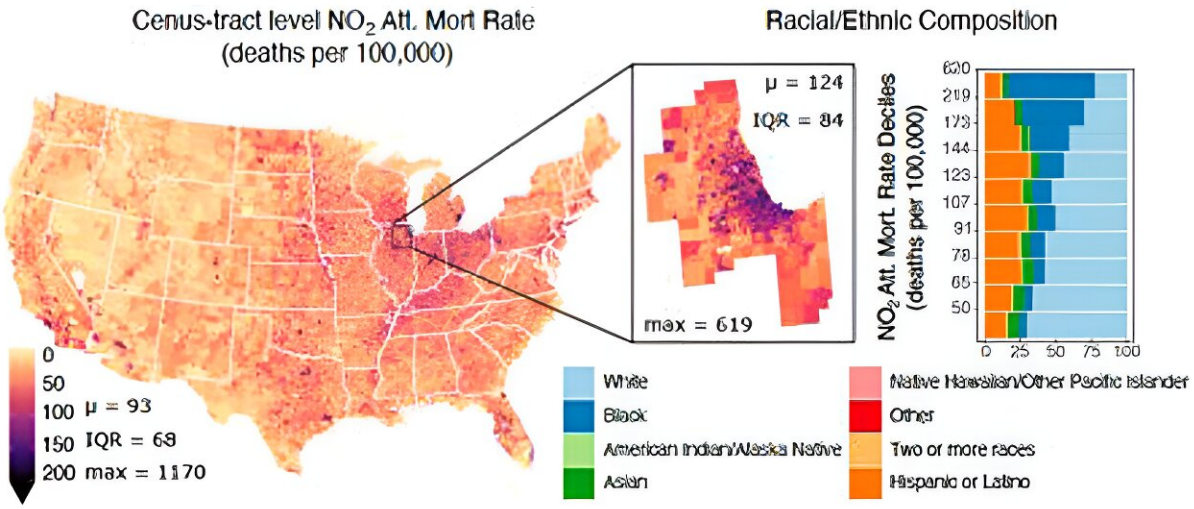
Communities of color suffer disproportionately higher pollution-related deaths, finds nitrogen dioxide exposure study

November 7 2023, by Amanda Morris



Credit: *Environmental Science & Technology Letters* (2023). DOI: 10.1021/acs.estlett.3c00500

In the United States, premature death associated with exposure to nitrogen dioxide (NO_2) pollution—a toxic gas emitted primarily by burning fossil fuels in cars, trucks and power plants—is more likely to impact people of color compared to the white population, a new Northwestern University study has found.

The study is the first to estimate premature deaths attributed to NO_2 exposure and associated disparities across the contiguous United States.

By combining air pollution concentrations from high-resolution models, relative risks from epidemiological studies and census mortality data, the researchers pinpointed where and who NO_2 pollution affects most.

Ultimately, they found that approximately 171,000 premature deaths per year are linked to NO_2 exposure, and a disproportionate number of those deaths occur in marginalized communities. In predominantly Black census tracts, for example, premature deaths related to NO_2 exposure are 47% higher than the national average, the study authors found.

The study provides further confirmation that historically marginalized communities shoulder disproportionate health burdens related to poor air quality.

The study titled "All-cause NO_2-attributable mortality burden and associated racial and ethnic disparities in the U.S.," was published today (Nov. 7) in the *Environmental Science & Technology Letters*. Although previous studies have confirmed the unjust burden of NO_2 exposure on marginalized communities, Northwestern's study is the first to estimate the mortality burden (from all natural causes excluding accidental deaths) attributed to NO_2 exposure across the continental United States.

"When looking at who is affected most by NO_2, we look at not just air pollution exposure, but also susceptibility of the population," said Northwestern's Sara Camilleri, who led the study. "We quantify this by looking at the underlying baseline mortality, which represents susceptibility. In this context, susceptibility could be related to higher occurrences of underlying conditions or lesser access to health care. The Black population, in particular, experiences both high susceptibility and higher NO_2 concentrations."

"Simultaneous advances in epidemiology and air-quality research have allowed us to more confidently quantify the impacts of NO_2 exposure on health outcomes," said Northwestern's Daniel Horton, the study's senior author. "Our results indicate that policies aimed at reducing NO_2 emissions could reduce long-standing environmental injustices and motivate targeted adoption of more stringent standards to protect public health."

Horton is an assistant professor of Earth and planetary sciences at Northwestern's Weinberg College of Arts and Sciences, where he directs the Climate Change Research Group. Camilleri is a postdoctoral scholar in Horton's laboratory.

Combining pollution models with census data

Particularly common in high-traffic and industrial areas, NO_2 exposure is linked to a number of health complications, including asthma, respiratory infections and even death. Although the U.S. Environmental Protection Agency has strengthened regulations aimed at reducing NO_2 concentrations, premature deaths associated with exposure remain.

"Over recent decades, we've seen a declining trend in NO_2 emissions," Camilleri said. "But recent epidemiological studies have shown that NO_2 is detrimental to health even at low concentrations. Therefore, low concentrations still have an impact, and disparities in air pollution exposure and associated health impacts still persist across the U.S."

To better understand the most affected populations, Camilleri, Horton and their co-investigators turned to a nationwide land use regression model (LURM) to estimate NO_2 concentrations. The LURM incorporates surface NO_2 observations and remotely sensed satellite observations along with land use and roadway information to predict the concentration of NO_2 pollution.

"Land use regression models estimate pollutant concentrations by associating land use with observed pollutant concentrations," Horton said. "We know that a roadway has higher NO_2 than a park, for example. Surface observations help inform that relationship, and satellite data can further constrain it. These associations allow us to estimate NO_2 concentrations across the contiguous United States."

Profound impact on Black communities

By combining land use, monitor and satellite data, the researchers estimated NO_2 concentrations across areas as small as one kilometer throughout the contiguous United States. Then, to characterize the residents living within these areas, the researchers used population and demographic data from the American Community Survey and mortality rates at the census-tract level derived by Industrial Economics, Inc.

At a national level, the researchers found areas with the largest estimated NO_2-attributable mortality rates are 29% Black, 18% Hispanic or Latinx, 5% Asian and 45% white. Considering that the racial and ethnic makeup of total U.S. population is 12% Black, 18% Hispanic or Latinx, 5% Asian and 61% white, the disproportionate impact on Black communities is profound.

Nationwide urban hotspots

Because internal combustion engine-based transportation is one of the greatest sources of NO_2 emissions, peak concentrations of the pollutant accumulate along highways and major road networks. A large portion of people living close to these hotspots are people of color, who generally have higher-than-average susceptibilities, the authors write.

Filled with dense highways and industrial activity, urban areas

experience the highest rates of NO_2-related deaths. The larger Detroit area in Michigan, specifically, experiences the highest premature death rate in the country with 1.6 times more NO_2-attributable mortalities than the U.S. average. The researchers uncovered a similar pattern in the Chicago and New York City metropolitan areas, where mortality rates are 1.3 and 1.4 times higher than the national average.

The disproportionate burden on marginalized communities is amplified in these areas. For example, Black people make up just 21% of the population in the larger Chicago and Detroit metropolitan areas, yet about 60% of the people affected by NO_2-related mortality in these areas are Black.

Exploring potential solutions

To address the unjust impacts of NO_2 pollution, Camilleri and Horton suggest the adoption of policies that incentivize vehicle electrification and the removal of high-emitting combustion-engine vehicles from roadways. Just last month, their team published a study finding in that electrifying 30% of on-road heavy-duty vehicles could save hundreds of lives per year—largely benefitting disadvantaged communities.

"Based on our previous work, we have shown that shifting to cleaner transportation options can have large implications for reducing inequitable transportation-related health burdens," Camilleri said. "The shift to electric vehicles is definitely one solution that is worth incentivizing from an air quality, public health, climate change and economic perspective."

More information: Sara F Camilleri et al, All-Cause NO2-Attributable Mortality Burden and Associated Racial and Ethnic Disparities in the United States, *Environmental Science & Technology Letters* (2023). DOI: 10.1021/acs.estlett.3c00500

Provided by Northwestern University