

Designing epidemiological studies to inform the NAAQS: Experiences studying air pollution, mortality, and inequalities using Medicare data

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NEW RESEARCH

Cleaner Air Helps Everyone. It Helps Black Communities a Lot.

A new study quantified the benefits of pollution reduction in terms of race and class.

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<https://www.nytimes.com/2023/03/24/climate/air-pollution-pm25-health-effects.html?smid=url-share>



Studies using Medicare data have provided key insights about the relationship between PM_{2.5} and mortality

1

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Air Pollution and Mortality in the Medicare Population

Qian Di, M.S., Yan Wang, M.S., Antonella Zanobetti, Ph.D., Yun Wang, Ph.D., Petros Koutrakis, Ph.D., Christine Choirat, Ph.D., Francesca Dominici, Ph.D., and Joel D. Schwartz, Ph.D.

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SCIENCE ADVANCES | RESEARCH ARTICLE

HEALTH AND MEDICINE

Evaluating the impact of long-term exposure to fine particulate matter on mortality among the elderly

X. Wu^{1*}, D. Braun^{1,2*}, J. Schwartz³, M. A. Kioumourtoglou⁴, F. Dominici^{1†}

3

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SPECIAL ARTICLE

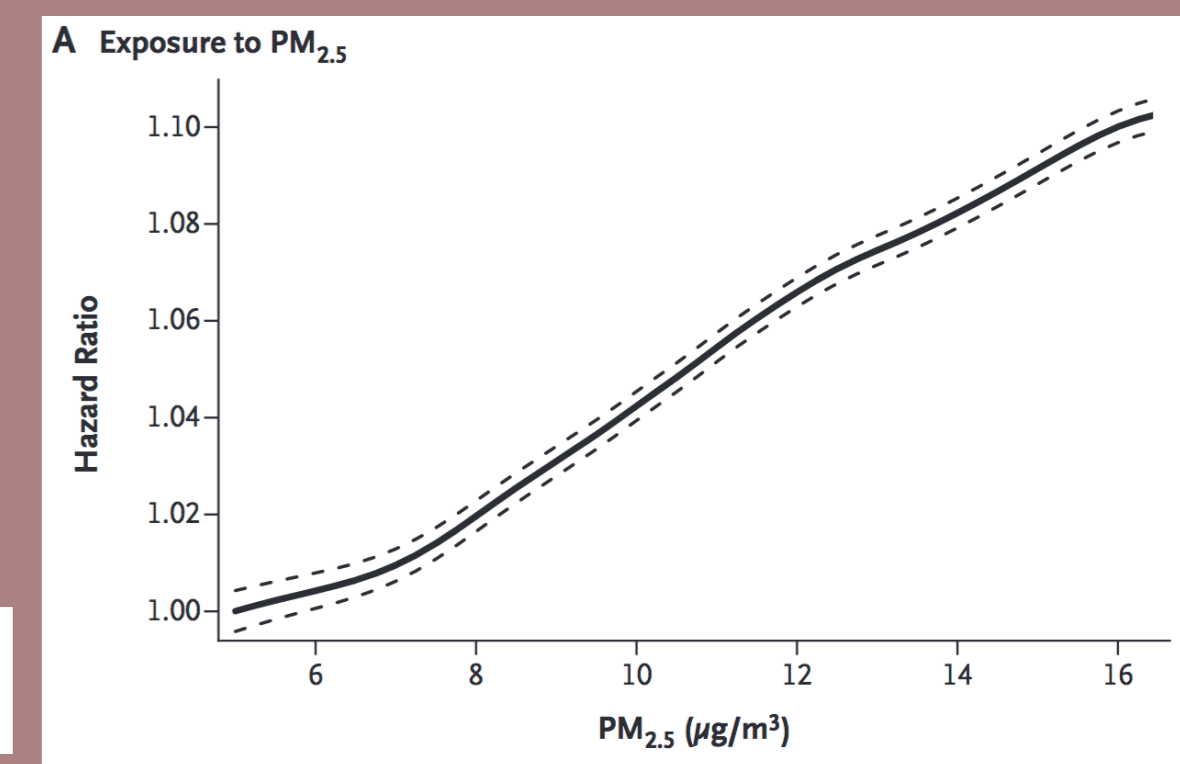
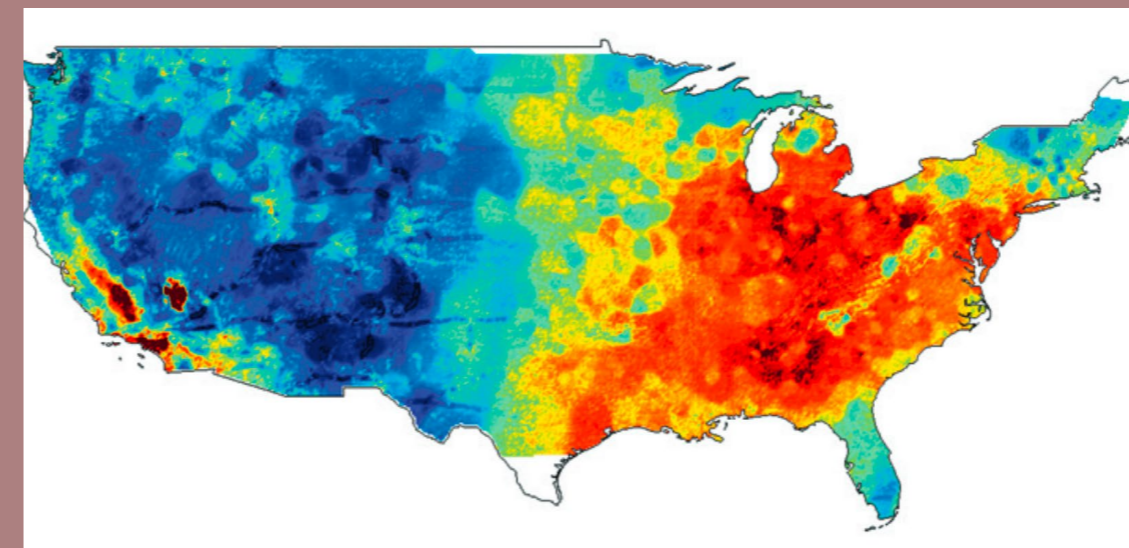
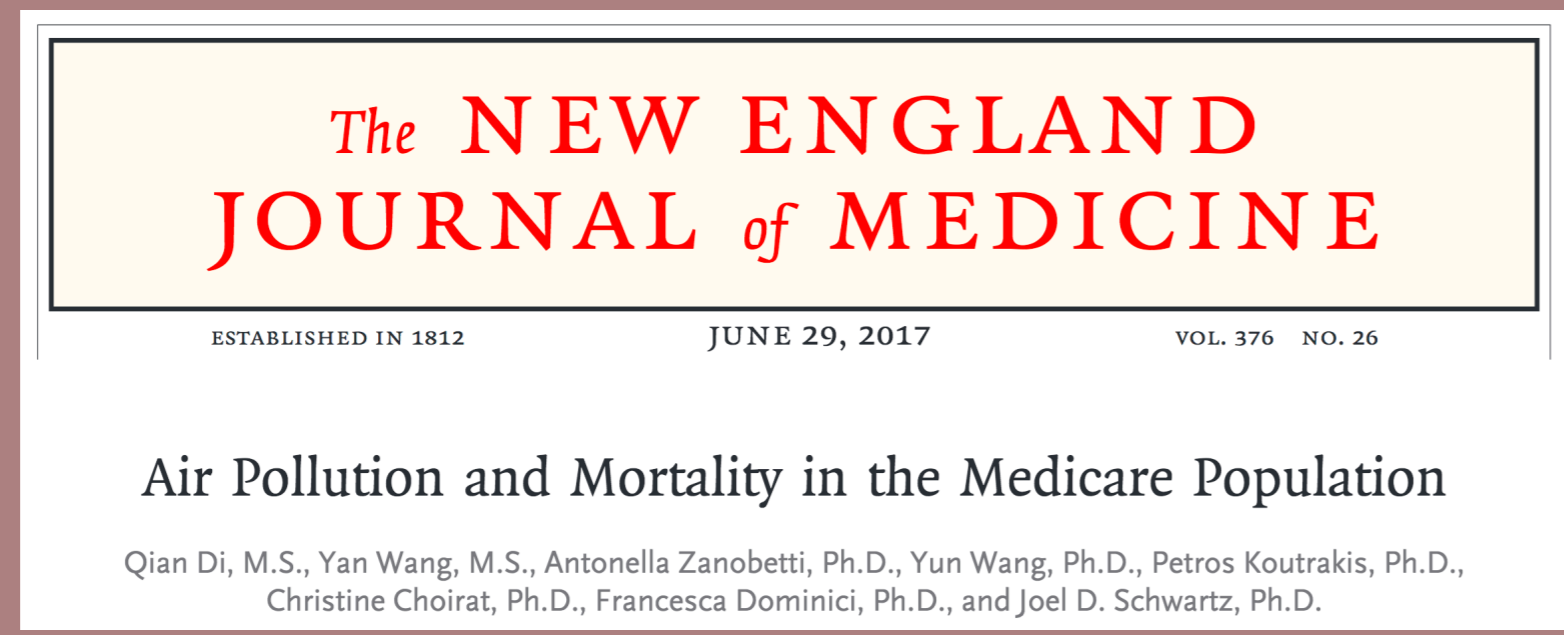
Air Pollution and Mortality at the Intersection of Race and Social Class

Kevin P. Josey, Ph.D., Scott W. Delaney, Sc.D., J.D., Xiao Wu, Ph.D., Rachel C. Nethery, Ph.D., Priyanka DeSouza, Ph.D., Danielle Braun, Ph.D., and Francesca Dominici, Ph.D.



Studies using Medicare data have provided key insights about the relationship between PM_{2.5} and mortality

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The full cohort included 60,925,443 persons living in 39,716 different ZIP Codes with 460,310,521 person-years of follow-up.

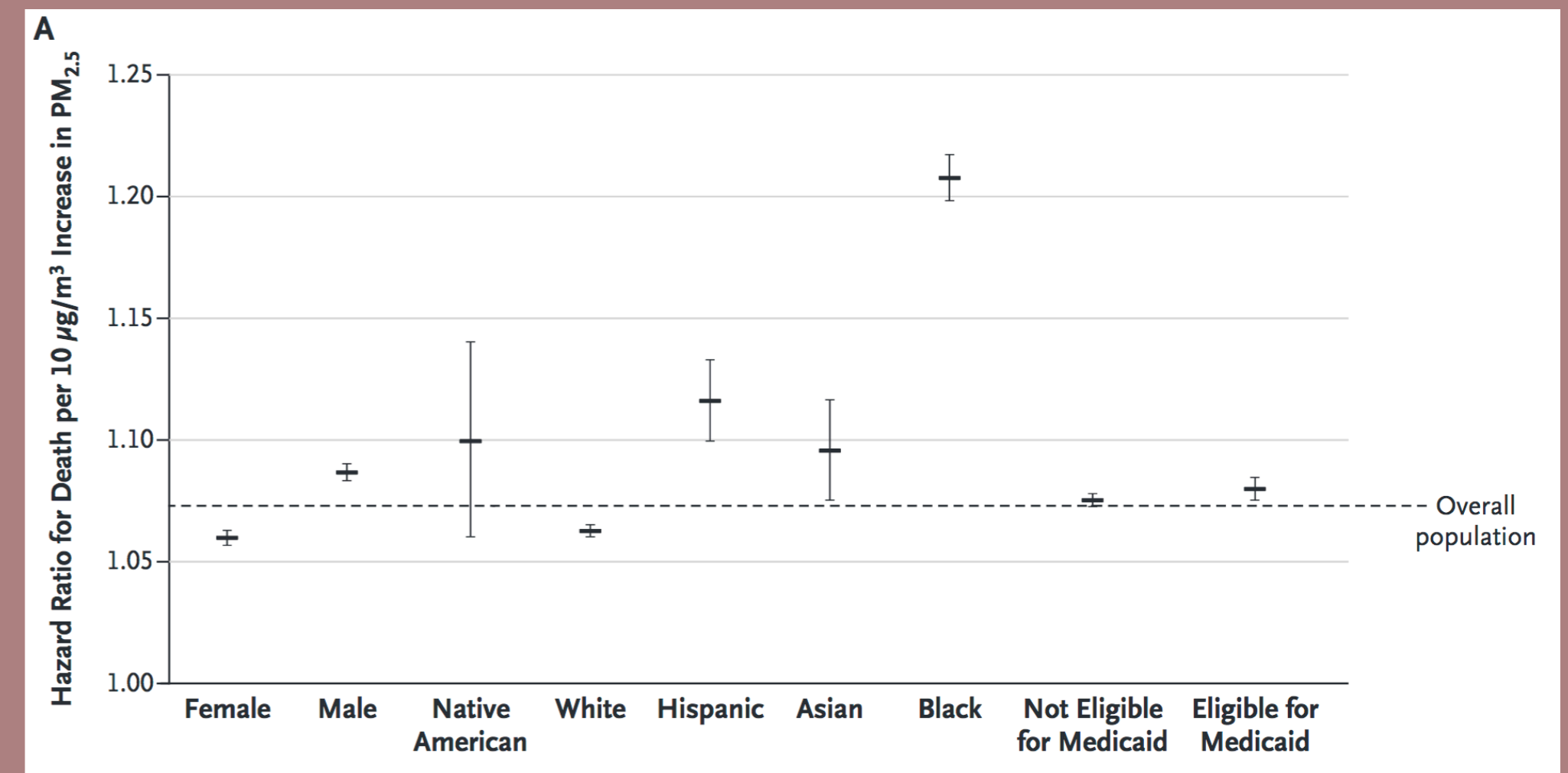
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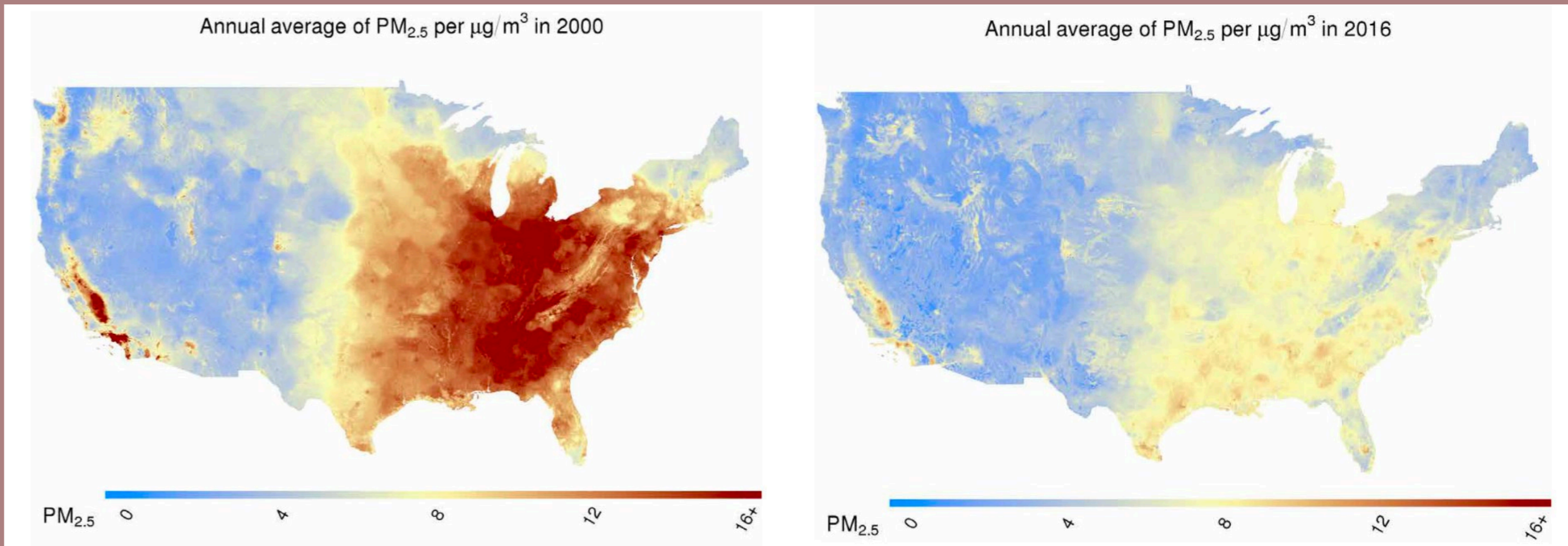
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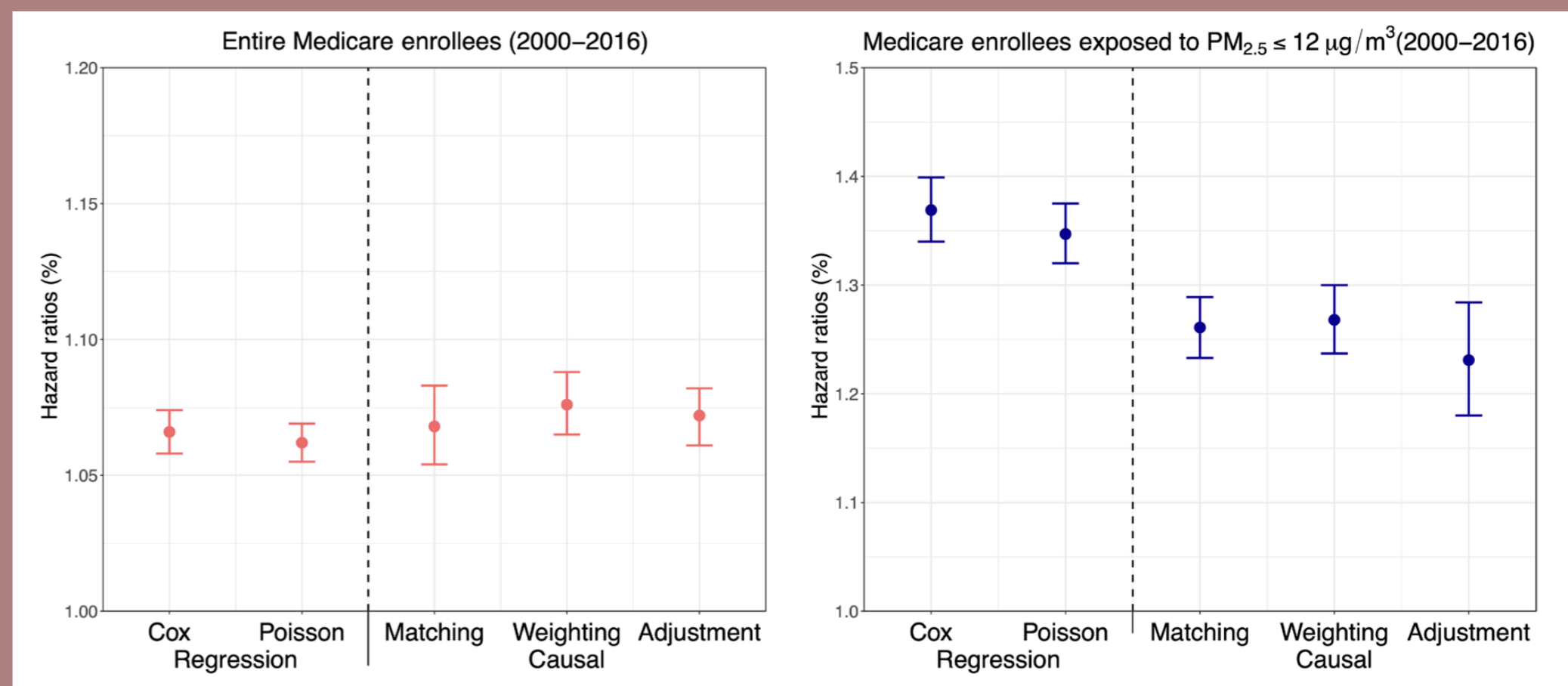
Evaluating the impact of long-term exposure to fine particulate matter on mortality among the elderly

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We obtained open cohort data for more than 68.5 million Medicare enrollees (65 years of age or older) from 2000 to 2016 (8),



Studies using Medicare data have provided key insights about the relationship between PM_{2.5} and mortality

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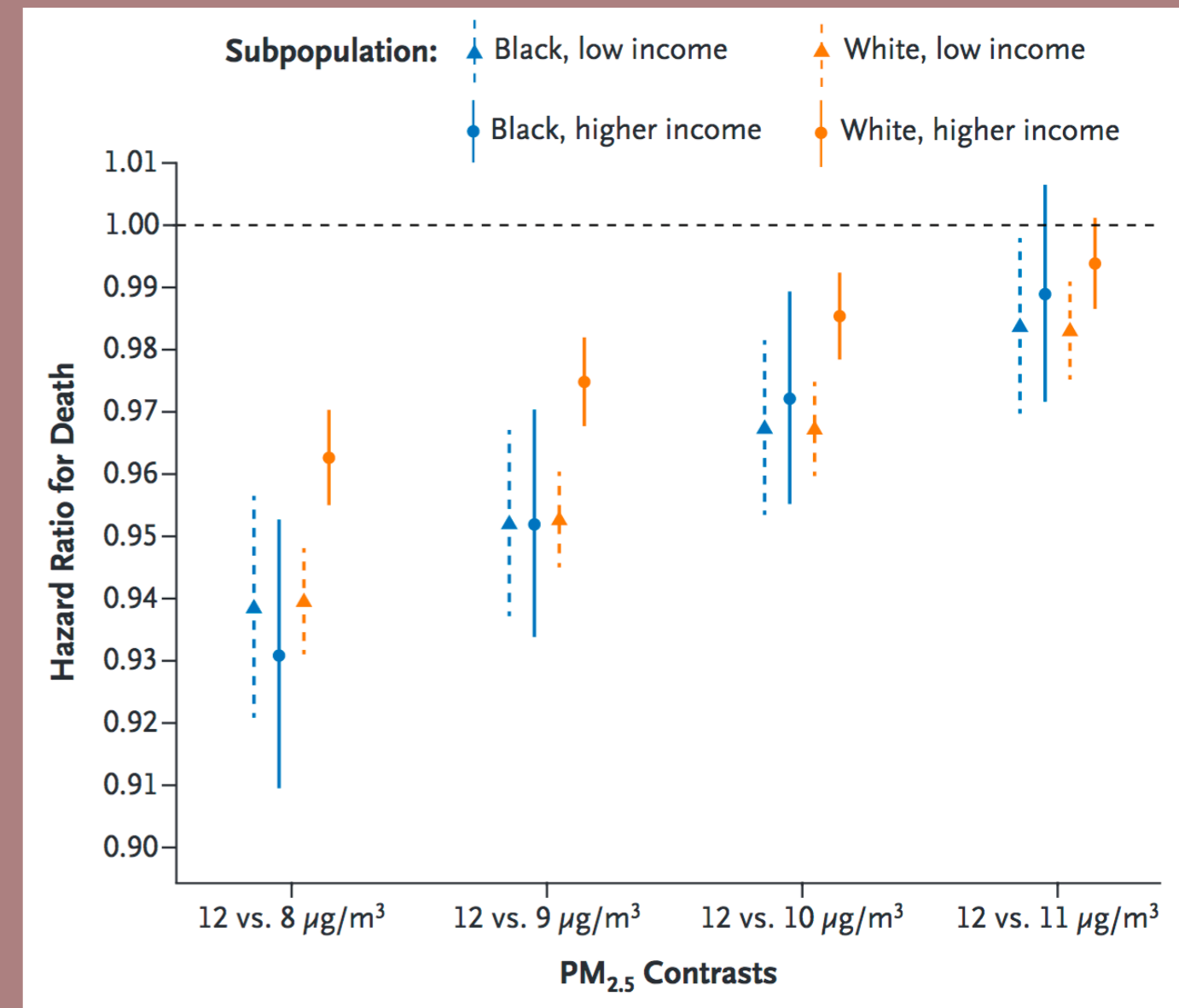
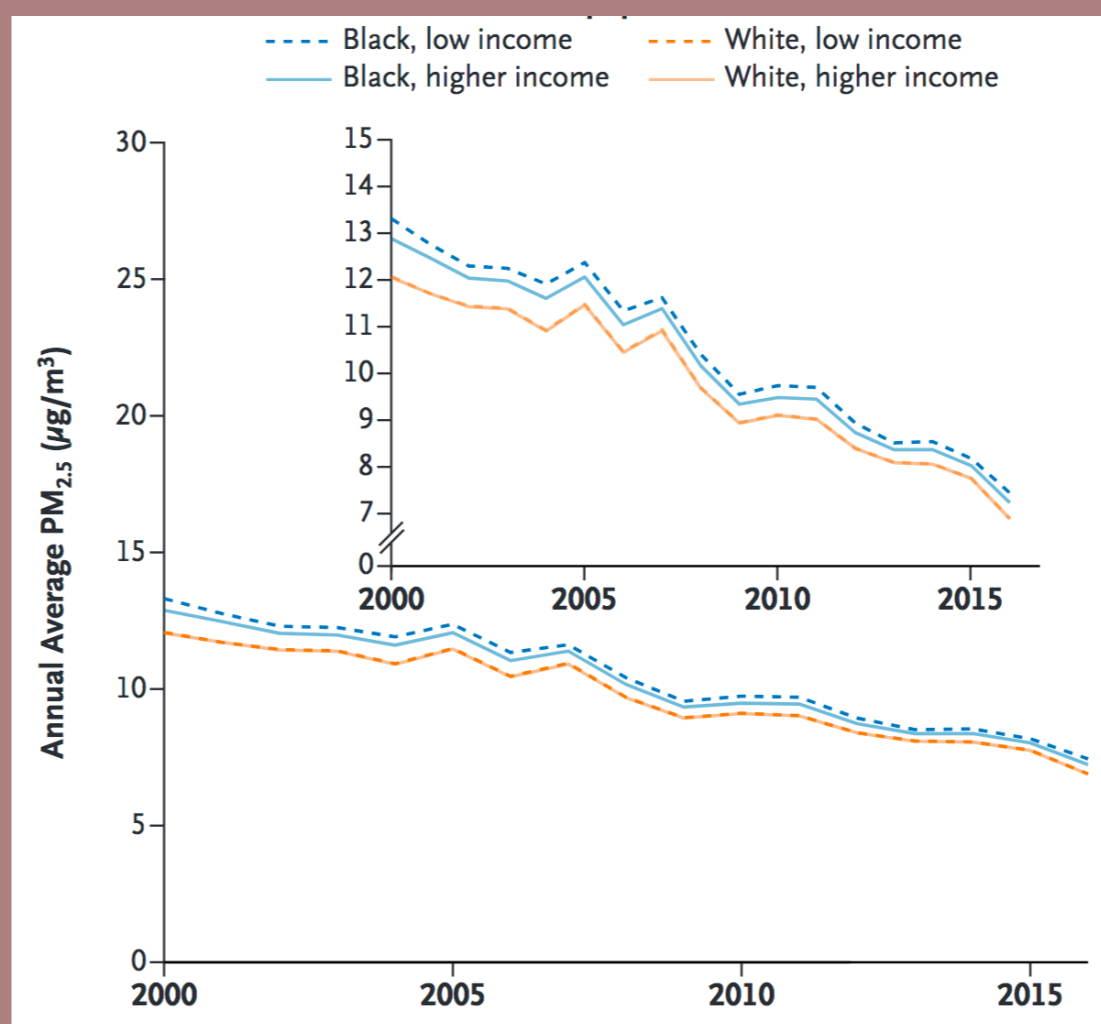
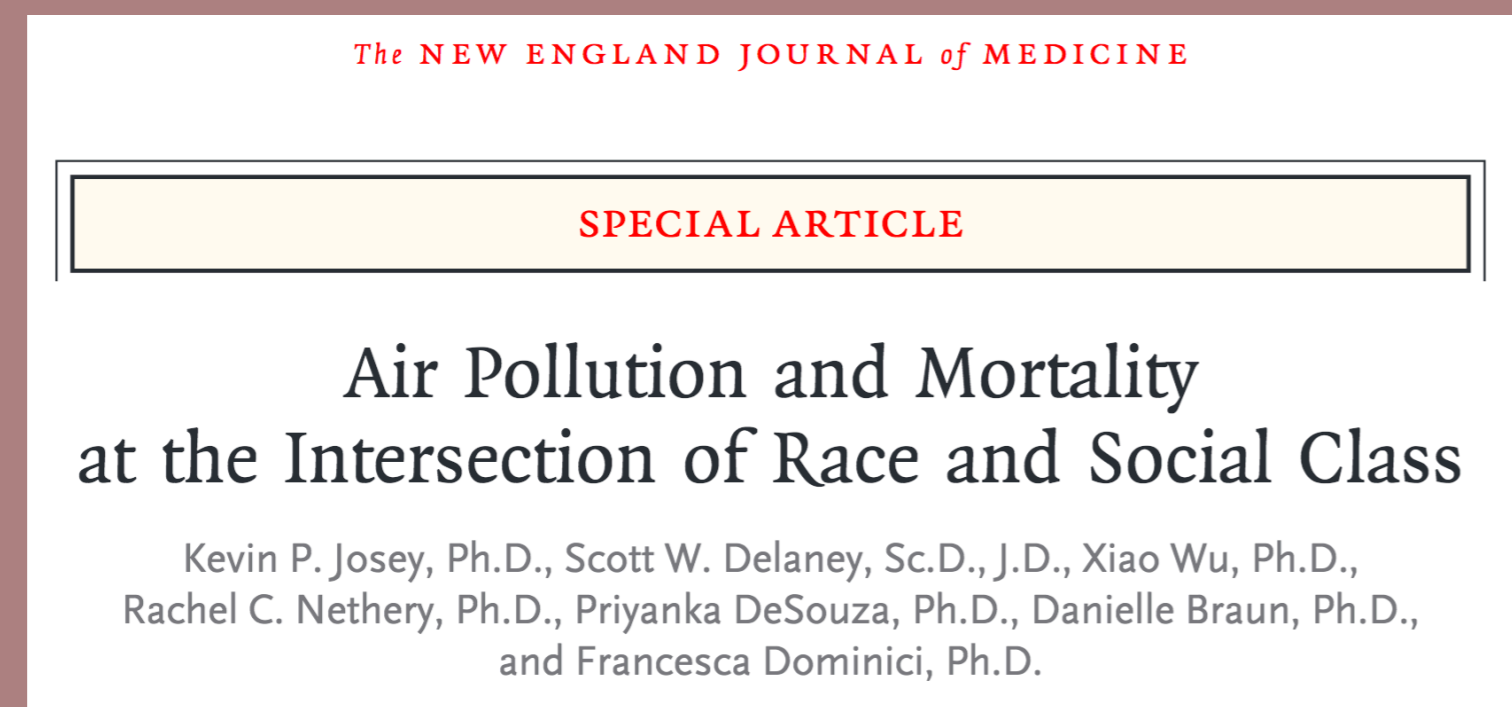


We analyzed 623 million person-years of Medicare data from 73 million persons 65 years of age or older from 2000 through 2016

2



3



Why Medicare?

What makes studies in the Medicare population well-suited to inform policy?

Representative



Diverse



Principled design



Medicare participants are representative...

- Of a key vulnerable population
 - Almost completely captures mortality in the age 65+ population in the US.
 - A 'sensitive population' that the Clean Air Act explicitly calls for the NAAQS to protect.
- Of exposures experienced throughout the US
 - Live in all parts of the US.
 - Provides data to inform estimates of health effects of pollution both above and below the current NAAQS.
 - Also can provide insights into differential health impacts over space, possibly due to different pollution sources, different levels of vulnerability, or different meteorology.

Medicare participants are diverse

- Medicare data provide nearly complete mortality data on marginalized groups, such as low-income and Black individuals.
- These groups are typically under-represented in cohort studies.
- This allows us to characterize inequities across groups.

Characteristic	Full Cohort†	Black Persons		White Persons	
		Higher Income‡	Low Income§	Higher Income‡	Low Income§
Persons — no. (% of full cohort)	73,129,782 (100)	4,872,714 (6.7)	1,671,776 (2.3)	56,422,414 (77.2)	4,989,457 (6.8)
Person-yr — no. (% of total person-yr)	623,042,512 (100)	37,862,780 (6.1)	14,886,928 (2.4)	483,479,863 (77.6)	48,247,908 (7.7)
Deaths — no. (% of total deaths)	29,467,648 (100)	1,488,555 (5.1)	1,154,227 (3.9)	20,773,208 (70.5)	4,769,240 (16.2)

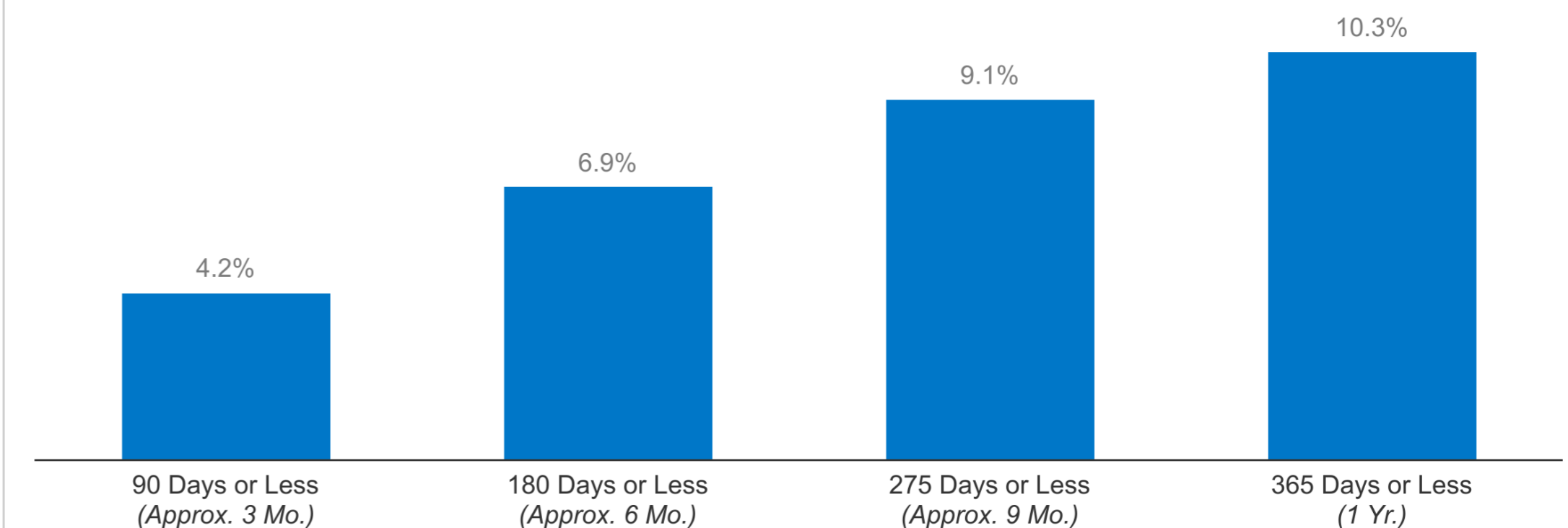
Medicare data allow for principled study designs

- Huge sample size
- Unlike other health claims data, they represent a well-defined population.
 - This gives us accurate population denominators.
- Most people are followed continuously over time between cohort entry and death
 - Little “churning”, i.e., exiting and re-entering the population, which is common in other health claims data

Figure 1

One In Ten Medicaid/CHIP Enrollees Disenrolled And Then Re-enrolled In Less Than One Year, And Many Of Them Did So In Less Than Six Months.

Percent of full-benefit Medicaid/CHIP enrollees who disenrolled and then re-enrolled within varying time periods, 2018



NOTE: Based on 41 states; FL, KY, ME, MS, NE, IN, OK, OR, UT, and WY were excluded due to missing or inconsistent data.

SOURCE: KFF analysis of the Transformed Medicaid Statistical Information System (T-MSIS) Analytic Files (TAF) Research Identifiable Files (RIF).

KFF

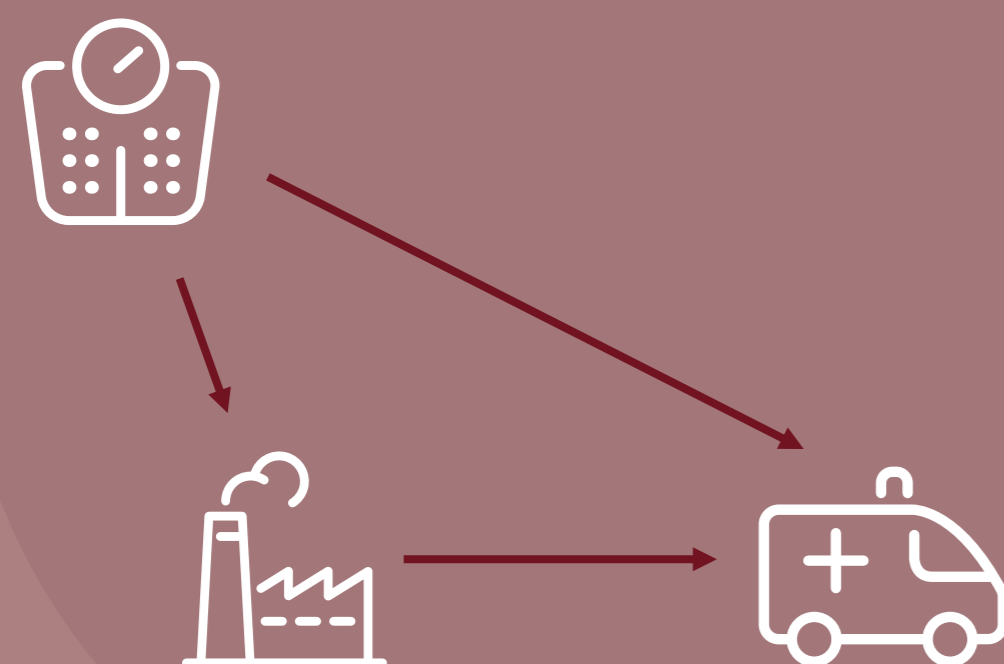
<https://www.kff.org/medicaid/issue-brief/medicaid-enrollment-churn-and-implications-for-continuous-coverage-policies/>

Medicare studies: Open challenges

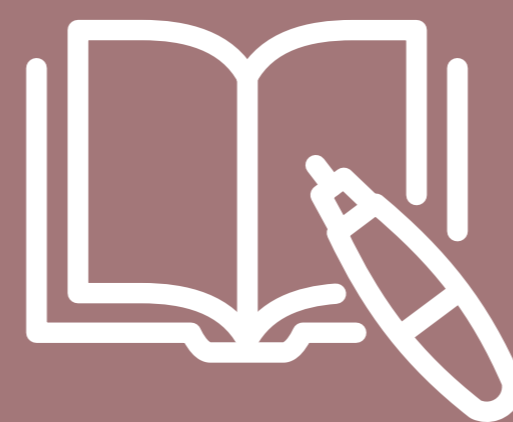
What challenges do we face when conducting studies of air pollution effects on mortality and inequities using Medicare data?

How can we address them?

Confounding



Measurement error



Computation + data security



Potential for unmeasured confounding

- Few measured individual level characteristics of Medicare enrollees
 - E.g., we don't know incomes, education levels, engagement in health behaviors
 - These are potential confounders.
- Current solutions:
 - Link to area-level measures
 - Causal inference methods to enable robust adjustment for measured features
 - Use e-value to assess potential sensitivity to unmeasured confounding
 - Confirm associations in validation sub-sample with more measured features.

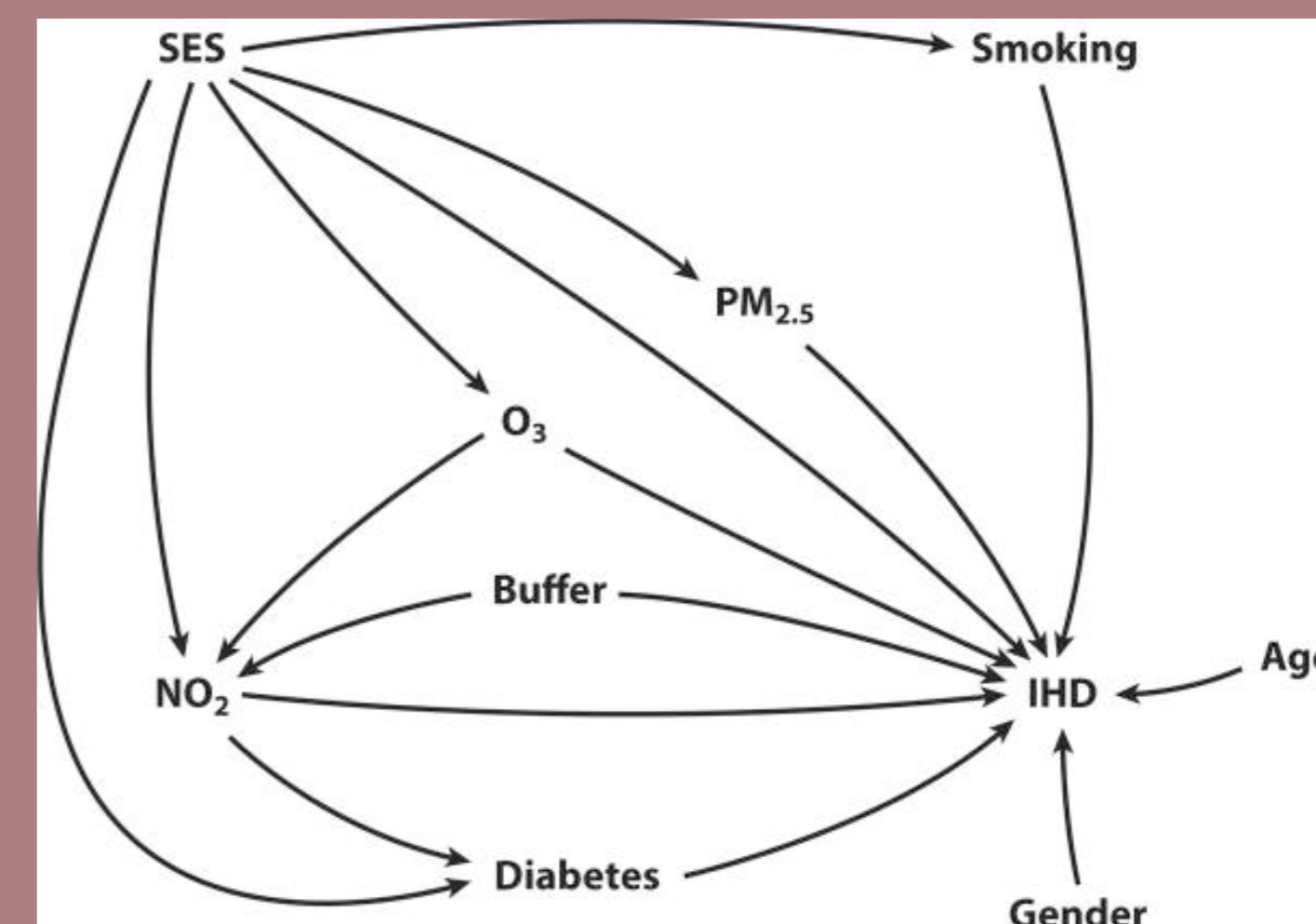
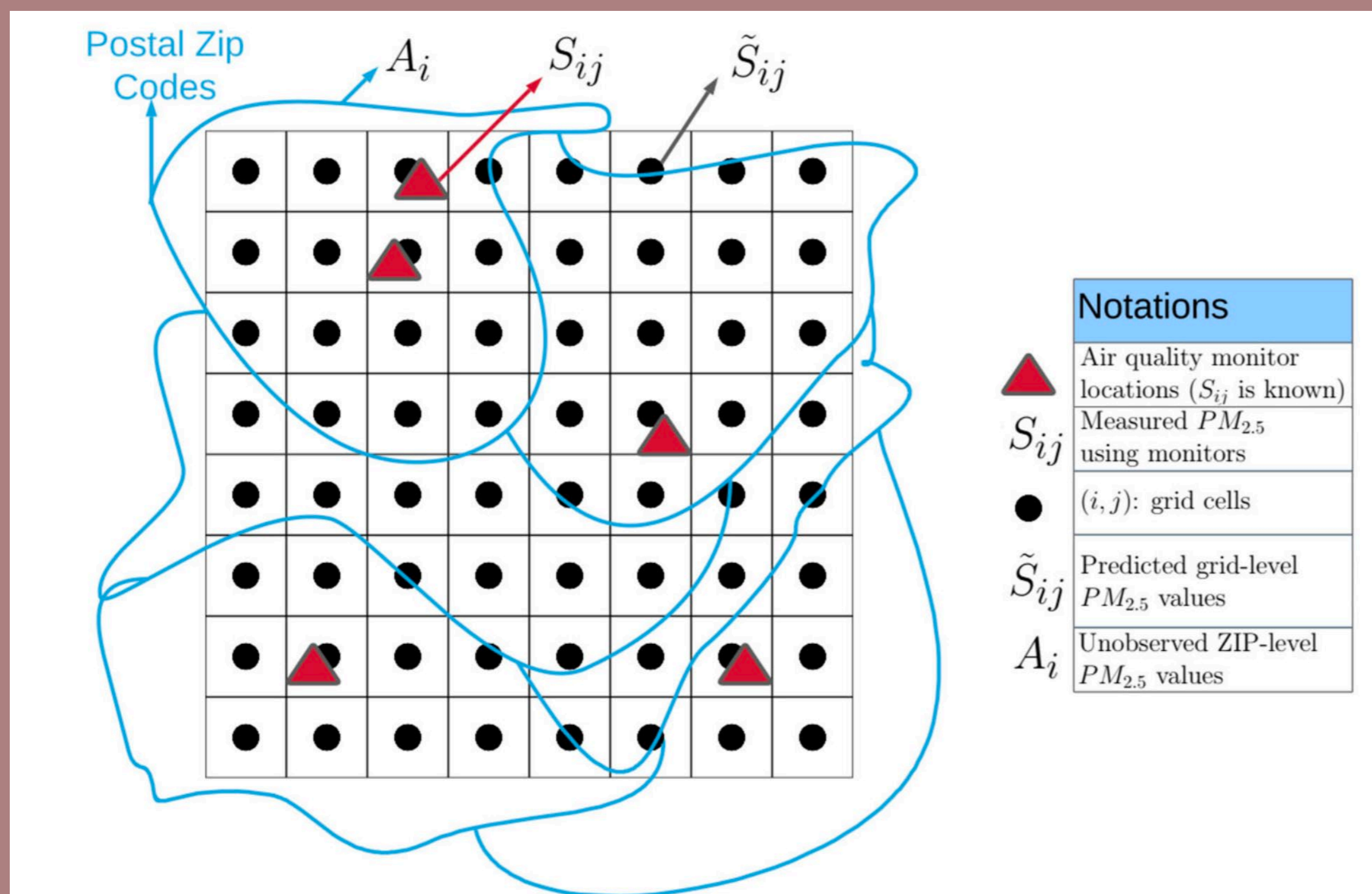


Image from Bind, M. A. (2019). Causal modeling in environmental health. *Annual review of public health*, 40, 23-43.

Potential for measurement error



- Exposure measurement error due to reliance on gridded exposure predictions aggregated to zip code of residence
 - Aggregate by averaging grid cells within zip codes
 - Can conduct sensitivity analyses using people living near monitors
 - Have developed causal methodology to account for exposure error
- Poor classification of Hispanic and Asian individuals
 - Makes it difficult to understand inequities experienced by these groups

Image from Josey, K. P., deSouza, P., Wu, X., Braun, D., & Nethery, R. (2023). Estimating a Causal Exposure Response Function with a Continuous Error-Prone Exposure: A Study of Fine Particulate Matter and All-Cause Mortality. *Journal of Agricultural, Biological and Environmental Statistics*, 28(1), 20–41.

Computational burdens and data privacy

- Costly Federal Information Security Modernization Act (FISMA)-compliant system required to store and analyze the data.
- Running causal models on the full data can require >500 GB of memory.
- Open question of how to best handle these issues.
- Currently we hire a lot of staff to help with data processing, data security, and code scalability.

How might we use the Medicare data in new ways to inform future policy?

- Estimate more informative, directly policy-relevant quantities
 - Not just hazard ratios / exposure-response curves
- Estimate impacts on less severe but more widespread outcomes
 - Invoke outpatient and Part D data (although less representative)
- Apply novel environmental policy design methods

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Research Team



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Data



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Di, Q., Wang, Y., Zanobetti, A., Wang, Y., Koutrakis, P., Choirat, C., Dominici, F., & Schwartz, J. D. (2017). Air Pollution and Mortality in the Medicare Population. *New England Journal of Medicine*, 376(26), 2513–2522. <https://doi.org/10.1056/NEJMoa1702747>

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