



# *Environmental and Public Health, Air Pollution and the Healthcare System*

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# Health Impact of PM Pollution

## *Air pollution remains a Significant U.S. Public Health Problem*

- Estimated excess mortality **125,000 deaths/year**
- Over **20 million school days and work days lost**
- Over **1 million life-years lost**
- **122.5 million people living in counties with one or more pollutants exceeding the NAAQS in 2016**

Fann N. et al. Risk Anal 2012; Fann et al. *Environ Sci Tech* 2013





# Foundation of PM's Health Effect Exposure Linked to Morbidity and Mortality

## AHA Scientific Statement

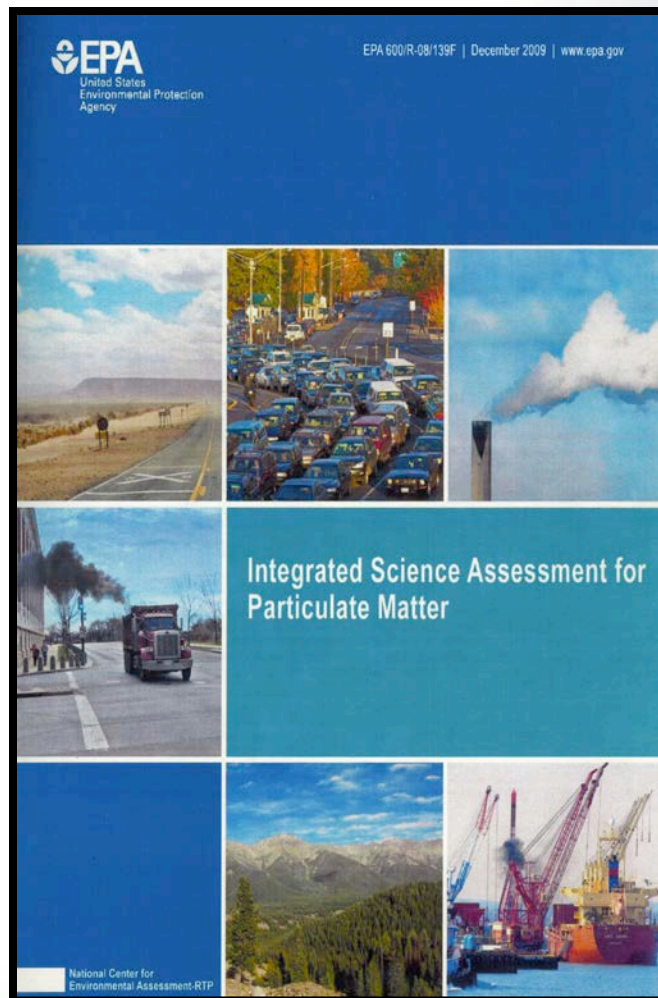
### Air Pollution and Cardiovascular Disease

#### A Statement for Healthcare Professionals From the Expert Panel on Population and Prevention Science of the American Heart Association

Robert D. Brook, MD; Barry Franklin, PhD, Chair; Wayne Cascio, MD; Yuling Hong, MD, PhD;  
George Howard, PhD; Michael Lipsett, MD; Russell Luepker, MD; Murray Mittleman, MD, ScD;  
Jonathan Samet, MD; Sidney C. Smith, Jr, MD; Ira Tager, MD

**Abstract**—Air pollution is a heterogeneous, complex mixture of gases, liquids, and particulate matter. Epidemiological studies have demonstrated a consistent increased risk for cardiovascular events in relation to both short- and long-term exposure to present-day concentrations of ambient particulate matter. Several plausible mechanistic pathways have been described, including enhanced coagulation/thrombosis, a propensity for arrhythmias, acute arterial vasoconstriction, systemic inflammatory responses, and the chronic promotion of atherosclerosis. The purpose of this statement is to provide healthcare professionals and regulatory agencies with a comprehensive review of the literature on air pollution and cardiovascular disease. In addition, the implications of these findings in relation to public health and regulatory policies are addressed. Practical recommendations for healthcare providers and their patients are outlined. In the final section, suggestions for future research are made to address a number of remaining scientific questions. (*Circulation*. 2004;109:2655-2671.)

***Short-term and long-term exposure to ambient air particulate matter is causally associated with cardiovascular morbidity and mortality. (EPA ISA 2009)***





# PM Described as Modifiable Cardiovascular Risk Factor

## AHA Scientific Statement

### 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

**Abstract**—In 2004, the first American Heart Association scientific statement on “Air Pollution and Cardiovascular Disease” concluded that exposure to particulate matter (PM) air pollution contributes to cardiovascular morbidity and mortality. In the interim, numerous studies have expanded our understanding of this association and further elucidated the physiological and molecular mechanisms involved. The main objective of this updated American Heart Association scientific statement is to provide a comprehensive review of the new evidence linking PM exposure with cardiovascular disease, with a specific focus on highlighting the clinical implications for researchers and healthcare providers. The

*“PM<sub>2.5</sub> exposure is deemed a modifiable factor that contributes to cardiovascular morbidity and mortality.”*

*Brook RD et al. Circulation 2010*

*“Health professionals, including cardiologists, have an important role to play in supporting educational and policy initiatives as well as counseling their patients.”*

*Newby DE et al. Eur Heart J 2014*

European Heart Journal Advance Access published December 9, 2014



European Heart Journal  
doi:10.1093/eurheartj/ehu458

CURRENT OPINION

### Expert position paper on air pollution and cardiovascular disease

David E. Newby<sup>1</sup>, Pier M. Mannucci<sup>2</sup>, Grethe S. Tell<sup>3</sup>, Andrea A. Baccarelli<sup>4</sup>, Robert D. Brook<sup>5</sup>, Ken Donaldson<sup>6</sup>, Francesco Forastiere<sup>7</sup>, Massimo Franchini<sup>8</sup>, Oscar H. Franco<sup>9</sup>, Ian Graham<sup>10</sup>, Gerard Hoek<sup>11</sup>, Barbara Hoffmann<sup>12</sup>, Marc F. Hoylaerts<sup>13</sup>, Nino Künzli<sup>14,15</sup>, Nicholas Mills<sup>1</sup>, Juha Pekkanen<sup>16,17</sup>, Annette Peters<sup>18,19</sup>, Massimo F. Piepoli<sup>20</sup>, Sanjay Rajagopalan<sup>21</sup>, and Robert F. Storey<sup>22\*</sup>, on behalf of ESC Working Group on Thrombosis, European Association for Cardiovascular Prevention and Rehabilitation and ESC Heart Failure Association



# Personal Health Care Spending in U.S. for Chronic Disease is High

COPD	\$ 53.8 billion
Asthma	\$ 32.5 billion
Pneumonia	\$ 37.1 billion
Lung cancer	\$ 13.1 billion
Ischemic heart disease	\$ 88.1 billion
High blood pressure	\$ 83.9 billion
Stroke	\$ 43.8 billion
Heart failure	\$ 28.5 billion
Atrial fibrillation	\$ 27.7 billion
Peripheral vascular disease	\$ 2.7 billion
Diabetes	\$101.4 billion
Preterm birth	\$ 4.9 billion

***½ Trillion Dollars in 2013***

Dieleman JL et al.  
JAMA 2016

***Air Pollutant Exposure is a Risk Factor***



# *Populations At-Risk Are Known*

## *Populations At-Risk from PM<sub>2.5</sub>*

### ***Susceptible populations include –***

- those with pre-existing respiratory disease
- those with pre-existing cardiovascular disease
- older adults
- those with lower socio-economic status
- children & the developing fetus

### ***Populations suspected to be at greater risk –***

- those with chronic inflammatory diseases (e.g., diabetes, obesity)
- those with specific genetic polymorphisms (e.g., GSTM1)



# Progress in Reducing Cardiovascular Mortality has Stalled in the U.S.

- *Obesity and diabetes are on the rise*
- *Since 2011, improvements in mortality from heart disease & stroke have slowed*

Research

## Brief Report

# Recent Trends in Cardiovascular Mortality in the United States and Public Health Goals

Stephen Sidney, MD, MPH; Charles P. Quesenberry Jr, PhD; Marc G. Jaffe, MD; Michael Sorel, MPH; Mai N. Nguyen-Huynh, MD; Lawrence H. Kushi, ScD; Alan S. Go, MD; Jamal S. Rana, MD, PhD

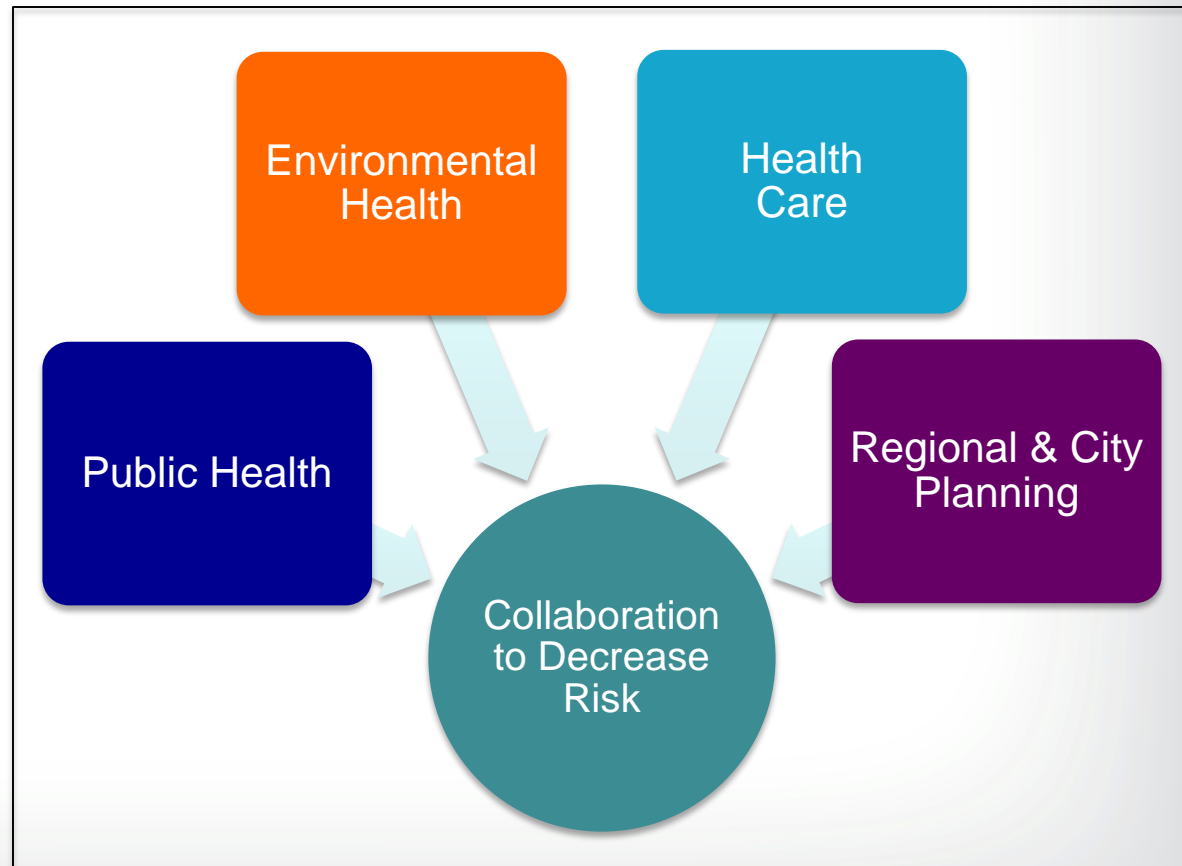
**CONCLUSIONS AND RELEVANCE** Deceleration in the decline of all CVD, HD, and stroke mortality rates has occurred since 2011. If this trend continues, strategic goals for lowering the burden of CVD set by the American Heart Association and the Million Hearts Initiative may not be reached.

*JAMA Cardiol.* doi:10.1001/jamacardio.2016.1326  
Published online June 29, 2016.



# Public Health Action Needed along with EPA Standards

- *EPA's PM air pollution standards provide the largest health benefits of any federal regulation*
- *Greater engagement of*
  - *Healthcare system will better help communities and individuals address environmental health risks*





- **Air pollution adversely affects:**
  - Health, Wellbeing, Longevity, and Resources
- **Most healthcare professionals & patients at-risk know of air pollution's adverse health effects**

*Despite Knowledge of the Risks the Healthcare System is Not Engaged*

- **Few healthcare professionals discuss the risks with their patients**
- **At-risk patients don't take action to reduce exposure**



# *The World is Changing:* Opportunities to Improve Health

- **Health Care Reform**
  - Value-based payment
  - Electronic health records
  - Accountable care organizations
  - Focus on quality metrics & costs
    - Community benefits programs
    - Medicare/Medicaid (CMS)
  - Hospital readmissions reduction program
- **Predictive risk models & population health surveillance**
- **Environmental and physiological sensors**



# Populations at Higher Risk

## Air Pollution and Readmissions

### EPA – Sensitivity to PM Air Pollution

*Populations showing increased sensitivity include those having:*

#### ✧ Cardiovascular disease

- Ischemic heart disease

- Heart failure

- Ventricular arrhythmia

#### ✧ Pulmonary disease

- COPD

#### ✧ Diabetes

### CMS Readmission Reduction Program

*Conditions evaluated for excess readmissions:*

#### ✧ Cardiovascular disease

- Acute myocardial infarction

- Heart failure

#### ✧ Pulmonary disease

- COPD

#### ✧ Pneumonia

#### ✧ Hip and/or Knee Arthroplasty



[www.epa.gov/healthyheart](http://www.epa.gov/healthyheart)

## Approach:

- Encourage adherence to secondary preventions guidelines
- Provide an environmental health message for patients who at high-risk for adverse cardiopulmonary outcomes from air pollutant exposure to limit exposure to PM

## Goal:

- Decrease vascular and arrhythmic events, improve overall cardiovascular health and wellbeing and lower healthcare expenditures





# Examples of Products Engaging the Public

**Local Air Quality Conditions**  
 Zip Code:  Go State: Alabama  Go My Current Location

**Forecast** **Current AQI** **AQI Loop** **More Maps**

**Today's AQI Forecast**  
 Saturday, June 17, 2017

**Fires: Current Conditions**  
 Click to see map

**U.S. Embassies and Consulates**  
 Data from air quality monitors at select U.S. embassies and consulates around the world

**Announcements**  
 6/15/17: National Air Quality Conference, September 11-13, 2017. Registration Now Open and Call for Presentations  
 6/7/17: 2017 Air Quality Flag Program Spring Challenge Winners. More  
 more announcements

**Air Quality Basics**  
 Air Quality Index | Ozone | Particle Pollution | Smoke from Fires | Other New Can Do

**EPA** United States Environmental Protection Agency

Environmental Topics | Laws & Regulations | About EPA

Search EPA.gov

Related Topics: Air Research

**Healthy Heart Toolkit and Research: Steps You Can Take**

Steps You Can Take to Reduce Health Effects from Air Pollution

CONTACT US | SHARE

**Particle Pollution and Your Patients' Health**

Helps health care providers advise their patients about particle pollution exposure.

This course is designed for family medicine physicians, internists, pediatricians, occupational and rehabilitation physicians, nurse practitioners, nurses, asthma educators, pulmonary specialists, cardiologists, and other medical professionals.

[Start the Course](#)

Course developers

**Healthy Heart**

A healthier environment for healthier hearts

Studies show that air pollution can trigger heart attacks, stroke, and other health effects. If you have a pre-existing heart condition, you are at risk for these conditions. If you have a family history of heart disease, you are also at risk for these conditions.

When are air pollution levels most likely to be high?

- Any time of year
- When weather is calm
- Near busy roads
- In urban areas
- In industrial areas
- When there is no wind

**EnviroFlash**

Current Location

Zip Code: 27707

The Air Quality Index (AQI) for Raleigh-Durham-Chapel Hill

Current: 2/6/2013 8:00 PM EST

Pollutant: PM2.5

Current: 2/6/2013 8:00 PM EST

Pollutant: OZONE

40 Good

23 Good

**EPA** United States Environmental Protection Agency

**AMERICAN COLLEGE of CARDIOLOGY**

**American Heart Association**

**Heart Disease, Stroke, and Outdoor Air Pollution**

1 Did you know that air pollution can trigger heart attacks, stroke, and other health effects?

Medical studies show that air pollution can trigger heart attacks, stroke, and irregular heart rhythms—especially in people who are already at risk for these conditions. Also, for people with a medical condition called heart failure, air pollution can further reduce the ability of the heart to pump blood the way that it should. Very small particles are the pollutants of greatest concern for triggering these effects. Particle pollution is found in haze, smoke, and dust—and sometimes in air that looks clean. This fact sheet tells you how you can:

3 How can you protect your health?

- Get up-to-date information about your

**Air Sensor** Citizen Science Toolbox

Measure · Learn · Share

**Air Sensor Guidebook**

**Efectos de los Contaminantes Comunes del Aire**

**EFFECTOS RESPIRATORIOS**

**EFFECTOS CARDIOVASCULARES**

Como los contaminantes causan sintomas

Como los contaminantes pueden causar sintomas

Reduce su riesgo, usando el Índice de Calidad del Aire (AQI) por sus signos en inglés: [signos en español](#) | [signos en español](#)

Medios de calidad del aire y su impacto en la salud	Valores del Índice	Qué significa para su salud
Buena	0-50	El aire es satisfactorio. La contaminación no representa un problema de salud.
Mediana	51-100	Personas con problemas de salud pueden experimentar molestias. El AQI de 100 indica que la contaminación puede ser un problema de salud para algunas personas que son especialmente sensibles a la contaminación del aire.
Deficiente para la salud	101-150	Grupos sensibles pueden experimentar molestias de salud. La contaminación puede ser un problema de salud para algunas personas que son especialmente sensibles a la contaminación del aire.
Deficiente para la salud	151-200	Salud de grupos sensibles puede verse afectada. La contaminación puede ser un problema de salud para algunas personas que son especialmente sensibles a la contaminación del aire.
Muy deficiente para la salud	201-300	Salud de grupos sensibles puede verse afectada. La contaminación puede ser un problema de salud para algunas personas que son especialmente sensibles a la contaminación del aire.

*OPD's Social-Environmental Science Exchange:*

Social Environmental Dialogues

Pilot 1: Collaboration & Coordination of Public Health Approaches and Integrating Environmental Health



- EPA's contributes the **Healthy Heart** program*
- *to the National Prevention Strategy*
  - *and the fight against heart attacks and strokes*



# HHS' Million Hearts<sup>®</sup> 2022 *Priorities*

## Keeping People Healthy

Reduce Sodium Intake

Decrease Tobacco Use

Increase Physical Activity

## Optimizing Care

Improve ABCS\*

Increase Use of Cardiac Rehab

Engage Patients in  
Heart-healthy Behaviors

## Improving Outcomes for Priority Populations

Blacks/African Americans

35- to 64-year-olds

People who have had a heart attack or stroke

People with mental illness or substance use disorders

\*Aspirin when appropriate, Blood pressure control, Cholesterol management, Smoking cessation



***Joint initiative of CMS and CDC***

## Support includes: Counseling on risks of particulate matter

Goals	Effective Health Care Strategies
<p><b>Improve ABCS*</b> Targets: 80%</p>	<p><i>High Performers Excel in the Use of...</i></p> <ul style="list-style-type: none"> <li>• <b>Technology</b>—decision support, patient portals, e- and default referrals, registries, and algorithms to find gaps in care</li> <li>• <b>Teams</b>—including pharmacists, nurses, community health workers, and cardiac rehab professionals</li> </ul>
<p><b>Increase Use of Cardiac Rehab</b> Target: 70%</p>	<ul style="list-style-type: none"> <li>• <b>Processes</b>—treatment protocols; daily huddles; ABCS scorecards; proactive outreach; finding patients with undiagnosed high BP, high cholesterol, or tobacco use</li> </ul>
<p><b>Engage Patients in Heart-healthy Behaviors</b> Targets: TBD</p>	<ul style="list-style-type: none"> <li>• <b>Patient and Family Supports</b>—training in home blood pressure monitoring; problem-solving in medication adherence; <b>counseling on</b> nutrition, physical activity, tobacco use, <b>risks of particulate matter</b>; referral to community-based physical activity programs and cardiac rehab</li> </ul>

\*Aspirin when appropriate, Blood pressure control, Cholesterol management, Smoking cessation





# Improving Outcomes for Priority Populations



Priority Populations	Major Strategies
<b>Blacks/African Americans</b>	Improving hypertension control
<b>35- to 64-year-olds, because event rates are rising</b>	<ul style="list-style-type: none"><li>• Improving hypertension control and statin use</li><li>• Increasing physical activity</li></ul>
<b>People who have had a heart attack or stroke</b>	<ul style="list-style-type: none"><li>• Increasing cardiac rehab referral and participation</li><li>• <b>Avoiding exposure to particulate matter</b></li></ul>
<b>People with mental illness or substance use disorders</b>	Reducing tobacco use



# The Environmental “Buckets” of Prevention Framework

## Total Population Community-Wide Prevention

**NAAQS  
Built-  
Environment  
Health Literacy**

## Innovative Clinical Prevention



## Traditional Clinical Prevention

**“evidence-based”  
clinical prevention  
management  
strategies**

- Attain & maintain NAAQS Stds
- Improve built-environment:
  - Places for physical activity
  - Create healthier near-road environments
- Improve overall CV health status

- Optimize clinical care of the at-risk priority population
- Increase awareness of health effects of PM among physicians, health care professionals, and the at-risk population
- Provide guidance to lower exposure & associated risk

- Long-term indoor air filtration lowered markers of oxidative stress and inflammation (*Chuang H-C, et al. Environ International 2017*)

**Public Health**

**Health Care**



# Moving to the Future

## ENVIRONMENTAL Science & Technology

Policy Analysis

pubs.acs.org/est

### Forecast-Based Interventions Can Reduce the Health and Economic Burden of Wildfires

Ana G. Rappold,<sup>\*,†</sup> Neal L. Fann,<sup>‡</sup> James Crooks,<sup>†</sup> Jin Huang,<sup>§</sup> Wayne E. Cascio,<sup>†</sup> Robert B. Devlin,<sup>†</sup> and David Diaz-Sanchez<sup>†</sup>

### Forecast-based interventions predicted to reduce the health and economic burden of wildfires

Rappold AG, et al.  
*Environ Sci Technol* 2014

**Cost effectiveness is improved by intervening only in the homes of those at highest risk, e.g. older persons**

### Health benefits and costs of filtration interventions that reduce indoor exposure to PM2.5 during wildfires

*Indoor Air* 2017; 27: 191–204  
wileyonlinelibrary.com/journal/ina  
Printed in Singapore. All rights reserved

**Abstract** Increases in hospital admissions and deaths are associated with increases in outdoor air particles during wildfires. This analysis estimates the health benefits expected if interventions had improved particle filtration in homes in Southern California during a 10-day period of wildfire smoke

**W. J. Fisk, W. R. Chan**

Indoor Environment Group, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Fisk WJ, Chan WR *Indoor Air* 2017

VIEWPOINT

### The Global Threat of Outdoor Ambient Air Pollution to Cardiovascular Health Time for Intervention

Robert D. Brook, MD

**Anthropogenic ambient fine particulate matter** less etal air pollution problem appears to be

**“... we believe that the time is ripe to definitively test the efficacy of personal-level interventions...”**

Brook RD, et al.  
*JAMA Cardiol.* 2017

- **Particle pollution increases short- and long-term pulmonary & cardiovascular morbidity & mortality**
- **Improvements in air pollution levels reduce health impacts and increase life expectancy**
- **Many regions of US fail to meet EPA standards**
- **Older-people, those with pre-existing heart & lung disease, & diabetes are at higher risk from air pollution**

- **High-risk patients should be educated about risks of air pollution and educated about measures to reduce exposure**
- **Randomized controlled trials are needed to prove effectiveness of interventions to reduce exposure**
- **Health risks need to be addressed through integrated efforts of public health and health care at the community and individual level**
- **Decreased short-term exposure in high patients is predicted to mitigate adverse health effects**

# Thank you

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