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Powerful ideas for a healthier world

Setting US National Ambient Air Quality Standards: What's science got to do with it?

(A lot!)

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- On January 6, 2023, the Environmental Protection Agency (EPA) announced a proposal to lower the National Ambient Air Quality Standard (NAAQS) for annual $PM_{2.5}$ pollution from 12 μg/m^3 to between 9 and 10 μg/m^3, though it continues to consider other options

Biden Administration Moves to Tighten Limits on Deadly Air Pollution

A new rule would, for the first time in a decade, reduce emissions of soot that disproportionately harm communities of color.

Give this article 95

Is exposure to $PM_{2.5}$ below the NAAQS (12 μg/m^3) associated with an increase mortality risks?

This is a question of trillion of US dollars

- Clean Air Act benefits ranging from \$1.9 trillion to \$3.8 trillion in 2020, and \$2.5 trillion to \$5.0 trillion in 2030

DATA

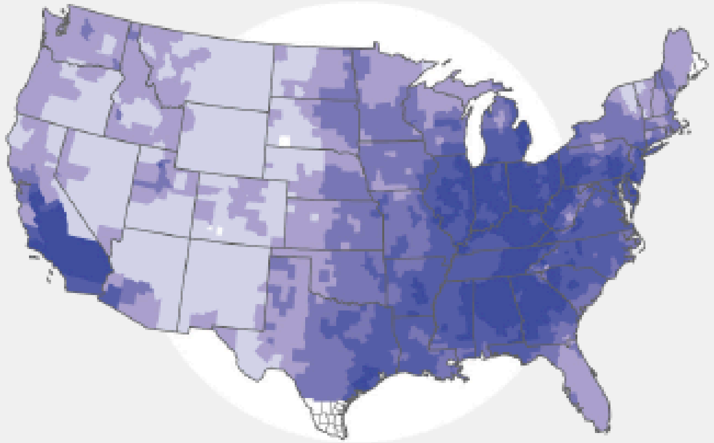
All Medicare participants (n=67,682,479) in the continental United States from 2000 to 2016 (updating to 2018)

Outcomes: all-cause mortality and cause specific hospitalization

Individual level information: date of death, age of entry, year of entry, sex, race, whether eligible for Medicaid (proxy for SES)

Zip code of residence and other covariates

EXPOSURES AND INTERVENTIONS (E OR I)



DATA SOURCES

Criteria air pollutants
EPA AQS daily average of $PM_{2.5}$, ozone, NO_2, 1995-2015;
Daily 1km x 1km predictions of $PM_{2.5}$, ozone, NO_2, 2000-2014

Methane
1km x 1km predictions at 3-day intervals, 2009-present

Weather
NOAA daily estimates (temperature, precipitation, humidity, ...) on a 0.3° grid

Power plants
EPA AMPD daily emissions, 1995-2015

Coal mines
MSHA location and producting pits, 1970-2015

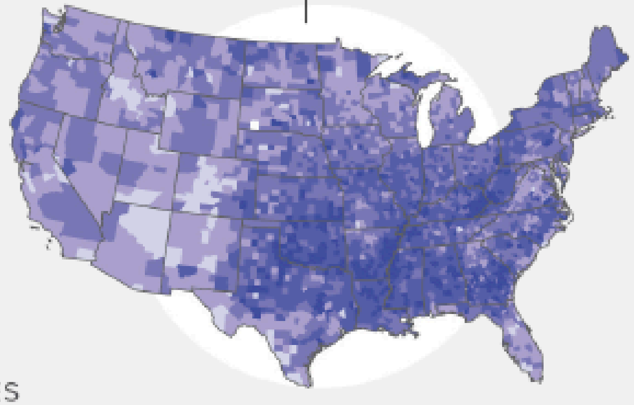
Fracking wells and disposal wells
Drillinginfo database with well location and depth, daily production

Traffic
Annual traffic counts and density from the Department of Transportation

Residential community green space
NASA vegetation index on a 250m² grid

Factories and industrial sites
Geocoded locations of businesses

HEALTH OUTCOMES (Y)



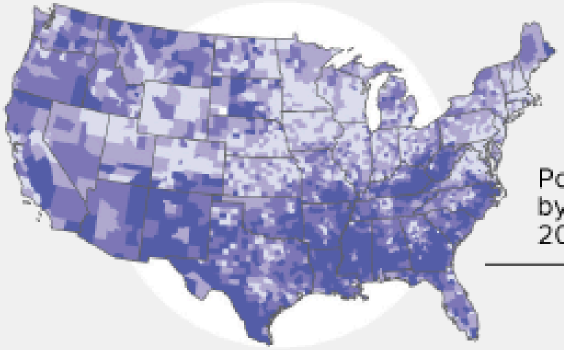
DATA SOURCES

Medicare
28 million per year, 1999-2015

Medicaid
28 million per year, low income, 2010-2011

Aetna
40 million, all ages, above-average income, 2008-2016

CONFOUNDERS (X)



DATA SOURCES

Individual demographics
Age, sex, race, ZIP code of residence

Individual medical history
Previous diagnoses, medications prescribed

ZIP code level variables
Income, education, demographics, employment, household size

County-level variables
Crime, smoking, BMI

The NEW ENGLAND JOURNAL of MEDICINE

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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.

Table 1. Cohort Characteristics and Ecologic and Meteorologic Variables.

Characteristic or Variable	Entire Cohort	Ozone Concentration		$PM_{2.5}$ Concentration	
		≥50 ppb*	<50 ppb	≥12 μg/m³	<12 μg/m³
Population					
Persons (no.)	60,925,443	14,405,094	46,520,349	28,145,493	32,779,950
Deaths (no.)	22,567,924	5,097,796	17,470,128	10,659,036	11,908,888
Total person-yr†	460,310,521	106,478,685	353,831,836	212,628,154	247,682,367
Median yr of follow-up	7	7	7	7	7
Average air-pollutant concentrations‡					
Ozone (ppb)	46.3	52.8	44.4	48.0	45.3
$PM_{2.5}$ ($\mu g/m^3$)	11.0	10.9	11.0	13.3	9.6

Table 2. Risk of Death Associated with an Increase of 10 μg per Cubic Meter in $PM_{2.5}$ or an Increase of 10 ppb in Ozone Concentration.*

Model	$PM_{2.5}$	Ozone
	hazard ratio (95% CI)	
Two-pollutant analysis		
Main analysis	1.073 (1.071–1.075)	1.011 (1.010–1.012)
Low-exposure analysis	1.136 (1.131–1.141)	1.010 (1.009–1.011)
Analysis based on data from nearest monitoring site (nearest-monitor analysis)†	1.061 (1.059–1.063)	1.001 (1.000–1.002)
Single-pollutant analysis‡	1.084 (1.081–1.086)	1.023 (1.022–1.024)

* Hazard ratios and 95% confidence intervals were calculated on the basis of an increase of 10 μg per cubic meter in exposure to $PM_{2.5}$ and an increase of 10 ppb in exposure to ozone.

† Daily average monitoring data on $PM_{2.5}$ and ozone were obtained from the Environmental Protection Agency Air Quality System. Daily ozone concentrations were averaged from April 1 through September 30 for the computation of warm-season averages. Data on $PM_{2.5}$ and ozone levels were obtained from the nearest monitoring site within 50 km. If there was more than one monitoring site within 50 km, the nearest site was chosen. Persons who lived more than 50 km from a monitoring site were excluded.

‡ For the single-pollutant analysis, model specifications were the same as those used in the main analysis, except that ozone was not included in the model when the main effect of $PM_{2.5}$ was estimated and $PM_{2.5}$ was not included in the model when the main effect of ozone was estimated.

Science Advances

RESEARCH ARTICLES

Cite as: X. Wu *et al.*, *Sci. Adv* 10.1126/sciadv.aba5692 (2020).

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

X. Wu,[1]† D. Braun,[1,2]† J. Schwartz,[3] M. A. Kioumourtzoglou,[4] F. Dominici[1]*

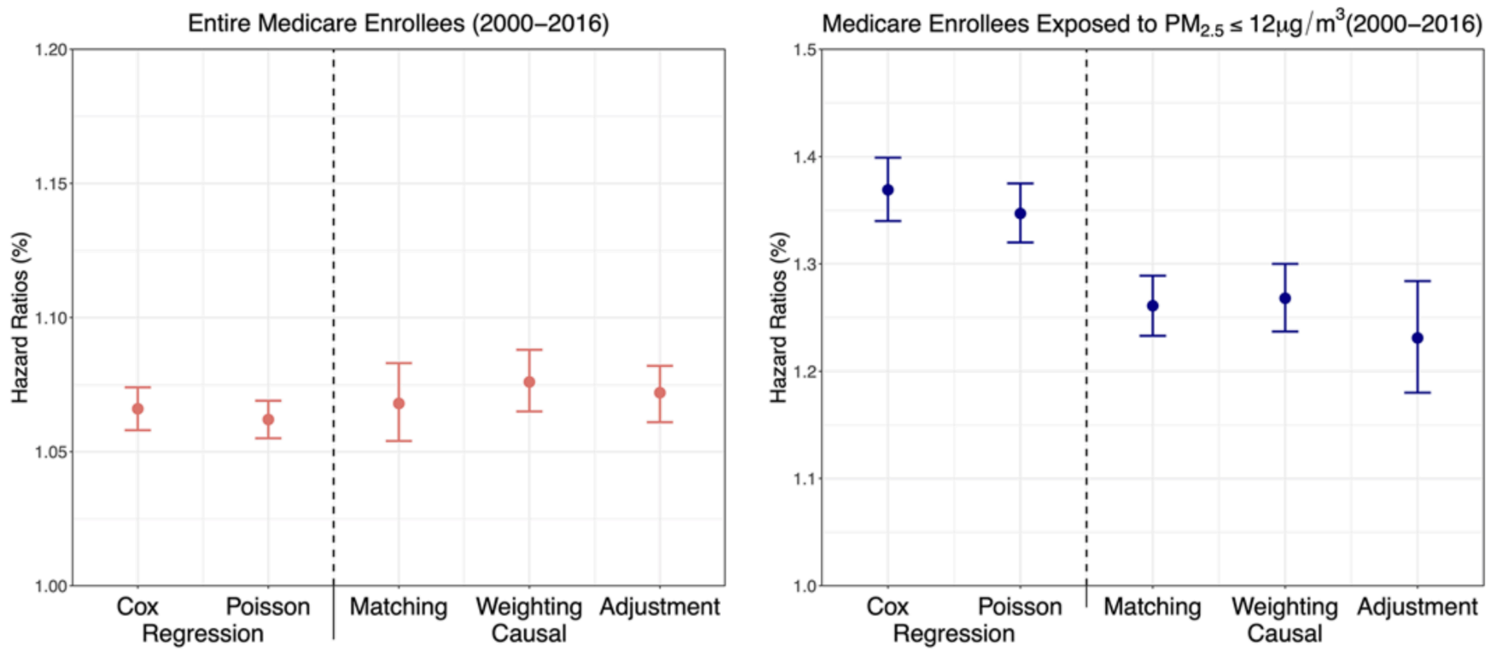


Fig. 3. Hazard Ratios (HR) and 95% Confidence Intervals (CIs). The estimated HRs were obtained under five different statistical approaches (two traditional approaches and three causal inference approaches). HRs were adjusted by 10 potential confounders, four meteorological variables, geographic region, and year.

Using five distinct statistical approaches, we found that a decrease of 10 μg/m3 PM2.5 leads to a statistically significant 6%–7% decrease in mortality risk.

Based on these models, lowering the air quality standard to 10 μg/m3 would save 143,257 lives (95% 30 confidence interval 115,581–170,645) in one decade

The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL ARTICLE

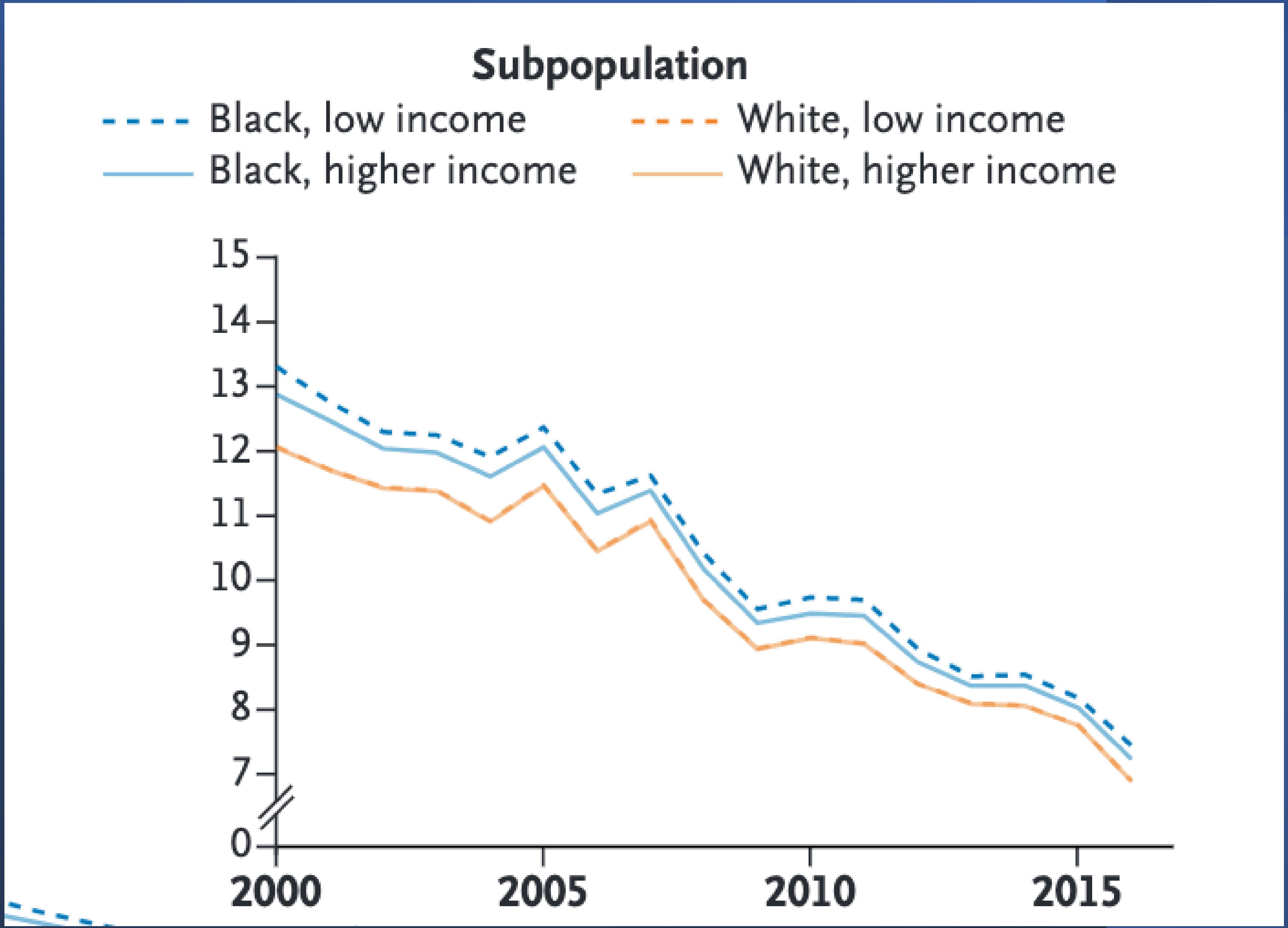
Air Pollution and Mortality at the Intersection of Race and Social Class

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.

AIR POLLUTION, MORTALITY, RACE, AND SOCIAL CLASS

Table 1. Characteristics of the Medicare Cohort, 2000 through 2016.*

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)
Median follow-up time — yr	8.0	7.0	8.0	8.0	8.0
Age at entry — %					
65–74 yr	80.6	86.2	77.4	80.4	72.7
75–84 yr	14.8	10.7	15.6	15.3	17.2
85–94 yr	4.2	2.5	6.2	4.0	9.0
≥95 yr	0.4	0.6	0.8	0.3	1.1
Female sex — %	55.4	54.9	68.1	54.3	68.0
Medicaid eligible — %	11.6	0	100	0	100


Subpopulation
Black, low income
White, low income
Black, higher income
White, higher income
15
14
13
12
11
10
9
8
7
0
2000
2005
2010
2015

Our study findings suggest that a comparatively lower annual $PM_{2.5}$ NAAQS will lead to larger reductions in mortality among older Americans and produce greater health benefits among a wider array of disproportionately affected Americans than previously recognized.

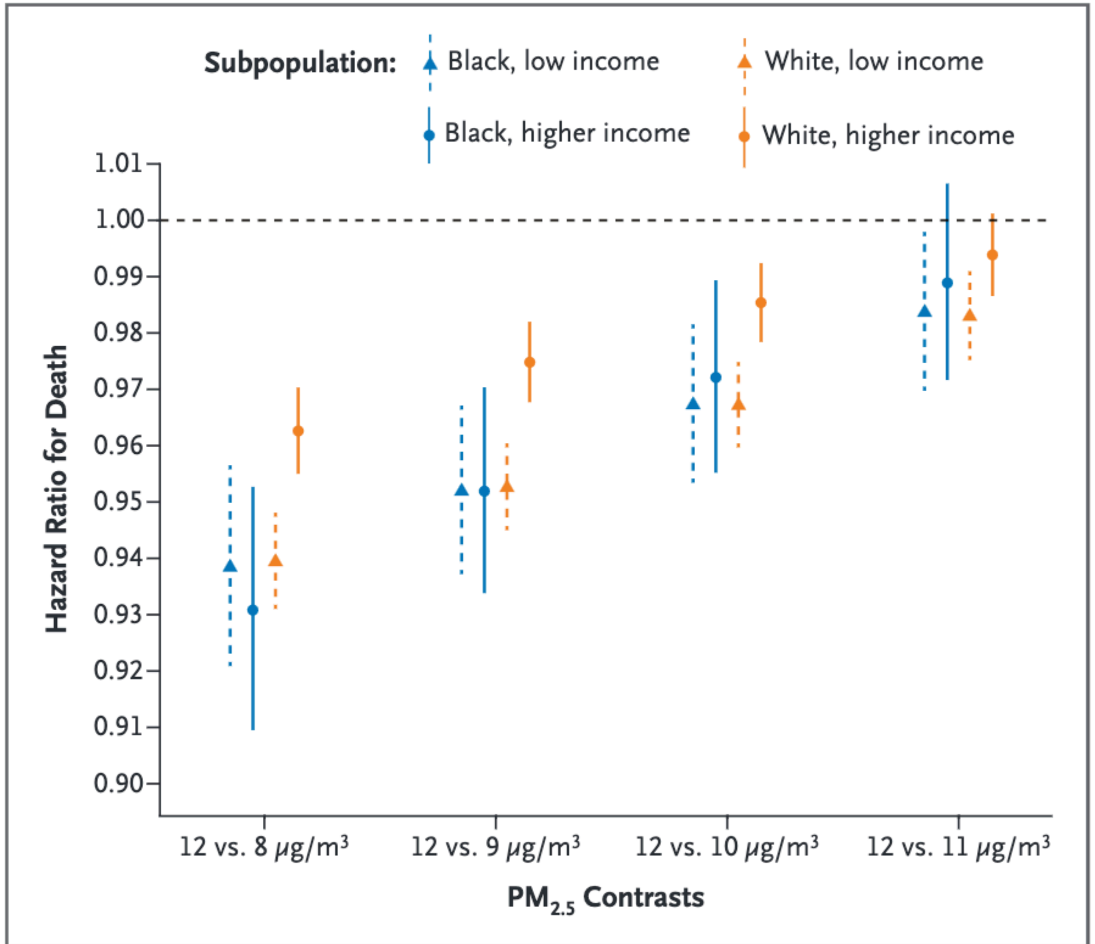


Figure 4. Differences in Mortality with Decreasing $PM_{2.5}$ Exposure among Marginalized Subpopulations.

Shown are point estimates and 95% confidence intervals of the hazard ratio for death comparing different levels of annual average $PM_{2.5}$ exposure (12 μg per cubic meter vs. 11, 10, 9, or 8 μg per cubic meter) on average for subpopulations defined in selected ways. Low income was defined as dual eligibility for both Medicare and Medicaid. Confidence intervals were not adjusted for multiplicity; therefore, they should not be used in place of hypothesis testing.

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.

Give this article

St. James, La., one of several Mississippi River towns dotted by chemical plants and oil refineries. William Widmer for The New York Times

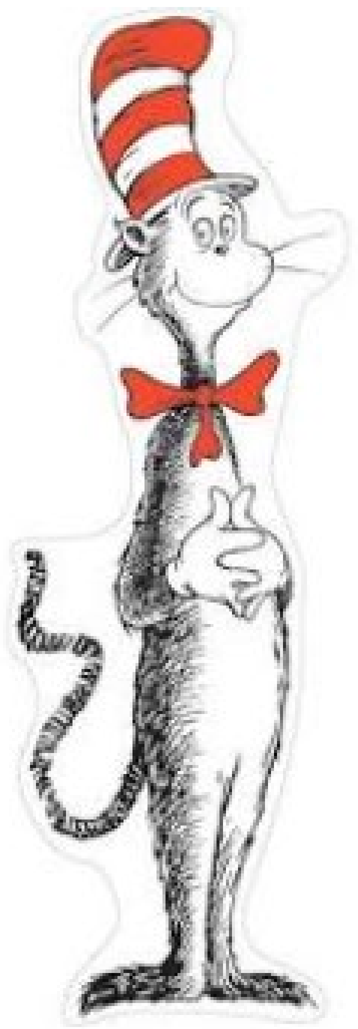
31 awardees since 1999!

Rosenblith New Investigator Award

The purpose of this award is to bring new, creative investigators into active research on the health effects of air pollution. It provides three years of funding for a small project relevant to HEI's research interests to a new investigator with outstanding promise at the Assistant Professor or equivalent level.

thank you

- Innovative science
- Career building
- Institutional commitment
- Mentoring
- Bringing people into the field of air pollution and health



Oh Dan Greenbaum, how great thou art,
Your work on air pollution, a work of heart!
Your research and expertise, second to none,
Keeping the air clean, for everyone!

You work hard to protect the earth,
And remind us of its priceless worth.
So we thank you, Dan Greenbaum,
For keeping our air clean and calm!

Yours, chatGPT