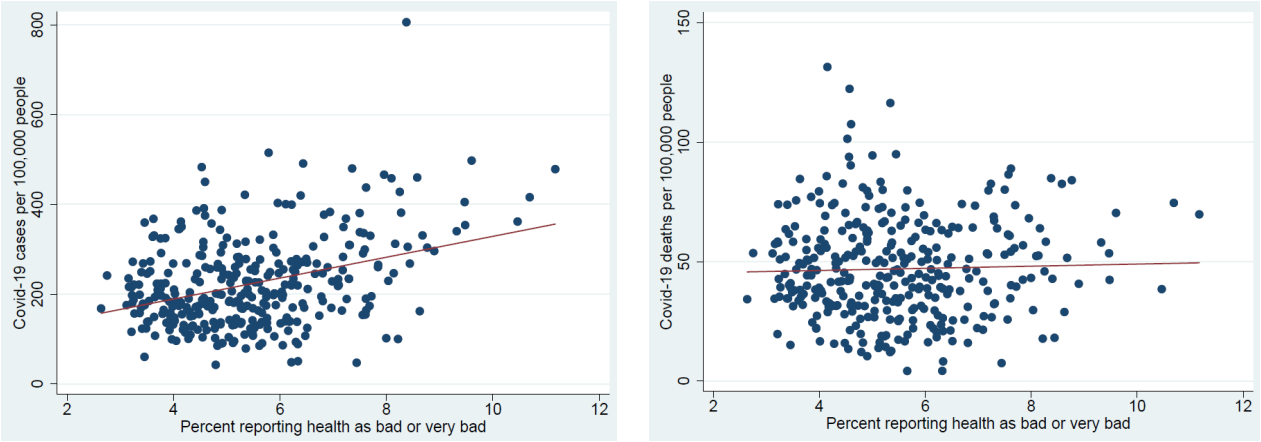
Figure 4



3.3 Health

To measure health conditions in different local authorities, I use data on self-reported health from the 2011 Census and calculate the percentage of the population reporting their health as bad or very bad. This measure is positively correlated with infections, but does not appear to be correlated with mortality.

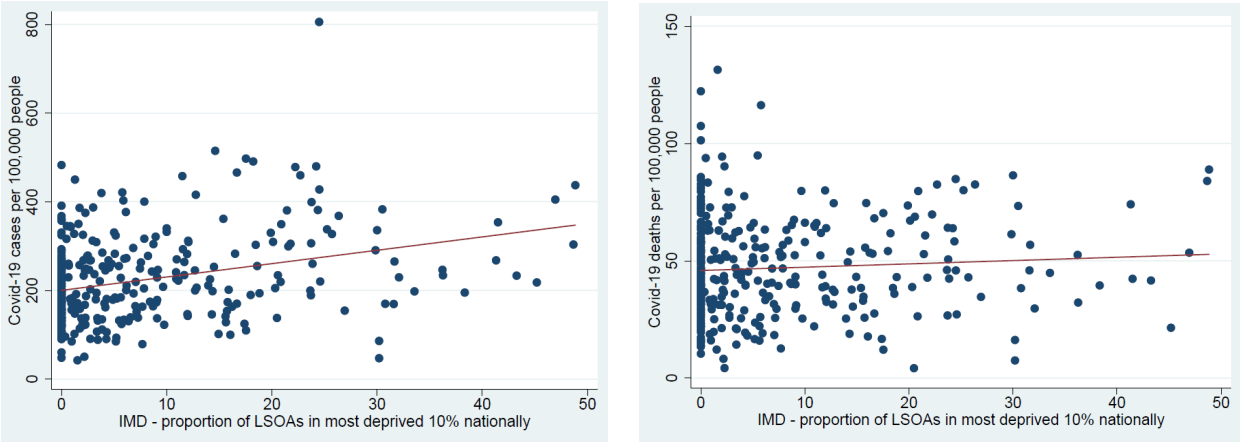
Figure 5



3.4 Deprivation

More deprived local authorities have more confirmed cases of Covid-19, but there is no correlation between deprivation and mortality.

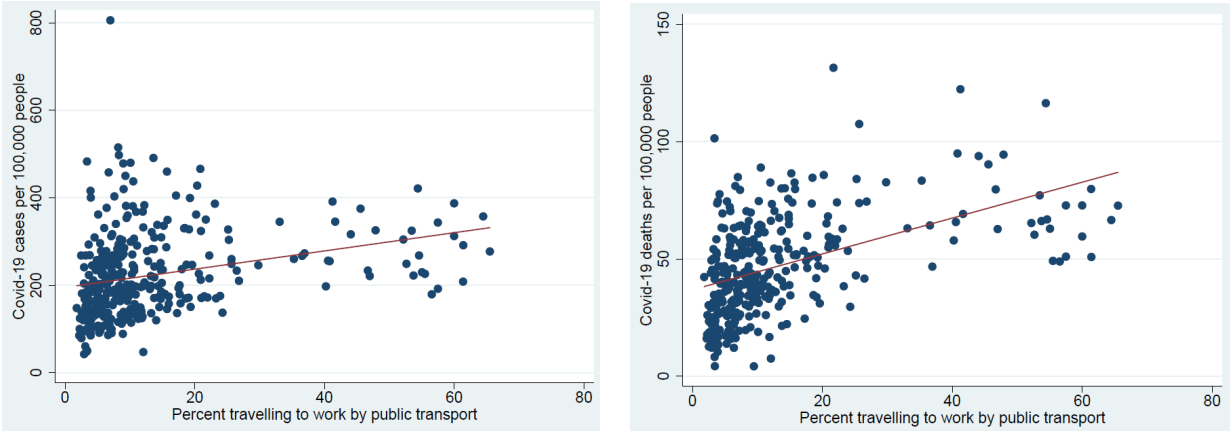
Figure 6



3.5 Use of public transport

I measure the intensity of use of public transport by calculating the percentage of people in each local authority who travel to work by underground, metro, light rail, tram, train, bus, minibus or coach. Data on method of travel to work are from the 2011 Census. There is a positive correlation between use of public transport and infections and mortality.

Figure 7



4 Regression results

I estimate a simple linear regression of infections and mortality on socioeconomic characteristics. I first include only basic demographic characteristics and then add deprivation, use of public transport and self-reported health. Data on the number of confirmed Covid-19 cases is only available by local authority district, but data on mortality is available at a finer level of geographic disaggregation (MSOA). By using more disaggregated data I am able to include local authority fixed effects in the mortality regressions. This is important because fixed effects capture local authority characteristics that have not been included in the model.

Looking at infections, local authorities with larger households have a higher number of Covid-19 cases per 100,000 people. The coefficient on the England dummy variable is very large and negative, confirming that the incidence of testing is higher in Wales. Local authorities where a larger share of the population commute by public transport and those with worse levels of self-reported health have significantly more Covid-19 cases per 100,000 people.

Mortality is higher in more densely populated MSOAs, but household size is less important than for infections and is not significant. After controlling for local authority fixed effects, the relation with age is much clearer and MSOAs with an older population have a higher number of Covid-19 deaths per 100,000 people. The relation with public transport, which is positive and significant for infections, is not present for mortality, but the relation with self-reported health is still strongly significant. Infections and mortality appear to be higher in more deprived areas, but in both cases the relation disappears after controlling for self-reported health. The relation with

ethnicity is much clearer for mortality than for infections, with local areas with a larger share of black or Asian population recording higher Covid-19 mortality rates. This relation with ethnicity remains after controlling for other factors, such as household size, age, deprivation and health.

Table 4

	Covid-19 cases per 100,000 people			Covid-19 deaths per 100,000 people		
Log population density	24.498***	13.616*	6.353	1.822***	1.892***	1.251***
	(8.017)	(7.963)	(7.932)	(0.343)	(0.342)	(0.345)
Percent female	22.371***	13.853*	20.109**	1.153***	1.001***	0.431*
	(7.600)	(8.068)	(8.177)	(0.236)	(0.238)	(0.239)
Percent age 60 and over	-0.819	1.371	-2.007	1.131***	1.196***	1.080***
	(2.133)	(2.057)	(2.274)	(0.073)	(0.075)	(0.075)
Percent black/African/Caribbean/black British	0.944	-1.379	-2.166	0.428***	0.393***	0.232*
	(1.347)	(1.912)	(2.038)	(0.128)	(0.131)	(0.132)
Percent Asian/Asian British	0.631	-1.331	-1.163	0.335***	0.320***	0.246***
	(1.001)	(1.118)	(1.113)	(0.055)	(0.056)	(0.055)
Average household size	24.963	145.043**	158.407**	-2.605	-2.578	2.675
	(56.794)	(59.034)	(62.154)	(2.326)	(2.355)	(2.323)
England	-145.239***	-140.032***	-96.279***			
	(25.343)	(25.785)	(33.368)			
IMD – proportion of LSOAs in most deprived 10% nationally		2.477***	0.692		10.113***	-5.396**
		(0.556)	(0.788)		(1.928)	(2.480)
Percent travelling to work by public transport		2.454***	2.268***		-0.168	-0.143
		(0.691)	(0.676)		(0.106)	(0.104)
Percent reporting health as bad or very bad			19.935***			3.253***
			(6.642)			(0.313)
Observations	337	337	337	7,201	7,201	7,201
R-squared	0.249	0.313	0.341	0.309	0.312	0.323

Weighted OLS by population size. Robust standard errors in parentheses.

Mortality regressions use data disaggregated by MSOA and include local authority fixed effects.

*** Significant at the 1% level; ** significant at the 5% level; *significant at the 10% level.

5 Conclusions

The results of the simple correlations and the regression analysis presented in this paper show that local areas that have larger households, worse levels of self-reported health and a larger fraction of people using public transport have more Covid-19 infections per 100,000 people. For mortality, household size and use of public transport are less important, but there is a clear relation with age, ethnicity and self-reported health. Local areas with an older population, a larger share of black or

Asian population and worse levels of self-reported health have more Covid-19 deaths per 100,000 people.

These results are useful to inform our understanding of the socioeconomic factors that affect infections and mortality. To prevent the spread of infection and reduce mortality, policymakers should introduce measures to improve housing conditions and improve the health of the population. Also, as many countries now begin to relax lockdown measures, they should pay particular attention to reducing the risk of infection in public transport. This can be done by encouraging people to use other forms of transport, as is being done in the UK, but also by increasing the frequency of services to avoid overcrowding. Businesses should also take the risk of infection in public transport into account when deciding how to get their employees back to the office. Working from home should continue to be encouraged when possible, especially for those who have to travel to work by public transport.

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[3] ONS (2020). 'Coronavirus (COVID-19) related deaths by ethnic group, England and Wales: 2 March 2020 to 10 April 2020', Office for National Statistics, May 7, 2020