

Harvard T.H. Chan School of Public Health

Long-term exposure to permissible concentrations of air pollution linked with increased mortality risk



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Boston, MA – Exposure to low concentrations of [air pollution](#), even at levels permitted under federal regulations, may be causing tens of thousands of early deaths each year among [elderly people](#) and other vulnerable groups in the U.S., according

to a large national study from Harvard T.H. Chan School of Public Health. The study was published October 7, 2021, in *The Lancet Planetary Health*.

“We found that among elderly patients enrolled in Medicare, small increases in long-term exposure to both particle and gaseous air pollutants increased the risk of death, even at levels deemed safe by current regulations,” said lead study author [Mahdiah Danesh Yazdi](#), a postdoctoral fellow in Harvard Chan School’s [Department of Environmental Health](#). “Our findings suggest that current air pollution limits are not adequate to protect the health of vulnerable groups.”

Previous studies have suggested that people exposed to air pollution concentrations that are lower than those permitted by the U.S. Environmental Protection Agency may still have an increased risk of illness and mortality. But most earlier studies did not focus on individuals who were continually exposed to lower concentrations of pollutants during the study period, as the new study does. Researchers also used a robust causal modeling technique and a large dataset for their analysis that gave them enough power to detect links between air pollution and mortality in demographic and socioeconomic subgroups.

The analysis included data on millions of Medicare enrollees from 2000 to 2016. The researchers predicted people’s exposure levels by using satellite-based measurements, land-use data, meteorological data, and chemical-transport models to generate daily air pollution predictions as well as annual averages of exposure levels across the U.S. Participants were assigned exposures based on their residential postal codes. The

researchers adjusted for factors such as age, sex, race, education level, and smoking history.

The study looked at the effects of three different types of pollutants, including fine [particulate matter](#), or PM2.5—particulates with a diameter of less than 2.5 micrometers per cubic meter of air ($\mu\text{g}/\text{m}^3$)—nitrogen dioxide (NO_2), and summer ozone (O_3). The researchers limited their dataset to individuals who were exposed to air pollution concentrations below the annual maximums recommended by the EPA. For PM2.5, the threshold is $12 \mu\text{g}/\text{m}^3$; for NO_2 , it's 53 parts per billion (ppb). There is no regulation regarding long-term exposure for O_3 , so the researchers chose 50 ppb as an upper exposure limit for the purposes of the study.

All of the studied pollutants increased the mortality risk among the participants. Thousands of deaths could be attributed to even small increases in annual air pollution concentrations, according to the researchers.

Each $1 \mu\text{g}/\text{m}^3$ increase in annual PM2.5 concentrations increased the absolute annual risk of death by 0.073%. Each 1 ppb increase in annual NO_2 concentrations increased the annual risk of death by 0.003%, and each 1 ppb increase in summer O_3 concentrations increased the annual risk of death by 0.081%. These increases translated to approximately 11,540 deaths attributable to PM2.5, 1,176 deaths attributable to NO_2 , and 15,115 deaths attributable to O_3 per year for each unit increase in pollution concentrations.

Men were at greater risk of death from PM2.5 and O_3 , and people who identified as Black had a higher risk of death caused by NO_2

and O₃. The study also found an increased risk of death for people living in lower-income areas, pointing to disparities in the adverse effects of air pollution.

The results suggest that a 2020 EPA decision not to tighten standards for ambient PM_{2.5} “was unjustified,” the researchers wrote. They listed interventions that could reduce air pollutants, such as stricter controls on industry and fossil-fuel electric-generating units, larger and more efficient catalysts on automobiles, city planning to promote active transport, and improved public transit.

“Our finding that people living in lower income areas are more susceptible to the harmful effects of air pollution means they are suffering a double whammy—more exposure, and greater risk from that exposure,” said [Joel Schwartz](#), professor of environmental epidemiology and senior author of the study. “The Clean Air Act requires the EPA to protect sensitive populations with an adequate margin of safety. It is time for it to do so.”

Other Harvard Chan School authors of the study included Yan Wang, Qian Di, Weeberb Requia, [Yaguang Wei](#), Liuhua Shi, Matthew Sabath, [Francesca Dominici](#), [Brent Coull](#), [John Evans](#), and [Petros Koutrakis](#).

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“Long-term Effect of Exposure to Lower Concentrations of Air Pollution on Mortality Among US Medicare Participants and Vulnerable Subgroups: A Doubly-Robust Approach,” Mahdieh Danesh Yazdi, Yan Wang, Qian Di, Weeberb J. Requia, Yaguang Wei, Liuhua Shi, Matthew Benjamin Sabath, Francesca Dominici, Brent Coull, John S. Evans, Petros Koutrakis, and Joel D. Schwartz, *The Lancet Planetary Health*, October 7, 2021, doi: 10.1016/S2542-5196(21)00204-7.

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