

Subtle but Potentially Serious: Long-Term Ambient PM_{2.5} Exposure and Risk of Cardiopulmonary Mortality

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Fossil fuel combustion emits a slew of air pollutants, including fine particulate matter. These minute particles cause human disease and mortality worldwide,^{1,2,3,4} but studies tend to be non-representative of entire populations.⁵ Using data for nearly 1.6 million adults in the U.S. general population, a recent study published in *Environmental Health Perspectives* reported evidence that PM_{2.5} at ambient concentrations increases mortality rates across diverse populations.⁵

PM_{2.5} can penetrate deep into the lungs.¹ The particles, which may include any combination of soot, metals, and an array of chemical compounds, can directly affect lung tissue as well as directly and indirectly inflict damage throughout the body.^{6,7} Long-term PM_{2.5} exposures have been associated with respiratory disorders as well as cardiovascular and metabolic diseases.⁶ In the most recent figures available (2016), an estimated 92% of

the world's population lived in areas where ambient PM_{2.5} exceeded the World Health Organization's annual mean guideline of 10 µg/m³.⁸

In the current study,⁵ the researchers used information collected from participants 18–84 years of age as part of the National Health Interview Surveys⁹ from 1986 to 2014. The analysis used data on 1,599,329 individuals who were representative of the U.S. population in terms of age, sex, education, socioeconomic status, race/ethnicity, and region. Additional data on body mass index and smoking status were available for a subset of 635,539 people.

“Whenever you do an analysis like this, what you really want is a representative cohort so your results can be generalizable,” says lead author C. Arden Pope III, a professor of economics at Brigham Young University. “You want to be able to say, ‘We think this is relevant to a general population.’”



Risk factors such as smoking, obesity, and poverty are strongly associated with an increased risk of cardiopulmonary-related death. At the individual level, the estimated excess risk from PM_{2.5} exposure is far smaller. At the population level, however, the ubiquity and unavoidability of PM_{2.5} may add up to a substantial public health burden over time.⁵ Image: © iStockphoto/fotoguy22.

The investigators obtained mortality data for participants who died before the end of 2015 through linkages with the National Death Index, and deaths were categorized by cause: cardiopulmonary (subdivided into cardiovascular disease, cerebrovascular disease, chronic lower respiratory disease, and influenza/pneumonia), any malignant cancer, lung cancer, and other/unknown. The team estimated PM_{2.5} concentrations for each person's census tract using a model based on local traffic, land use, emissions sources, satellite-based estimates, regulatory monitoring data, and other factors.

Estimated PM_{2.5} exposures and risk of mortality were significantly associated, particularly for deaths due to cardiovascular and cerebrovascular diseases and influenza/pneumonia. Overall, the associations were consistent across subgroups based on age, sex, race/ethnicity, region, and other characteristics.

One implication of these results, Pope says, is that reducing exposures to air pollution is likely to improve many people's health. "The evidence here is that continued efforts to reduce air pollution will continue to reduce the risk of cardiovascular and related disease," he says.

The study's strengths include the use of high-quality publicly available data on a large, representative population, with sufficient numbers to control for individual risk factors. Potential limitations are the lack of directly measured exposures and the possibility that unknown and unmeasured factors influenced the conclusions.

"The results are in keeping with what is been found before, so I think of this as another piece of evidence from a well-designed, well-conducted study that adds a lot of support," says Helen Suh, a professor of civil and environmental engineering at Tufts University, who was not involved with the work.

Suh also noted that the study is quite timely, given that the PM_{2.5} National Ambient Air Quality Standards are due for review.^{10,11} The primary (health-based) standard currently stands at an annual mean of 12 µg/m³, averaged over 3 years.¹² "It is really important that new studies come out," Suh explains, "especially those that investigate the impact of exposures at low levels that are perhaps lower than the standard or at the standard." Such studies will enable regulators to assess whether or not the standard is sufficient and whether there's new evidence that suggests the standard should be changed.

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References

1. Schraufnagel DE, Balmes JR, Cowl CT, De Matteis S, Jung S-H, Mortimer K, et al. 2019. Air pollution and noncommunicable diseases: a review by the Forum of International Respiratory Societies' Environmental Committee, part 1: the damaging effects of air pollution. *Chest* 155(2):409–416, PMID: 30419235, <https://doi.org/10.1016/j.chest.2018.10.042>.
2. Cohen AJ, Brauer M, Burnett R, Anderson HR, Frostad J, Estep K, et al. 2017. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *Lancet* 389(10082):1907–1918, PMID: 28408086, [https://doi.org/10.1016/S0140-6736\(17\)30505-6](https://doi.org/10.1016/S0140-6736(17)30505-6).
3. Li T, Zhang Y, Wang J, Xu D, Yin Z, Chen H, et al. 2018. All-cause mortality risk associated with long-term exposure to ambient PM_{2.5} in China: a cohort study. *Lancet Public Health* 3(10):e470–e477, PMID: 30314593, [https://doi.org/10.1016/S2468-2667\(18\)30144-0](https://doi.org/10.1016/S2468-2667(18)30144-0).
4. Burnett R, Chen H, Szyszkowicz M, Fann N, Hubbell B, Pope CA III, et al. 2018. Global estimates of mortality associated with long-term exposure to outdoor fine particulate matter. *Proc Natl Acad Sci USA* 115(38):9592–9597, PMID: 30181279, <https://doi.org/10.1073/pnas.1803222115>.
5. Pope CA III, Lefler JS, Ezzati M, Higbee JD, Marshall JD, Kim S-Y, et al. 2019. Mortality risk and fine particulate air pollution in a large, representative cohort of U.S. adults. *Environ Health Perspect* 127(7):77007, PMID: 31339350, <https://doi.org/10.1289/EHP4438>.
6. Schraufnagel DE, Balmes JR, Cowl CT, De Matteis S, Jung S-H, Mortimer K, et al. 2019. Air pollution and noncommunicable diseases: a review by the Forum of International Respiratory Societies' Environmental Committee, part 2: air pollution and organ systems. *Chest* 155(2):417–426, PMID: 30419237, <https://doi.org/10.1016/j.chest.2018.10.041>.
7. Pope CA III, Bhatnagar A, McCracken JP, Abplanalp W, Conklin DJ, O'Toole T. 2016. Exposure to fine particulate air pollution is associated with endothelial injury and systemic inflammation. *Circ Res* 119(11):1204–1214, PMID: 27780829, <https://doi.org/10.1161/CIRCRESAHA.116.309279>.
8. World Health Organization. 2016. *Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease*. Geneva, Switzerland: World Health Organization. <http://www.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf?ua=1> [accessed 7 February 2020].
9. Centers for Disease Control and Prevention, National Center for Health Statistics. 2020. National Health Interview Survey. [Website.] <https://www.cdc.gov/nchs/nhis/index.htm> [accessed 7 February 2020].
10. U.S. EPA (U.S. Environmental Protection Agency). 2019. *Integrated Science Assessment for Particulate Matter*. EPA/600/R-19/188. Washington, DC: U.S. EPA. http://ofmpub.epa.gov/eims/eimscmm.getfile?p_download_id=539630 [accessed 7 February 2020].
11. U.S. EPA. 2019. *Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft*. EPA-452/P-19-001. Washington, DC: U.S. EPA. https://www.epa.gov/sites/production/files/2019-09/documents/draft_policy_assessment_for_pm_2_5_09-05-2019.pdf [accessed 7 February 2020].
12. U.S. EPA. 2016. NAAQS Table. [Website.] <https://www.epa.gov/criteria-air-pollutants/naaqs-table> [accessed 7 February 2020].