$PM_{2.5}$ Air Pollution

Clearing the air

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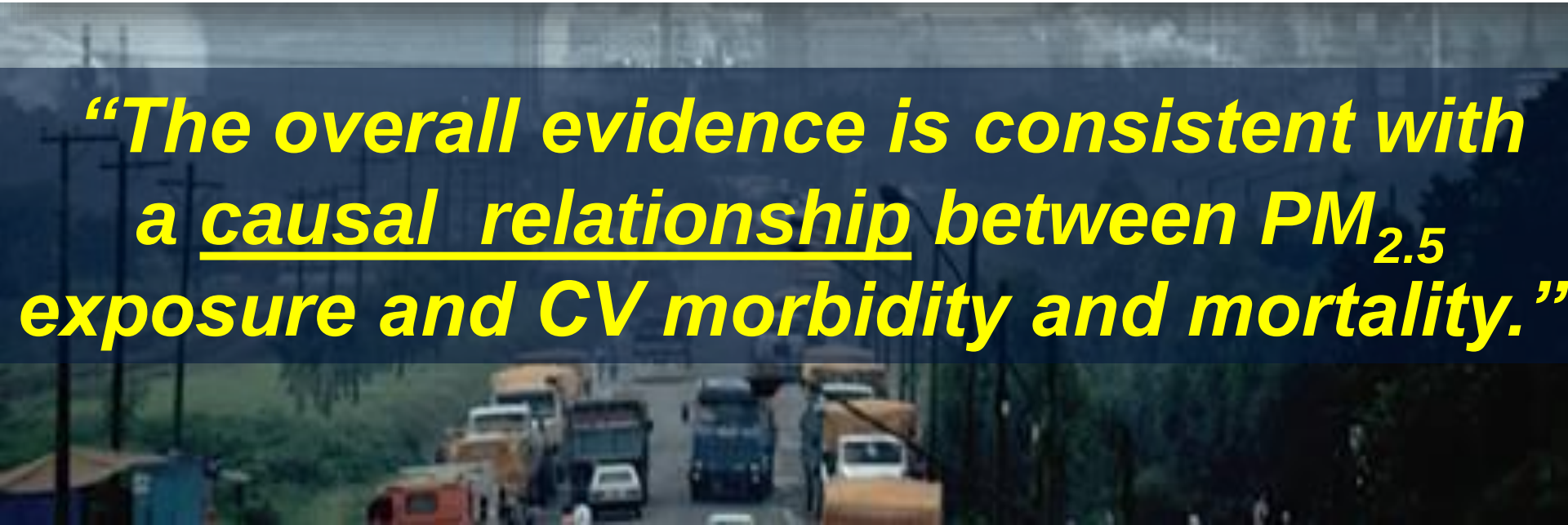
AHA Scientific Statement

Circulation 2010; 121: 2331-78

Particulate Matter Air Pollution and Cardiovascular Disease

An Update to the Scientific Statement From the American Heart Association

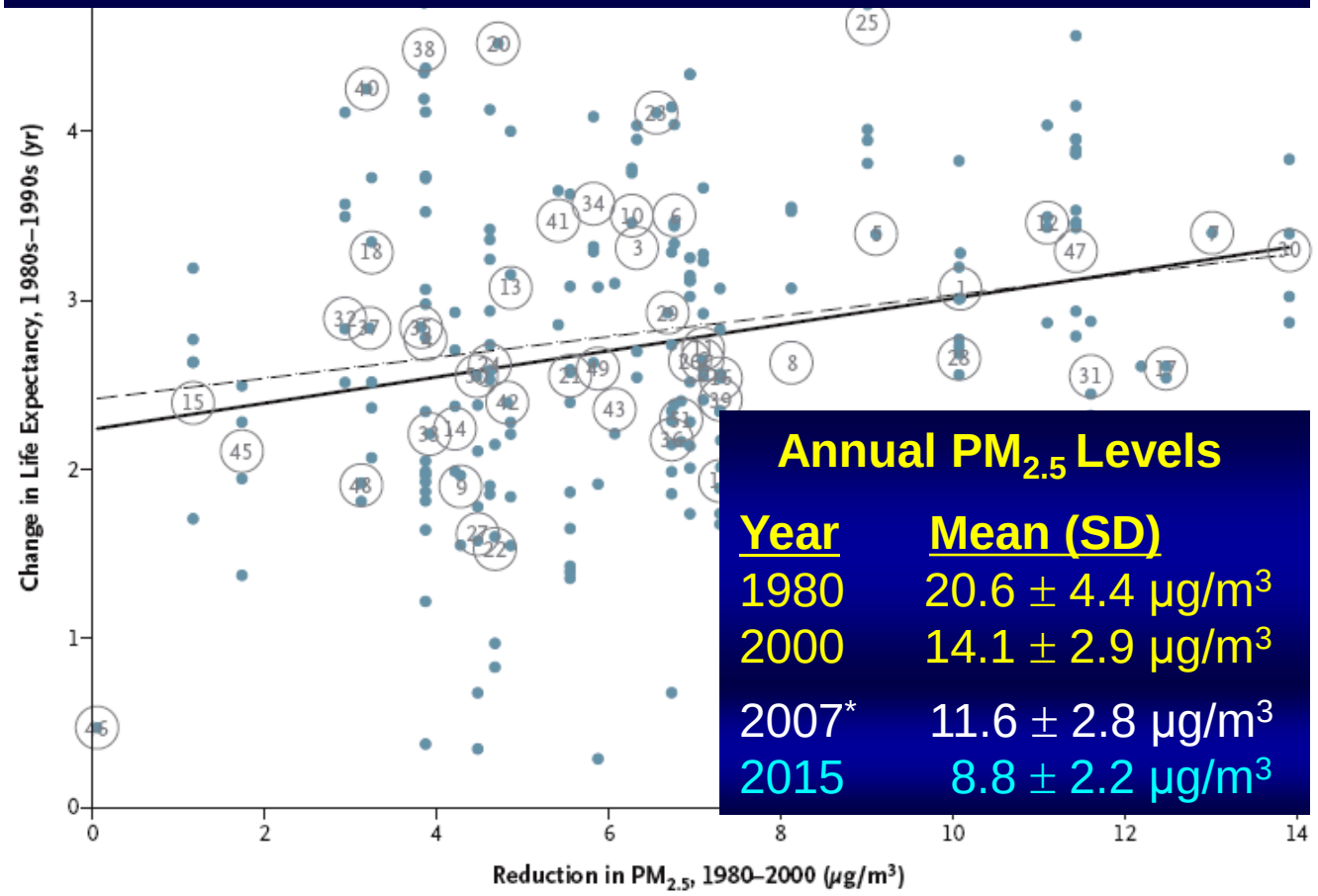
Robert D. Brook, MD, Chair; Sanjay Rajagopalan, MD; C. Arden Pope III, PhD; Jeffrey R. Brook, PhD; Aruni Bhatnagar, PhD, FAHA; Ana V. Diez-Roux, MD, PhD, MPH; Fernando Holguin, MD; Yuling Hong, MD, PhD, FAHA; Russell V. Luepker, MD, MS, FAHA; Murray A. Mittleman, MD, DrPH, FAHA; Annette Peters, PhD; David Siscovick, MD, MPH, FAHA; Sidney C. Smith, Jr, MD, FAHA; Laurie Whitsel, PhD; Joel D. Kaufman, MD, MPH; on behalf of the American Heart Association Council on Epidemiology and Prevention, Council on the Kidney in Cardiovascular Disease, and Council on Nutrition, Physical Activity and Metabolism



"The overall evidence is consistent with a causal relationship between $PM_{2.5}$ exposure and CV morbidity and mortality."

Fine-Particulate Air Pollution and Life Expectancy in the United States

10 µg/m^3 ↓ $PM_{2.5}$ = ↑ life expectancy 7 months
(15% of total ↑ life expectancy)



Annual $PM_{2.5}$ Levels

Year	Mean (SD)
1980	20.6 ± 4.4 µg/m^3
2000	14.1 ± 2.9 µg/m^3
2007*	11.6 ± 2.8 µg/m^3
2015	8.8 ± 2.2 µg/m^3

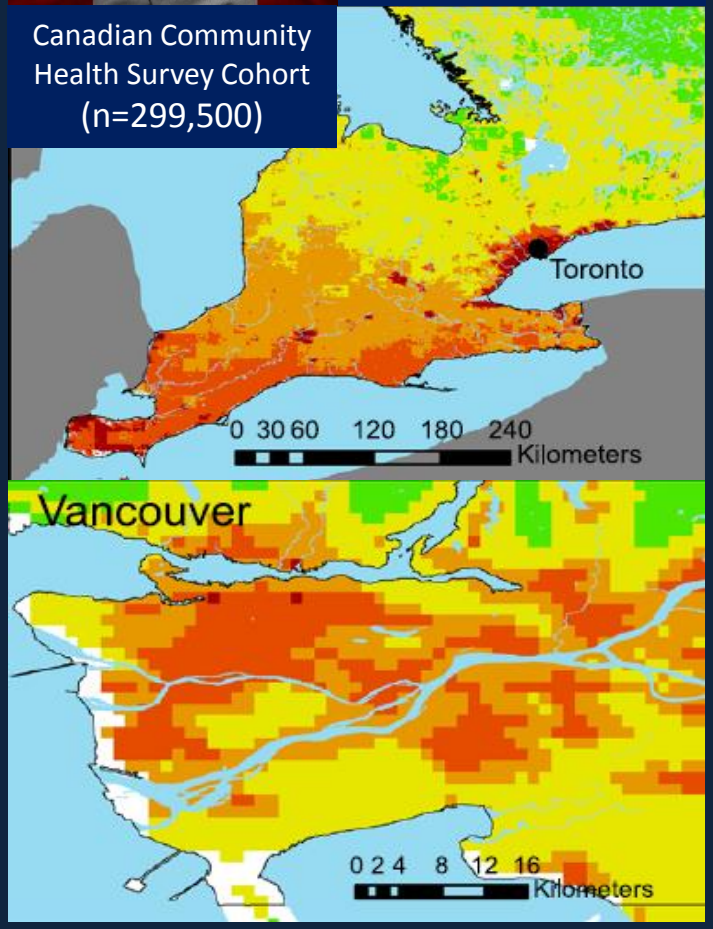
Figure 4. Changes in Life Expectancy for the 1980s–1990s, Plotted against Reductions in $PM_{2.5}$ Concentrations for 1980–2000.

*Epidemiology 2013; 24: 23

Even Very Low $PM_{2.5}$ Levels Increase Cardiovascular Mortality

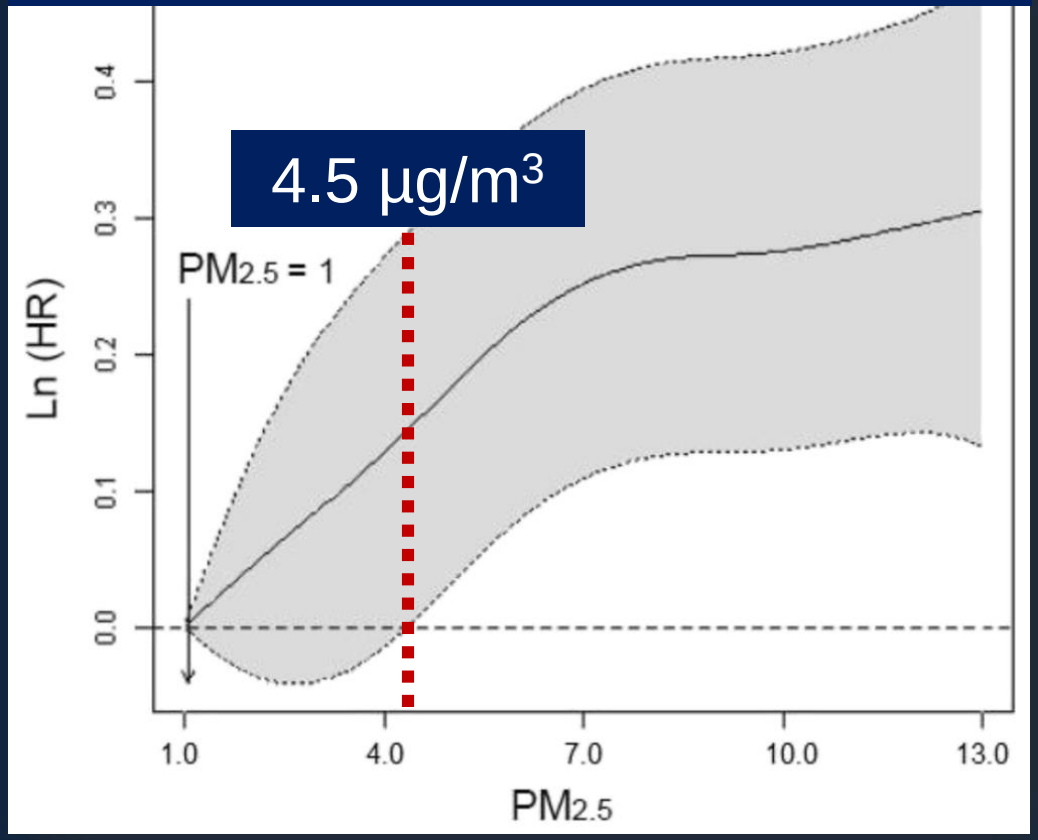
6.3 ± 2.5 µg/m³

Canadian Community Health Survey Cohort (n=299,500)



7.6 ±2.7 year follow-up

CVD: HR 1.19 (95% CI 1.07-1.31) per 10 µg/m³



Environmental Health (2016) 15:18

King Edward I (1272)
"Malleus Scotorum"

"Whosoever shall be found guilty
of burning coal shall
suffer the loss of his head"

"From Good Intentions to Proven Interventions: Effectiveness of Actions to Reduce the Health Impacts of Air Pollution"

- March 2009 international, multidisciplinary workshop in Vancouver, Canada
- Identified two strategies to address and mitigate air-pollution related health impacts:[1]
  - Reduce individual baseline risk of CV disease
  - Incorporate air pollution-related health impacts into land-use decisions

1. Environ Health Perspect. 2011; 119(1):29-36

“Personal-level interventions have the potential to reduce air pollution exposures”

Understanding Air Pollution and Cardiovascular Diseases: Is It Preventable? Masako Morishita[1], Kathryn C. Thompson[1], and Robert D. Brook[2]

Air Filtration

Wearing Face Masks

Car Filters and Particle Traps

Closing Windows and Air Conditioning

Behavioral Changes

Modified Cook Stoves

Curr Cardiovasc Risk Rep. 2015 June ; 9(6):

"Personalize" Your Air Space

HEPA Filters

(indoor protection)

48 hour: 57% ↓ in $PM_{2.5}$
(96.2 to 41.3 µg/m^3)

↓ Blood pressure

↓ MCP-1, IL-1, MPO, CD40L

J Am Coll Cardiol 2015; 65: 2279-87.

"N-95" Facemask

(outdoor protection)

48 hour: 97% ↓ in $PM_{2.5}$

↓ 2-hr walking blood pressure

↓ ECG ischemia (CAD pts)

Part Fibr Toxicol 2009; 6

Environ Health Perspect 2012; 120: 367–372.

No Evidence for “Simple” Facemasks

--Not an ideal long term solution--

RECOMMENDATIONS FOR HEALTH CARE PROVIDERS

AHA Scientific Statement

Particulate Matter Air Pollution and Cardiovascular Disease

- Evidence-based appropriate treatment of the traditional CV risk factors should be emphasized - may lessen susceptibility
  - Patients without CAD may not be at increased risk of short-term exposure[1]
  - Patients with a normal BMI are at less risk of long-term PM exposures[2]
  - Statins[3], low BMI[3], B vitamins[4], fish oil[5] may abrogate PM-induced HRV changes

1. Circulation 2006; 114: 2443; 2. NEJM 2007; 356: 447; 3. Am J Resp Crit Care Med 2005; 172: 1529
4. Circulation 2008; 117: 1802; 5. Am J Resp Crit Care Med 2005; 172: 1534

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- Based upon the forecasted Air Quality Index, *prudent* recommendations for reducing exposure and limiting activity should be provided based upon the patient's level of risk

  http://airnow.gov/ http://weather.com

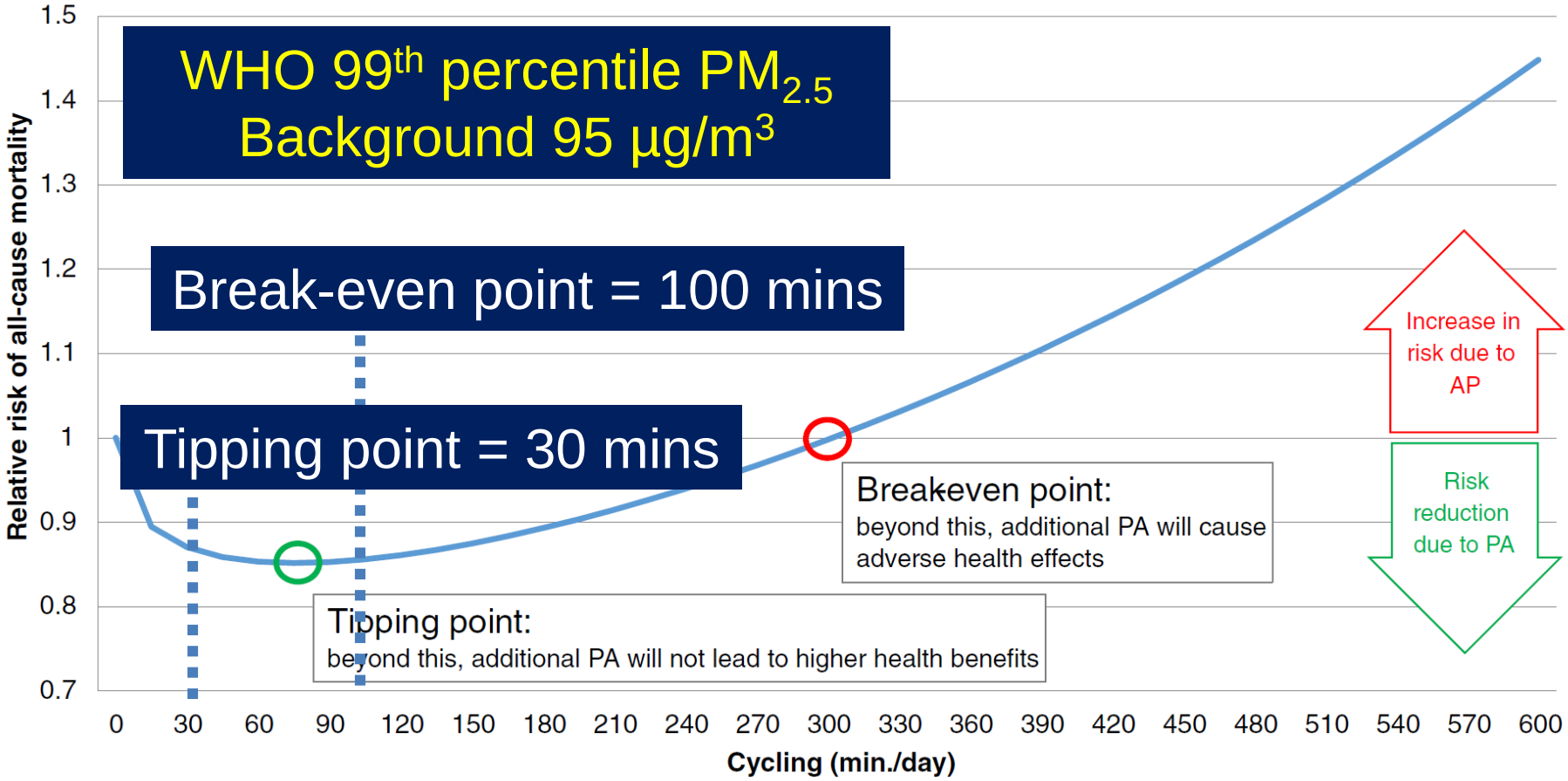
  - Reduce or eliminate non-mandatory travel and/or commutes
  - Reduce outdoor activities in polluted areas or times (rush hour)
  - Stay indoor or exercise inside using air conditioning/filters
  - Consider closing car windows, using recycled filtered cabin air

- Advocate for Air Quality Standards (AHA, ATS, ALA)
- Educate/guide patients - Air Quality Index (AQI)

$PM_{2.5}$

Air Quality Index	Who Needs to be Concerned?	What Should I Do?
<12 µg/m³ Good (0-50)	It's a great day to be active outside.	
Unhealthy for Sensitive Groups (101-150)	Sensitive groups include **people with heart or lung disease, older adults, children and teenagers.**	**Sensitive groups:** *Reduce* prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. **People with asthma** should follow their asthma action plans and keep quick relief medicine handy. **If you have heart disease:** Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.
>150 µg/m³ Very Unhealthy (201-300)	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **Everyone else:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
>250 µg/m³ Hazardous (301-500)	**Everyone**	**Everyone:** *Avoid all* physical activity outdoors. **Sensitive groups**: Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.

Can Air Pollution Negate the Health Benefits of Cycling and Walking?



BALANCING (MAYBE) COMPETING "PRECAUTIONARY PRINCIPLES" OF ACTION ON PM

The messaging is critically important (what/when/how and whom to inform?)

? Un-intended harms (unwanted behavioral Δ) vs. value of un-tested intervention(s)

Preventive Medicine 87 (2016) 233–236

RECOMMENDATIONS FOR HEALTH CARE PROVIDERS

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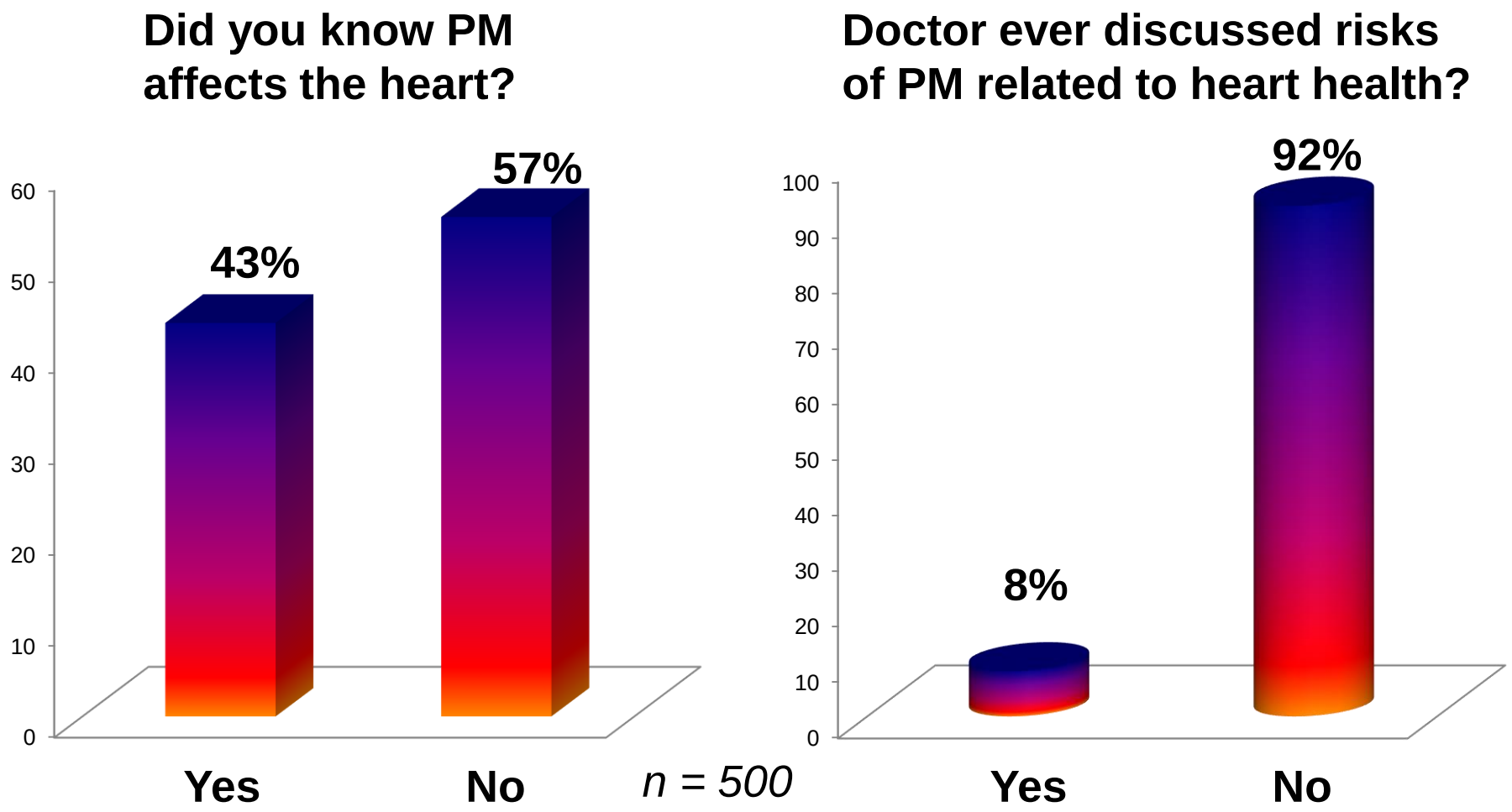
- All patients with CV disease should be educated about the CV risks posed by air pollution.
- Consideration should also be given for educating patients without CV disease but who are at high risk
  - Advice from media alerts and health professional to change outdoor behavior and activities[1]
  - Community educators can increase patient knowledge of the adverse health effects related PM[2]

1. J Comm Health 2009; 34: 40; 2. J Asthma 2008; 45: 839.

Cardiology Patients Unaware of PM Risks



Brook RD, et al. Prog Cardiovasc Dis 2011; 53: 379-84

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NO FORMAL RECOMMENDATIONS

For or against PERSONAL-LEVEL PROTECTION ACTIONS (home/car filtration, air conditioning, facemasks)

While a few studies shows favorable changes in surrogate health outcomes[1-3]; too many factors remain unknown:

- Comparative effectiveness of interventions
- Who/when to intervene
- Overall risk/benefit ratio, costs, and value
- Public health impact is not established

1. Epidemiology 2009: 20: 682; 2. Particle Fibre Toxicol 2009; 6: 8; 3. Am J Resp Crit Care Med 2008; 177: 419.

Important Future Directions/Research

Individual-Behavioral Changes

- *Lower underlying CV risk*
- *Change activity patterns*

Individual-Exposure Reduction

- *Facemasks*
- *Home and car air filters*

Health Care Provider & System

- *Clinician education*
- *EMR-based alerts*
- *Access to care*
- *Optimal messaging*

Community-level

- *Outreach*
- *Education*
- *Built environment*
- *Healthy food access*
- *Exercise facilities*

Societal-level

- *Air quality*
- *Emissions*
- *Roadways*
- *Climate Δ*