

Under the Weather: The Impact of Climate Change on Older Adults

Marin County Commission on Aging

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Climate and Health

- Air pollution
- Wildfires
- Heat
- Covid

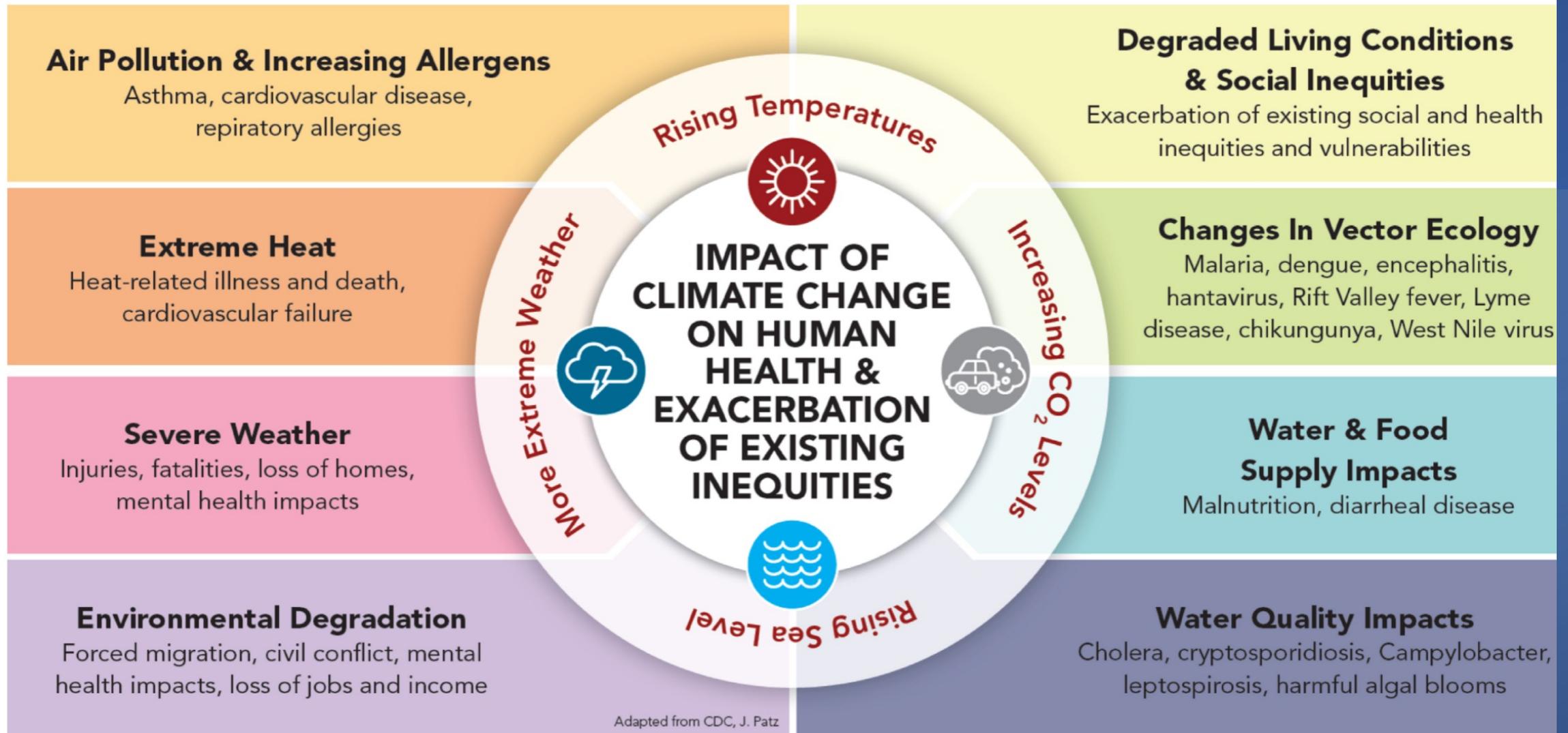


Figure 1. Impact of Climate Change on Human Health and Exacerbation of Existing Inequities (Adapted from CDC, J. Patz).

What is the relationship of climate change and air quality?

Ozone Smog



Pollen



Wildfires

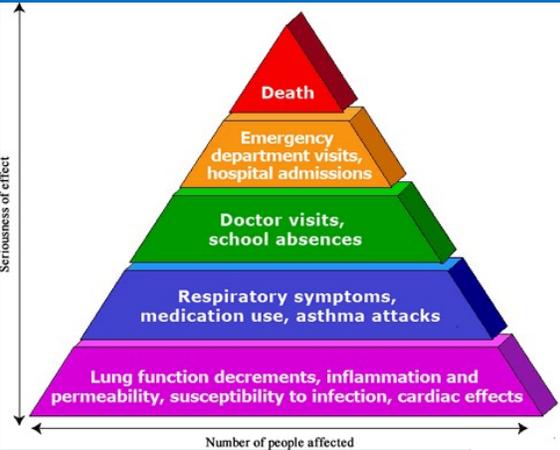


Fuel Combustion Pollution



CLIMATE CHANGE
and
AIR POLLUTION

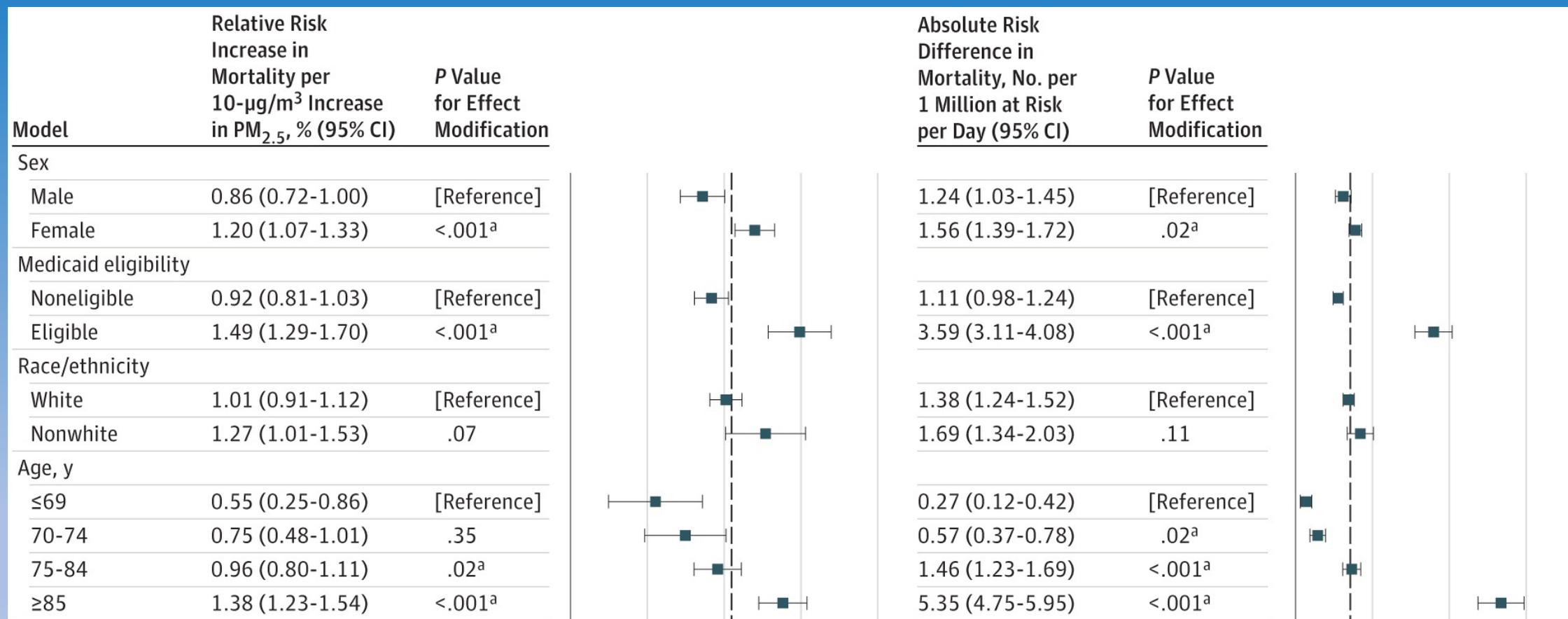
Association of Short-term Exposure to Ozone With Mortality in Older Adults



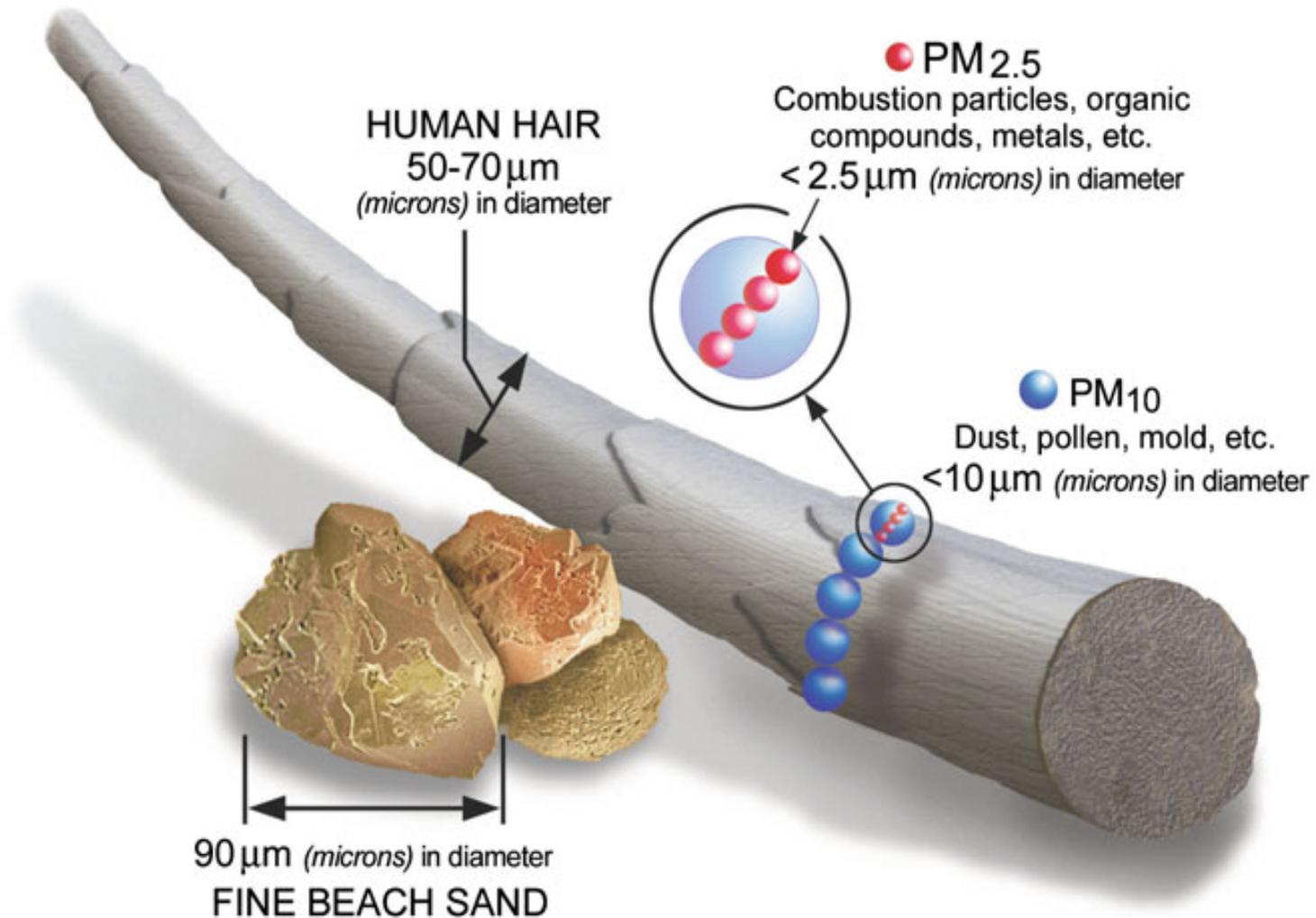
EPA

| Model | Relative Risk Increase in Mortality per 10-ppb Increase in Ozone, % (95% CI) | P Value for Effect Modification | Absolute Risk Difference in Mortality, No. per 1 Million at Risk per Day (95% CI) | P Value for Effect Modification |
|-----------------------------|--|---------------------------------|---|---------------------------------|
| Sex | | | | |
| Male | 0.44 (0.30-0.59) | [Reference] | 0.61 (0.41-0.80) | [Reference] |
| Female | 0.56 (0.43-0.69) | .23 | 0.69 (0.53-0.85) | .53 |
| Medicaid eligibility | | | | |
| Noneligible | 0.49 (0.38-0.60) | [Reference] | 0.56 (0.44-0.69) | [Reference] |
| Eligible | 0.57 (0.36-0.77) | .53 | 1.29 (0.83-1.76) | .003 ^a |
| Race/ethnicity | | | | |
| White | 0.51 (0.40-0.61) | [Reference] | 0.65 (0.52-0.79) | [Reference] |
| Nonwhite | 0.54 (0.28-0.80) | .81 | 0.69 (0.36-1.01) | .85 |
| Age, y | | | | |
| ≤69 | 0.69 (0.17-1.21) | [Reference] | 0.33 (0.08-0.57) | [Reference] |
| 70-74 | 1.18 (0.73-1.63) | .16 | 0.86 (0.53-1.19) | .01 ^a |
| 75-84 | 1.30 (1.03-1.57) | .04 ^a | 1.87 (1.48-2.25) | <.001 ^a |
| ≥85 | 1.83 (1.55-2.11) | <.001 ^a | 6.54 (5.56-7.52) | <.001 ^a |

Association of Short-term Exposure to Particulate Matter With Mortality in Older Adults



Toxins can be active at parts per billion



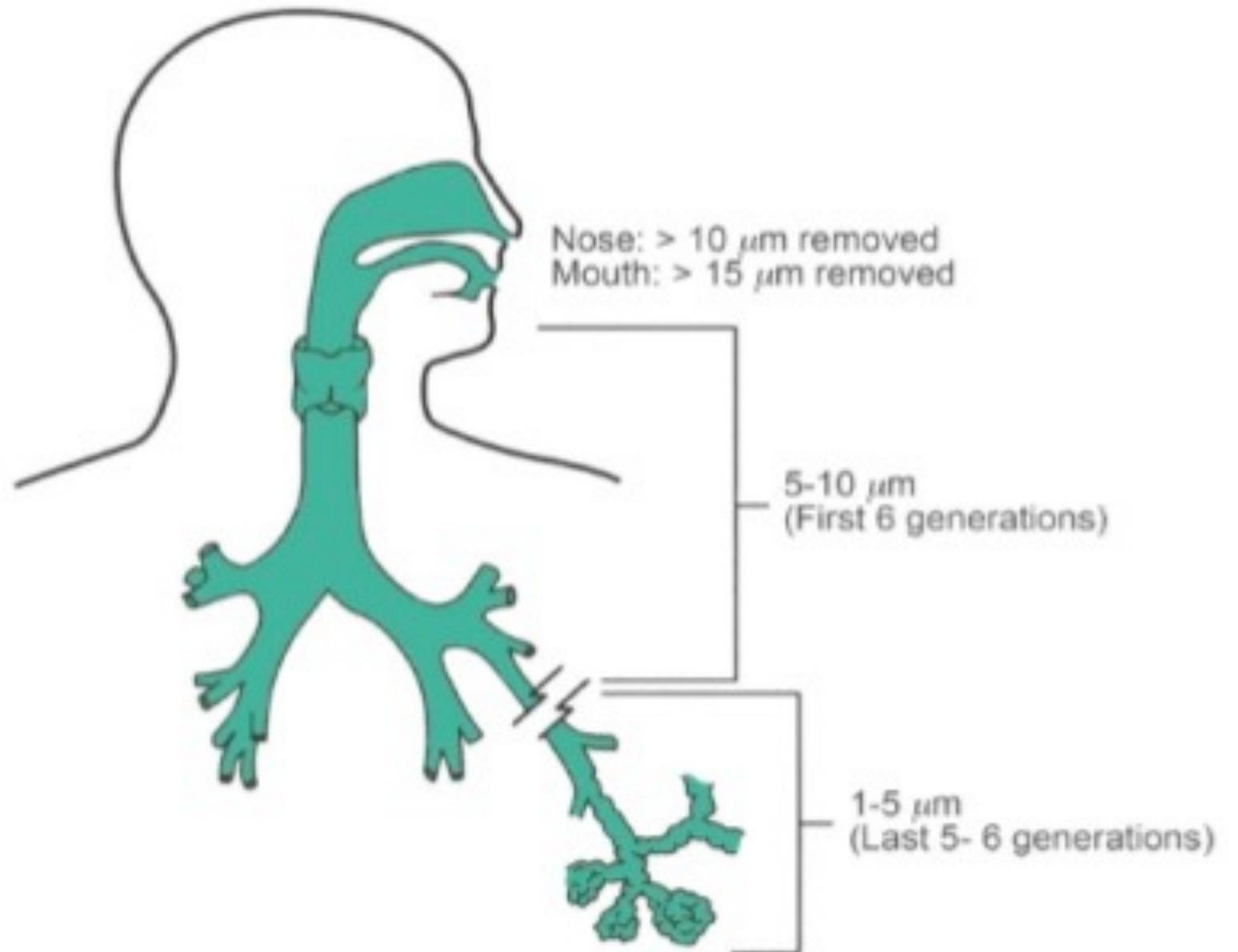
Particulate matter (PM) is classified according to particle diameter, commonly in categories of PM2.5 (particles 2.5 μm and smaller) and PM10 (particles 10.0 μm and smaller).

Figure courtesy of US EPA

Image courtesy of the U.S. EPA

S.L. Steinberg and W.A. Sprigg (eds.), *Extreme Weather, Health, and Communities, Extreme Weather and Society*, 2016

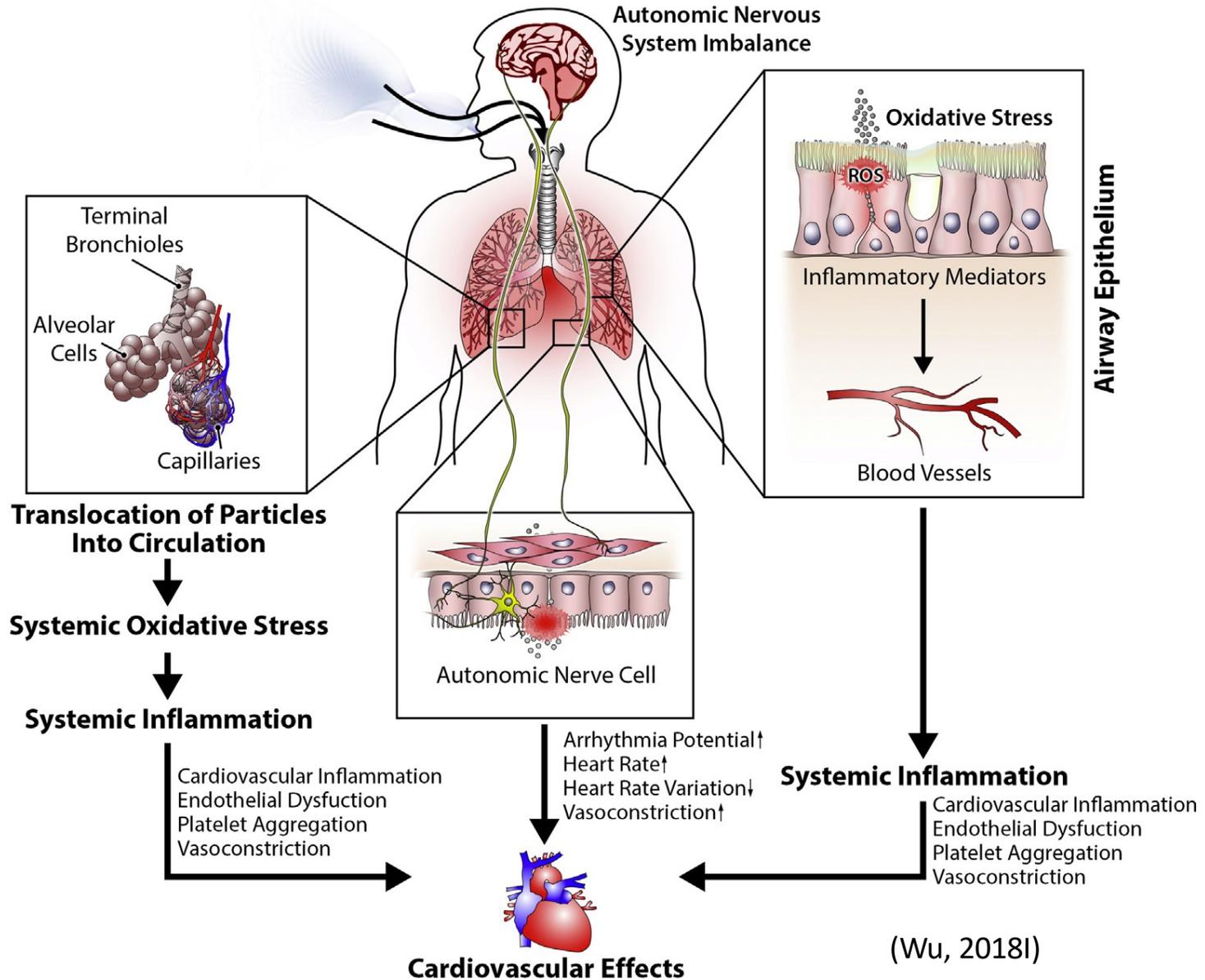
Particle Inhalation Based on Size



(American Assoc for Respir Care, 2011)

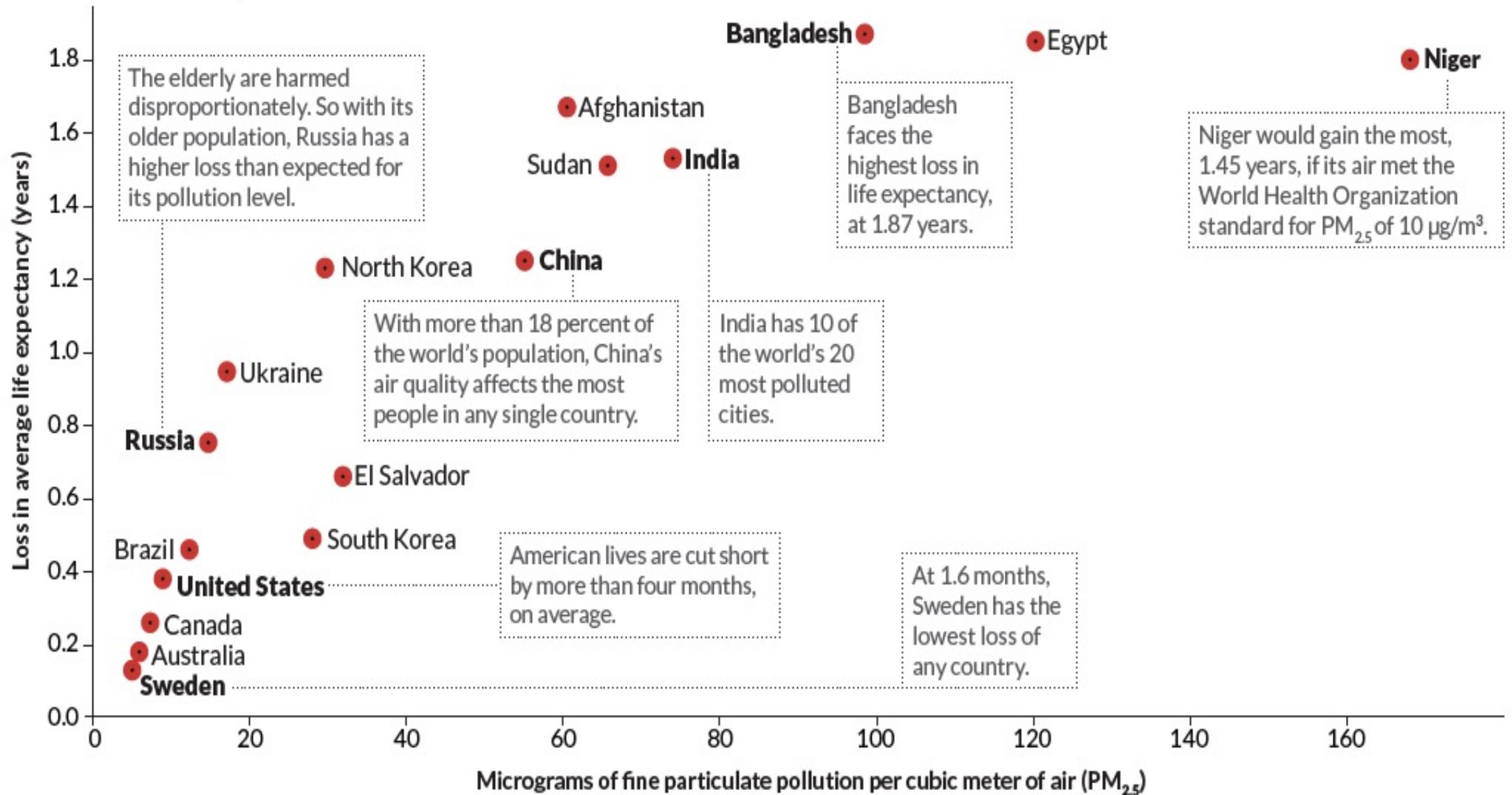
What are the effects of the PM_{2.5} once inside the body?

- Lung inflammation
 - 1.6 million COPD deaths
 - Asthma exacerbations
- Systemic inflammation
 - Cardiovascular system
 - 19% CVD deaths
 - 21% stroke deaths
 - Immune system
 - Allergies
 - Autoimmune disorders
 - Endocrine System
 - Diabetes
 - Brain
 - Alzheimer's
 - Lower child IQ
 - Autism
- Cancer
 - 500,000 lung cancer deaths
 - Bladder cancer
 - Childhood leukemia



PM_{2.5} is shortening lives around the world

How much air pollution shortens lives, for selected countries



CLIMATE CHANGE
and
WILDFIRES

Chemistry of Wildfires



- **Primary air pollutants**
 - Particulate Matter (PM)
 - CO
 - NO₂
 - Polycyclic aromatic hydrocarbons (PAHs)
 - Volatile organic compounds (VOCs)
- **Secondary air pollutants**
 - Particulate Matter (PM)
 - Ozone
- **When vehicles and buildings burn:**
 - Structural fire smoke contains other toxic air contaminants
 - HCN, HCl, phosgene, metals
 - toluene, styrene, dioxins

Over 80% of wildfire smoke is PM_{2.5}

Wildfire and Health: Respiratory Effects

Wildfire PM_{2.5} assoc with inflammation-related respiratory effects

Asthma: Increased ER and hospital admissions

- Peat forest fires in NC (Rappold, 2011), Bush fires in Australia (Morgan, 2010), Forest fires in British Columbia (Henderson, 2011)
- Increase of 70 ug/m³ assoc with 34% increase in asthma admissions in CA (Delfino, 2009)
- Elderly: Age >65 % had 10.1% increase in asthma admissions per 10 ug/m³ increase in PM_{2.5} (Delfino, 2009).

COPD: Increased ER and hospital admissions

- Increase 3.8% of admission assoc with 10 ug/m³ increase of PM₁₀ (Morgan, 2010)
- Increase 6.9% admission assoc with 10 ug/m³ increase PM_{2.5} (Delfino, 2009)

Acute bronchitis and pneumonia admissions increased

- Every 10 ug/m³ increase in PM_{2.5} with 9.6 % increase AB admissions and 6.4% increase pneumonia admissions (Delfino, 2009)

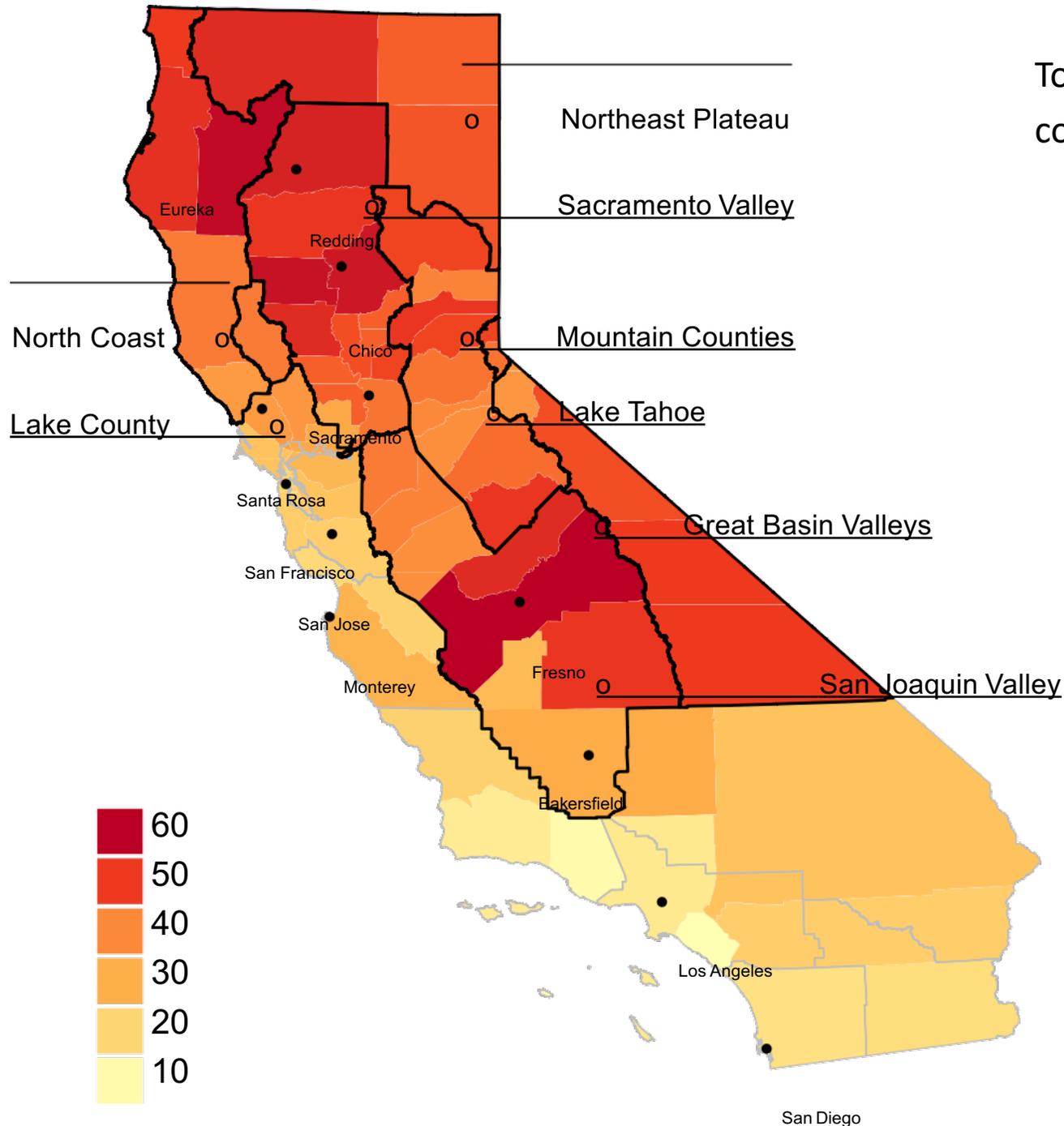
Wildfire and Health: Cardiovascular Effects

Wildfire PM_{2.5} assoc with inflammation-related CVD effects

- Increased cardiovascular (ischemic heart disease, dysrhythmia, heart failure, PE) and cerebrovascular (stroke) ER visits in CA in 2015, esp > 65 yrs old (Wettstein, 2018)
- Mechanism: Increased systemic inflammation, oxidative stress and coagulation through PM_{2.5} mediated changes in ANS (Reid, 2016)
- 10 ug/m³ increase PM_{2.5} assoc with 8% to 18% increase in mortality (Pope, 2003)
- Pre-existing Respiratory and CVD Disorders at increased risk.

Total number of days with any smoke plumes by county from May 1 through September 30, 2015.

- Smoke exposure was associated with increased rates of emergency department visits for numerous cardiovascular disease outcomes, including ischemic heart disease, dysrhythmia, heart failure, pulmonary embolism, and stroke.
- Risk was greatest among adults aged >65 years. With an increase in the risk of heart attacks similar to the increase in risk of a heart attack if you smoke 2 cigarettes per day for a year.

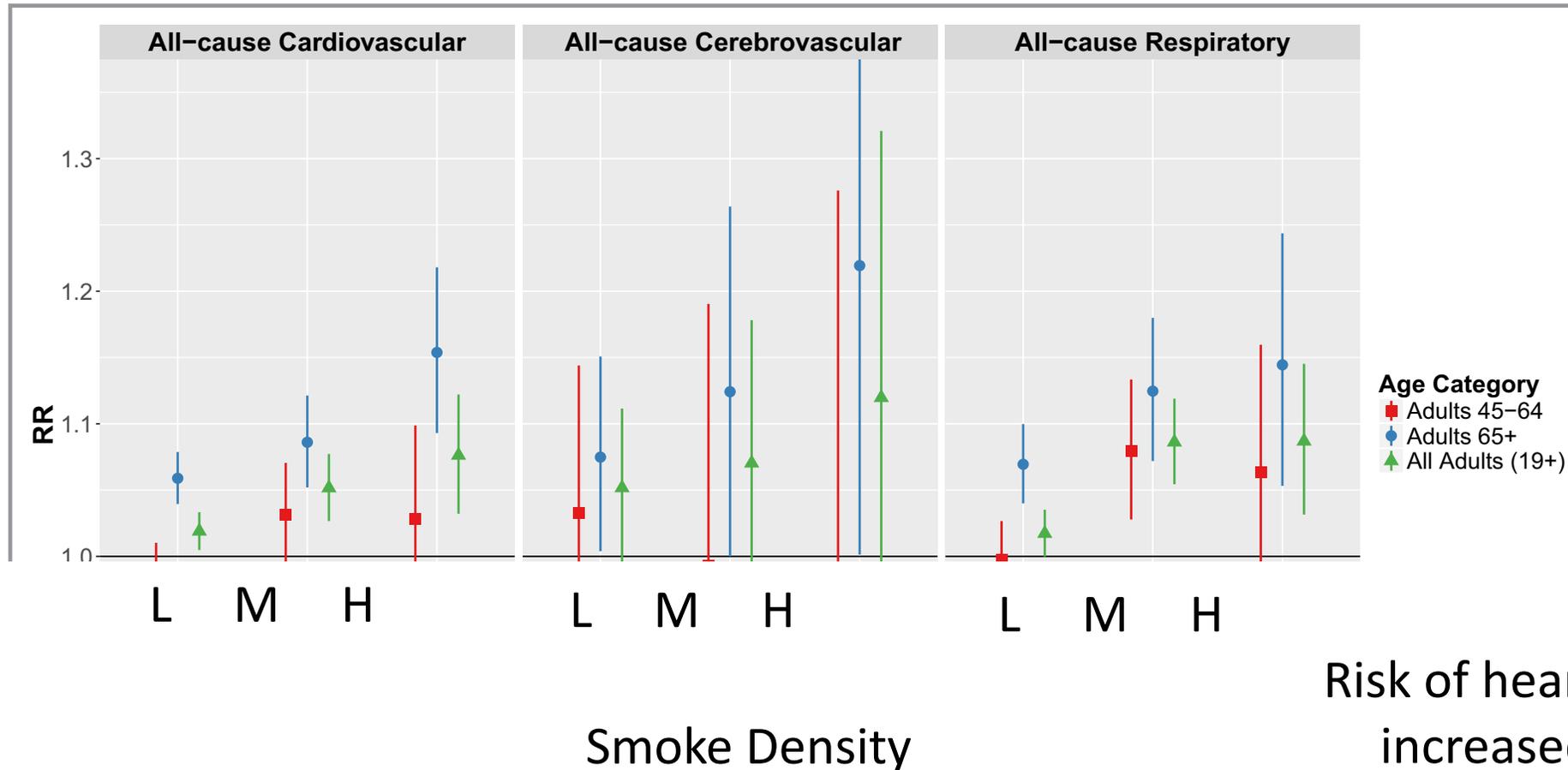


Cardiovascular and Cerebrovascular Emergency Department Visits Associated With Wildfire Smoke Exposure in California in 2015

Wettstein, 2018

Heart, Brain, and Lung affected by Wildfires in Short term

Emergency Department Visits Associated With Wildfire Smoke Exposure in California in 2015

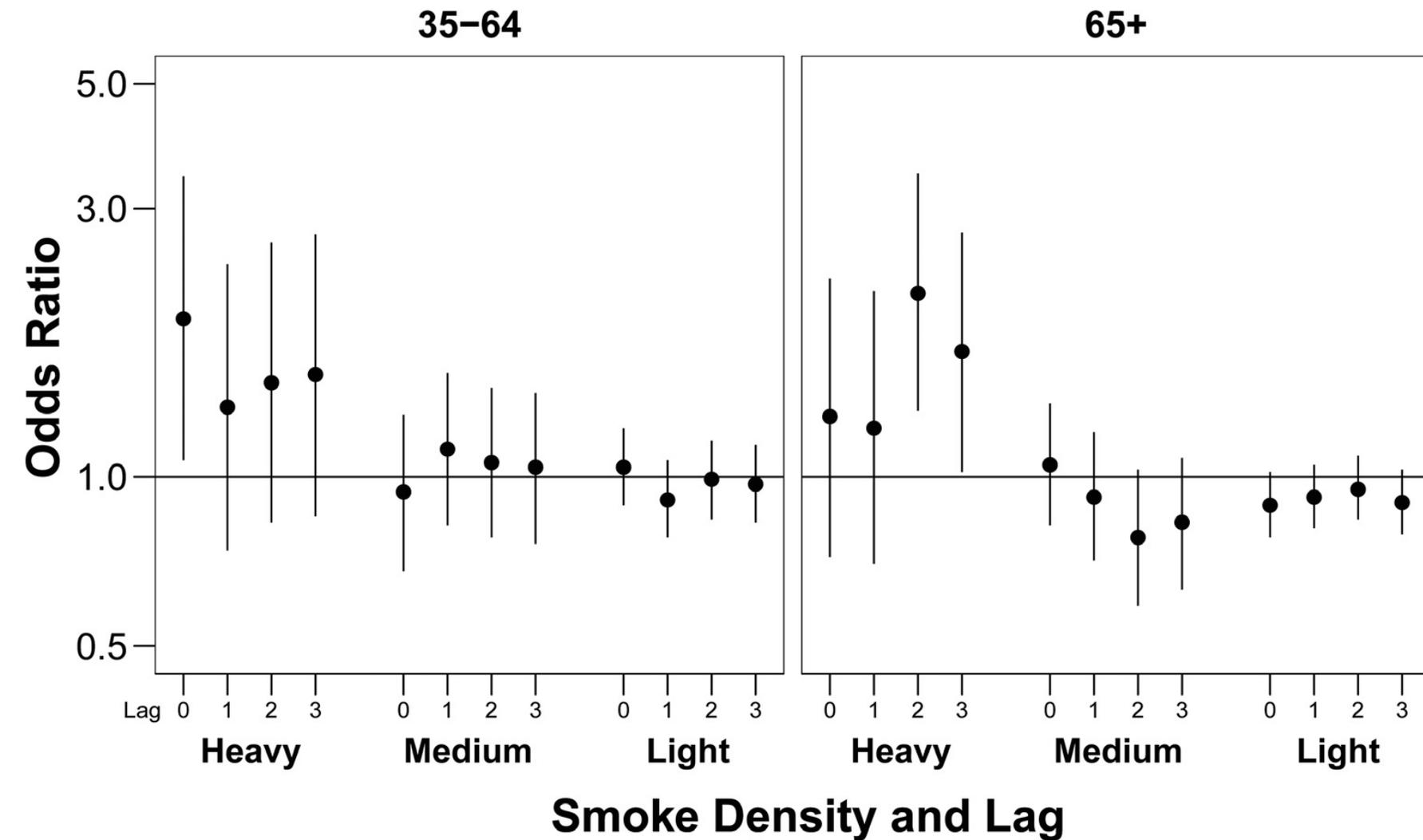


Risk of heart problems increased by 42% due to wildfires, especially for those >65 yrs!

- Looking at smoke wave (2 days $PM_{2.5} > 20 \text{ ug}/m_3$), 7.2 % increase respiratory admissions in elderly if $PM_{2.5} > 37 \text{ ug}/m_3$ (Liu, 2017)

Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires

(Jones, et al, 2020)



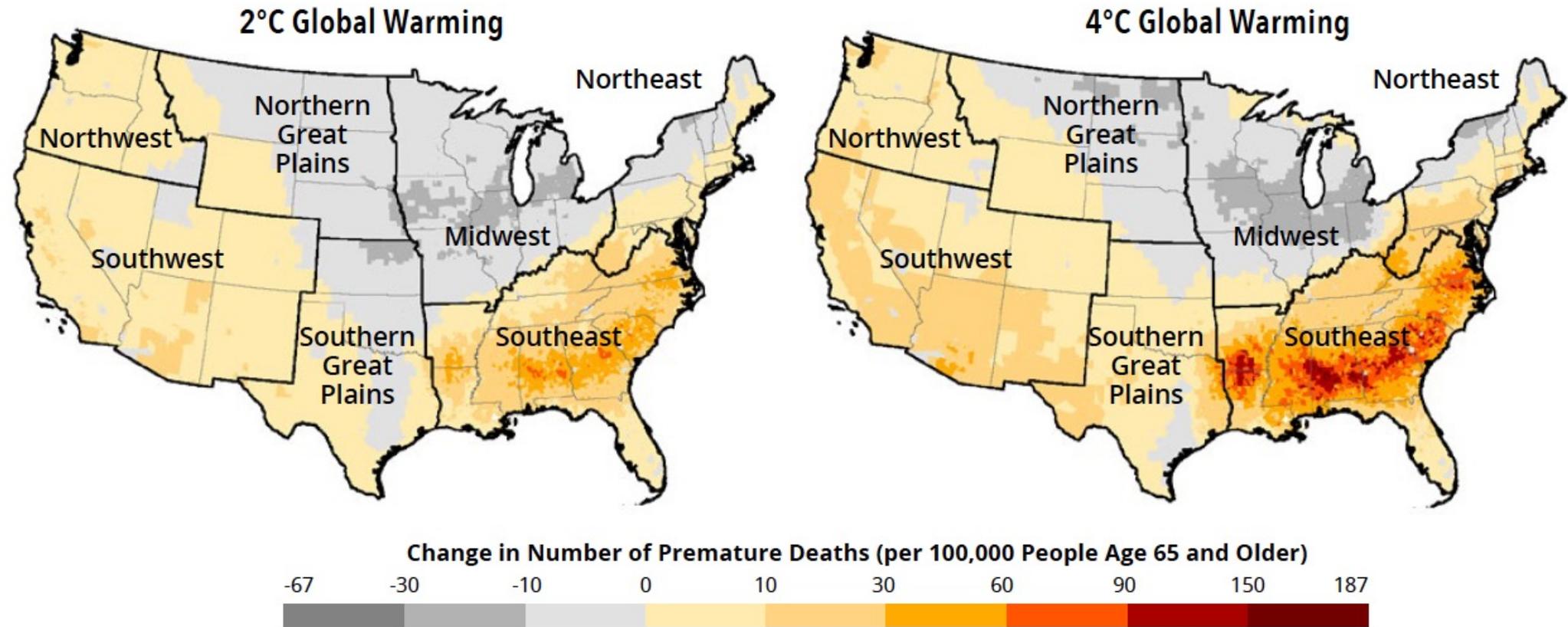
- 35- to 64-year highest risk at lag day 0
- Delayed effect was suggested in ≥ 65 years and older for heavy smoke, stronger on later lag days (2-3 days)
- Risk was the highest on dense smoke days and the effects persisted for several days following the exposure.
- Unsure if biological or behavioral cause

CLIMATE CHANGE
and
HEAT



Projected Changes in Annual Premature Deaths due to Climate-Driven Effects on PM2.5

The analysis estimates changes in premature deaths among people ages 65 and older at the Census tract level. Levels of global warming are relative to the 1986-2005 average.

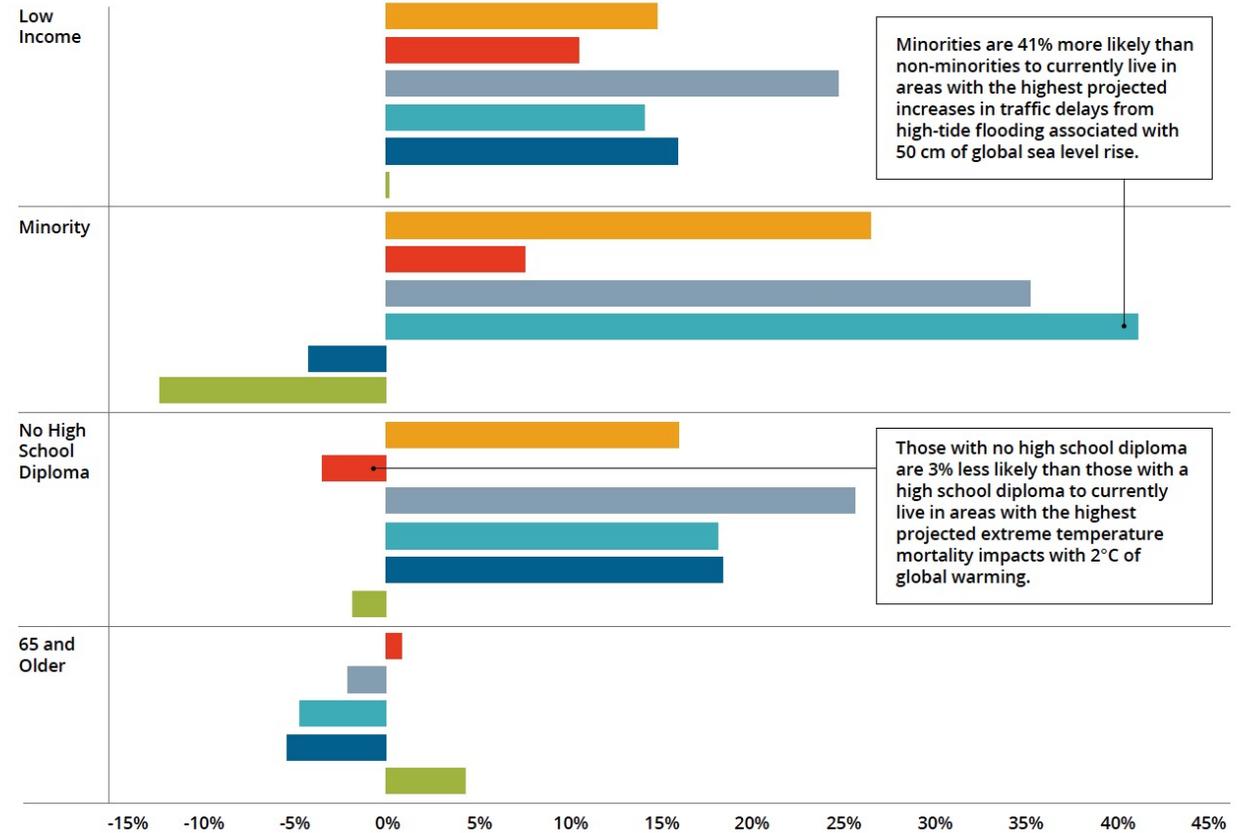


Climate Change and Social Vulnerability in the United States: A Focus on Six Impact Sectors

EPA

4 socially vulnerable populations more exposed to the highest impacts of climate change: income, educational attainment, race and ethnicity, and age.

- Higher baseline mortality rates
- More susceptible to heat exposure
- Heat exacerbates the heat stress on preexisting conditions, esp cardiac.



AIR QUALITY AND HEALTH*

New asthma diagnoses in children due to particulate air pollution.



EXTREME TEMPERATURE AND HEALTH

Deaths due to extreme temperatures.



EXTREME TEMPERATURE AND LABOR

Lost labor hours for weather-exposed workers.



COASTAL FLOODING AND TRAFFIC

Traffic delays from high-tide flooding.



COASTAL FLOODING AND PROPERTY

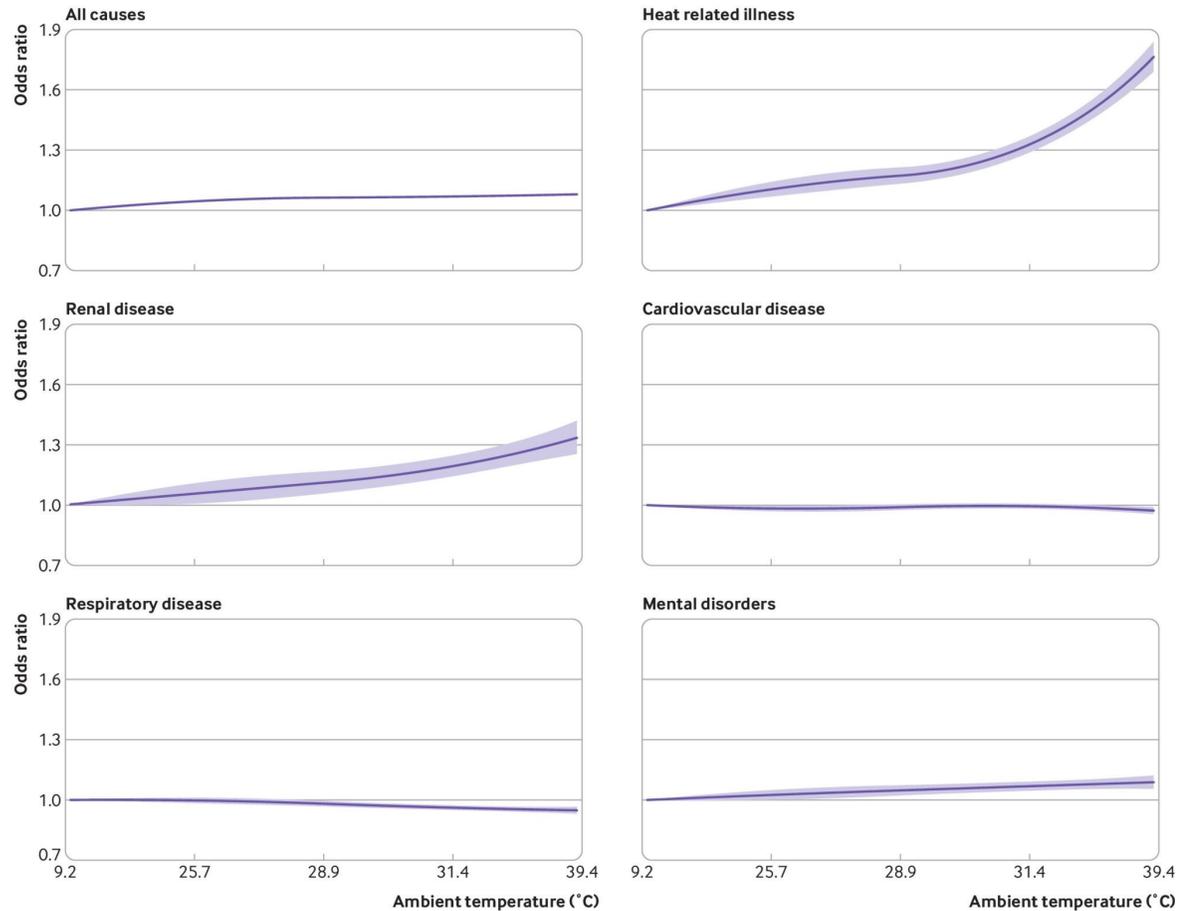
Property inundation due to sea level rise.



INLAND FLOODING AND PROPERTY

Property damage or loss due to inland flooding.

Ambient heat and risks of emergency department visits among adults in the United States: time stratified case crossover study, *BMJ* 2021; 375



- 21 996 670 ED visits from 2010 to 2019
- Heat was not associated with a higher risk of ED visits for cardiovascular or respiratory diseases.
- Associations were more pronounced among men and in counties in the north east of the US or with a continental climate.
- **For** both younger and older adults, extreme heat is associated with a higher risk of ED visits for any cause, heat related illness, renal disease, and mental disorders.

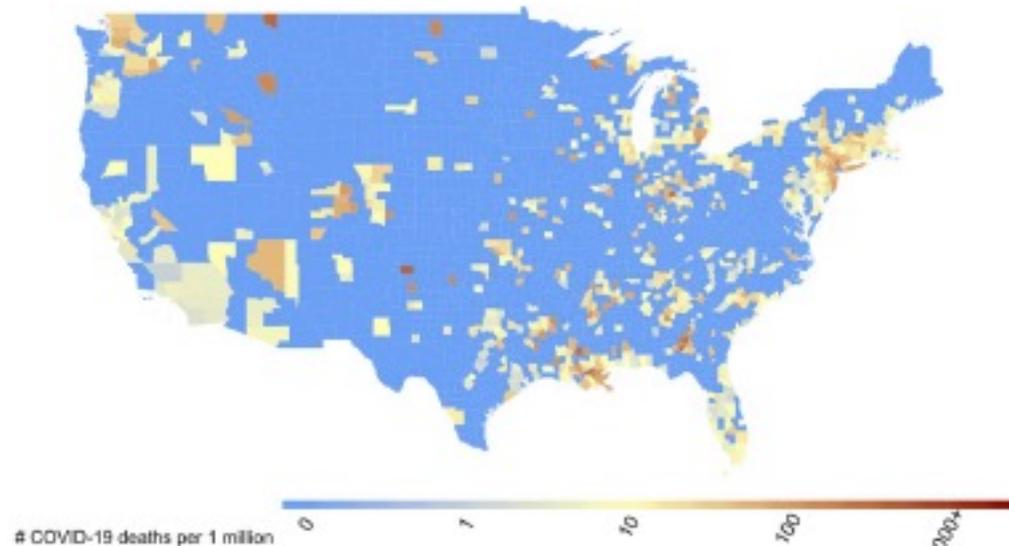
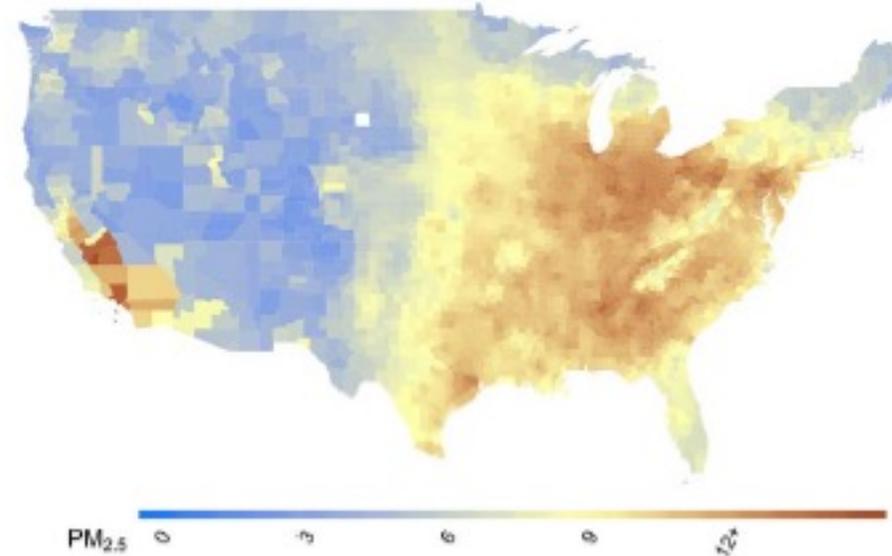
CLIMATE CHANGE
and
COVID

Exposure to air pollution and COVID-19 mortality in the United States

Xiao Wu MS, Rachel C. Nethery PhD, M. Benjamin Sabath MA, Danielle Braun PhD, Francesca Dominici PhD

3,080 counties, of which 2,395 (77.8%) have reported zero COVID-19 deaths the time of analysis

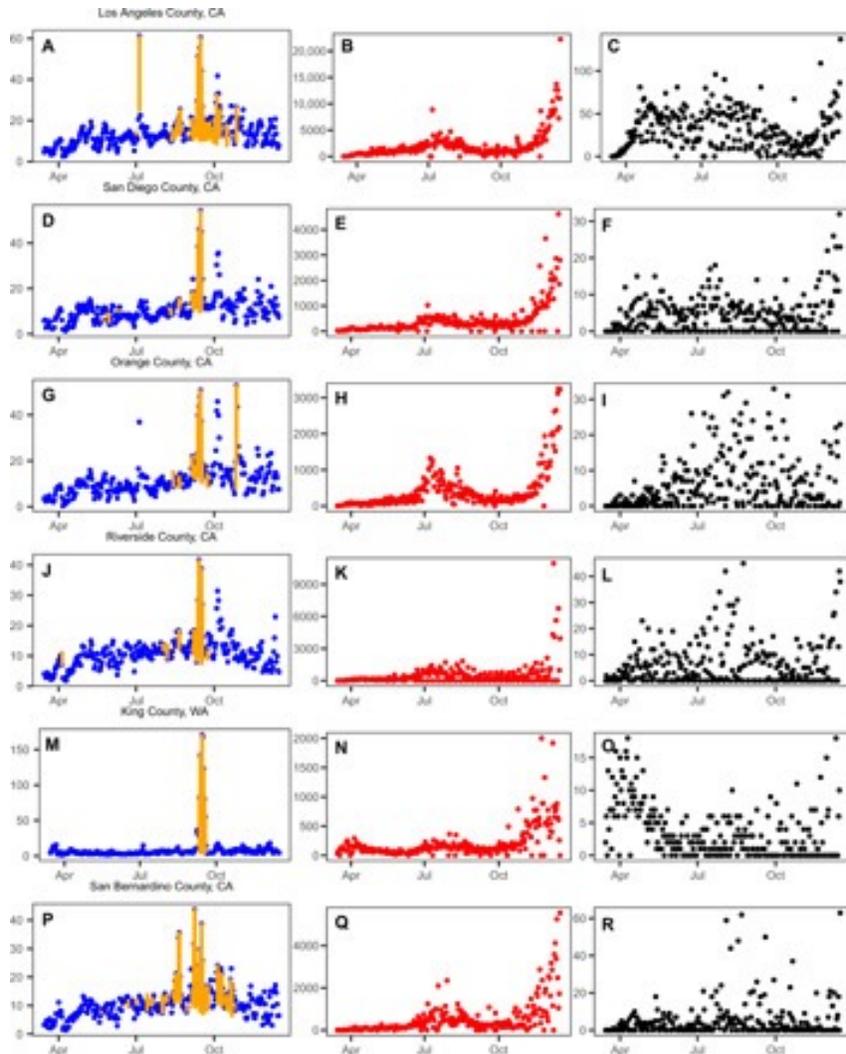
These spatial patterns in COVID-19 death rates generally mimic patterns both high population density and high PM_{2.5} exposure are



Conclusions

- Increase of only 1 $\mu\text{g}/\text{m}^3$ in $\text{PM}_{2.5}$ is associated with a 15% increase in the COVID-19 death rate.
- A small increase in long-term exposure to $\text{PM}_{2.5}$ leads to a large increase in COVID-19 death rate, with the magnitude of increase 20 times that observed for $\text{PM}_{2.5}$ and all-cause mortality.
- (60 million Americans older than 65 years: a 1 mg/m^3 in long-term $\text{PM}_{2.5}$ exposure is associated with a 0.73% increase in the rate of all-cause mortality. Therefore, a small increase in long-term exposure to $\text{PM}_{2.5}$ leads to a large increase in COVID-19 death rate of a magnitude that is 20 times the one estimated for all-cause mortality)
- **importance of continuing to enforce existing air pollution regulations to protect human health both during and after the COVID-19 crisis.**

Excess of COVID-19 cases and deaths due to fine particulate matter exposure during the 2020 wildfires in the United States



Short-term exposure to $PM_{2.5}$ is associated with increased risk of COVID-19 cases and deaths

Time series of $PM_{2.5}$ levels, COVID-19 positive cases and deaths in the six most populated counties

Daily $PM_{2.5}$ levels ($\mu\text{g}/\text{m}^3$, in blue)

Daily COVID-19–positive cases (in red)

Daily COVID-19 deaths (in black)

Orange vertical bars denote daily increases in $PM_{2.5}$ attributable to each wildfire day.



**TACKLING CLIMATE
CHANGE COULD
BE THE GREATEST
GLOBAL HEALTH
OPPORTUNITY OF
THE 21ST CENTURY**

The Lancet, June 2015

Thank you!

Questions?



Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires
 (Jones, et al, 2020)

