Office for National Statistics

Statistical bulletin

Coronavirus (COVID-19) mortality and long-term outdoor air pollution in London: September 2020 to January 2022

Experimental analysis of the risk of death involving coronavirus (COVID-19) for people living in areas with different air pollution exposure levels within London, using linked data from the Office for National Statistics' Public Health Data Asset. This analysis has been produced in partnership with the University of Leicester and Imperial College London.

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1 . Main points

- Exposure levels to four long-term air pollutants among people living in London who tested positive for SARS-CoV-2 between 1 September 2020 and 12 December 2021 were associated with an increase in risk of death involving coronavirus (COVID-19) in initial analyses that adjusted for sex and age, but did not take account of all risk factors.

- The positive association between air pollution exposure and risk of death involving COVID-19 disappeared when further adjusting for factors related to area characteristics, ethnicity and deprivation.

- The association between air pollution exposure and risk of death involving COVID-19 did not change when further adjusting for factors relating to virus variant and pre-existing health conditions.

- The results suggest that the positive association between death involving COVID-19 and long-term air pollution exposure is because of other risk factors such as deprivation and ethnicity, or that the contribution of effect of air pollution exposure to the risk of death involving COVID-19 after a positive test is small.

These are Experimental Statistics, which are statistics that are in the testing phase and not yet fully developed.

Statistician's comment

"Today's analysis shows that air pollution exposure has little impact on the risk of dying from COVID-19 among people who lived in London and tested positive for SARS-CoV-2.

When comparing people of the same sex and age, we found that those who lived in more polluted areas were at greater risk of death after infection. However, this relationship disappeared when we accounted for other factors, such as deprivation or ethnicity, suggesting that long-term air pollution has no large effect on the risk of dying from COVID-19."

Vahé Nafilyan, senior statistician, Health Analysis and Pandemic Insight Directorate, Office for National Statistics

2 . Risk of death involving coronavirus (COVID-19) by air pollution exposure levels

Using data on people living in London who tested positive for SARS-CoV-2 in NHS Test and Trace data between 1 September 2020 and 12 December 2021, we used Cox proportional hazards regression to estimate how the risk of death involving coronavirus (COVID-19) varied by local air pollution exposure levels. We assessed exposure to the 2016 annual average of four air pollutants (NO2, NOx, PM10 and PM2.5), with a separate Cox model for each pollutant.

We estimated hazard ratios for death involving COVID-19 for each pollutant. We adjusted for factors known to be risk factors for COVID-19 and likely to influence the relationship between air pollution exposure and risk of death. To tease apart the influence of different factors on the relationship between air pollution and death, we additively adjusted for these factors. (See Section 5. Measuring the data for more details on the methods used in this analysis).

In the initial model, adjusted for just age and sex, a 10 micrograms per cubic metre (g/m^3) increase in NO2 exposure was associated with a 10% increase in the risk of death involving COVID-19 following a positive test. For NOx, this was 7% per 20 g/m^3, for PM10 48% per 10 g/m^3, and for PM2.5 42% per 5 g/m^3.

To account for all factors that could be related to air pollution exposure and the risk of death involving COVID-19, our main model was further adjusted for COVID-19 vaccination, geographicalfactors, ethnicity, and measures of deprivation. The results of this adjusted model were close to zero, and no longer statistically significant: there was no longer a positive association.

Further adjusting for dominant virus variant at the time of positive test and both non-respiratory and respiratory pre-coronavirus pandemic, pre-existing health conditions did not change the results, which remained close to zero.

The results suggest that the positive association between death involving COVID-19 and long-term air pollution exposure are because of other factors, or that air pollution effects are small in comparison with other risk factors such as deprivation and ethnicity.

Figure 1: The positive association between air pollution exposure and death involving COVID-19 disappeared when adjusted for factors related to geographical area characteristics, ethnicity and deprivation

Hazard ratios for death involving COVID-19 for four measures of air pollution exposure, London: 1 September 2020 to 18 January 2022

Notes:

1. Hazard ratios are calculated per 10 g/m^3 increase in NO2 exposure, per 20 g/m^3 for NOx, per 10 g/m^3 for PM10, and per 5 g/m^3 for PM2.5.

Download the data

.xlsx

3 . Coronavirus (COVID-19) mortality and long-term outdoor air pollution in London data

Coronavirus (COVID-19) mortality and long-term outdoor air pollution in London
Dataset | Released 30 January 2023
All data relating to Coronavirus (COVID-19) mortality and long-term outdoor air pollution in London.

4 . Glossary

Air pollution

Air pollution is dirty air. The air that we breathe can be contaminated with particles or substances that can be harmful to health. Important air pollution sources are gases (nitrogen oxides (NOx), a group of gases that can lead to nitrogen dioxide (NO2), a harmful gas), and particle matter, defined by its maximum size (that is, less than 10 or 2.5 micrometres in diameter, PM10 and PM2.5, respectively).

Confidence intervals

Confidence intervals use the standard error to derive a range in which we think the true value is likely to lie. A confidence interval gives an indication of the degree of uncertainty of an estimate and helps to decide how precise a sample estimate is. It specifies a range of values likely to contain the unknown population value. These values are defined by lower and upper limits.

Coronavirus and COVID-19

Coronaviruses are a family of viruses that cause disease in people and animals. They can cause the common cold or more severe diseases, such as COVID-19. COVID-19 is the name used to refer to the disease caused by the SARS-CoV-2 virus, which is a type of coronavirus. The Office for National Statistics (ONS) takes COVID-19 to mean presence of SARS-CoV-2 with or without symptoms.

Cox proportional hazards regression

Cox proportional hazards regression is a statistical model used to measure the association between a time-to-event outcome (such as death involving COVID-19) and a characteristic of interest (in this case, air pollution exposure). It can be used to adjust for other characteristics expected to be related to both the characteristic of interest and the outcome.

Hazard ratio

A hazard ratio is a measure of how often a particular event occurs at one level of a factor (here a certain level of increase in air pollution), compared with how often it occurs in another level of that factor (the reference), at any point in time. A hazard ratio greater than 1 shows that the rate of the event occurring is higher for the level of interest compared with the reference level. A hazard ratio of less than 1 shows that the rate is lower for the level of interest compared with the reference level.

5 . Measuring the data

Data sources

The study covers 737,356 individuals aged 10 to 110 years, usually resident in London, who tested positive for coronavirus (COVID-19) in NHS Test and Trace data between 1 September 2020 and 12 December 2021. Of these, 9,315 individuals (1.3%) died of coronavirus-related causes by 18 January 2022.

The data source for the study was the Office for National Statistics' (ONS's) Public Health Data Asset (PHDA). These data were linked to mid-2018 population density data, national testing data from NHS Test and Trace, and 2016 annual average air pollution concentrations from the London Data Store, using postcodes of residence from the 2011 Census.

The ONS's PHDA covers England only and combines:

- Census 2011 records
- death registrations data
- electronic health records (Hospital Episode Statistics (HES) and General Practice Extraction Service (GPES) Data for Pandemic Planning and Research (GDPPR))
- National Immunisation Management Service (NIMS) data
- NHS Test and Trace (Pillar 1 and Pillar 2) data

Coverage

To be included in the study, individuals had to have evidence of COVID-19 infection between 1 September 2020 and 12 December 2021. They also had to be:

- a resident in Greater London at the beginning of the pandemic according to the 2011 Census
- alive as of 1 September 2020
- registered with a GP
- counted at the 2011 Census
- aged up to 100 years in 2011
- not in a care home in 2019

Death involving COVID-19 was identified by the International Classification of Diseases, tenth revision (ICD-10) code for either U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified) mentioned anywhere on the death certificate.

For individuals with multiple positive COVID-19 tests, we took the first positive test record.

The study covers 52.7% of all positive COVID-19 cases recorded in London during the study period, and 68.2% of all deaths involving COVID-19 that were registered in London up until 18 January 2022.

Variables used in the analysis included:

- age - measured in years at time of positive test
- sex - male or female
- COVID-19 vaccination - having received one or two COVID-19 vaccine dose(s) at least 14 days before the COVID-19 infection
- population density - measured as people per square kilometre
- rural or urban - major conurbation, city and town, town and fringe, village, hamlets and isolated dwellings
- local authority code - 44 areas plus one that combined 11 areas with low variance
- ethnicity - White, South Asian, Black, Other
- household-level deprivation (2011 Census) and area-level deprivation (English Index for Multiple Deprivation 2019 (IMD) deciles) - these were adjusted and rescaled to exclude the health-related components that can be mediating variables in the relationship between air pollution and death involving COVID-19
- dominant COVID-19 variant - unknown (prior to 1 December 2020), Alpha (1 December 2020 to 16 May 2021), or Delta (17 May 2021 to 18 January 2022)
- pre-existing health conditions were derived from the primary care and hospital data

6 . Strengths and limitations

Strengths

The primary strength of the study is using a linked population-level dataset, covering a large general population sample of those testing positive for coronavirus (COVID-19) in London. The comprehensive linkage of Census 2011 to NHS national testing data allowed us to adjust for a range of socio-economic factors, including ethnicity and deprivation both at the area and household level.

Limitations

Results may not generalise to other geographical areas. The study covered the area of Greater London, with people of different ages, ethnicity and socio-economic background generally living relatively mixed across the city. Disentangling effects of these factors can be difficult.

The study used data from the Census 2011. Some people may have relocated during the study period to a region with different air pollution levels. Some patients may not have updated their registration data, resulting in misclassified location measurements for these people.

We used the 2016 air pollution average as a proxy for long-term exposure to outdoor air pollution. Air pollution levels may fluctuate over time, although the spatial distribution should remain relatively similar. We also did not have information on indoor air pollution, that may add to total exposure to dirty air.

7 . Collaboration

This analysis was produced in collaboration with:

- Professor Anna L Hansell from the University of Leicester
- Chris Gale from the Office for National Statistics
- Jasper Morgan from the Office for National Statistics
- Myer Glickman from the Office for National Statistics
- Dr Sean Beevers from Imperial College London

8 . Related links

Does exposure to air pollution increase the risk of dying from the coronavirus (COVID-19)?
Article | Released 13 August 2020
This article measures the link between long-term exposure to dirty air and COVID-19 deaths in England during the early stages of the coronavirus pandemic.

9 . Cite this statistical bulletin

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