Obesity and Air Pollution:

Sensitive Populations in the National Ambient Air Quality Standards and Why a Public Health Perspective Matters

Trish Koman and Peter Mancuso
University of Michigan, School of Public Health

APHA PRESENTATION

Presenter Disclosures

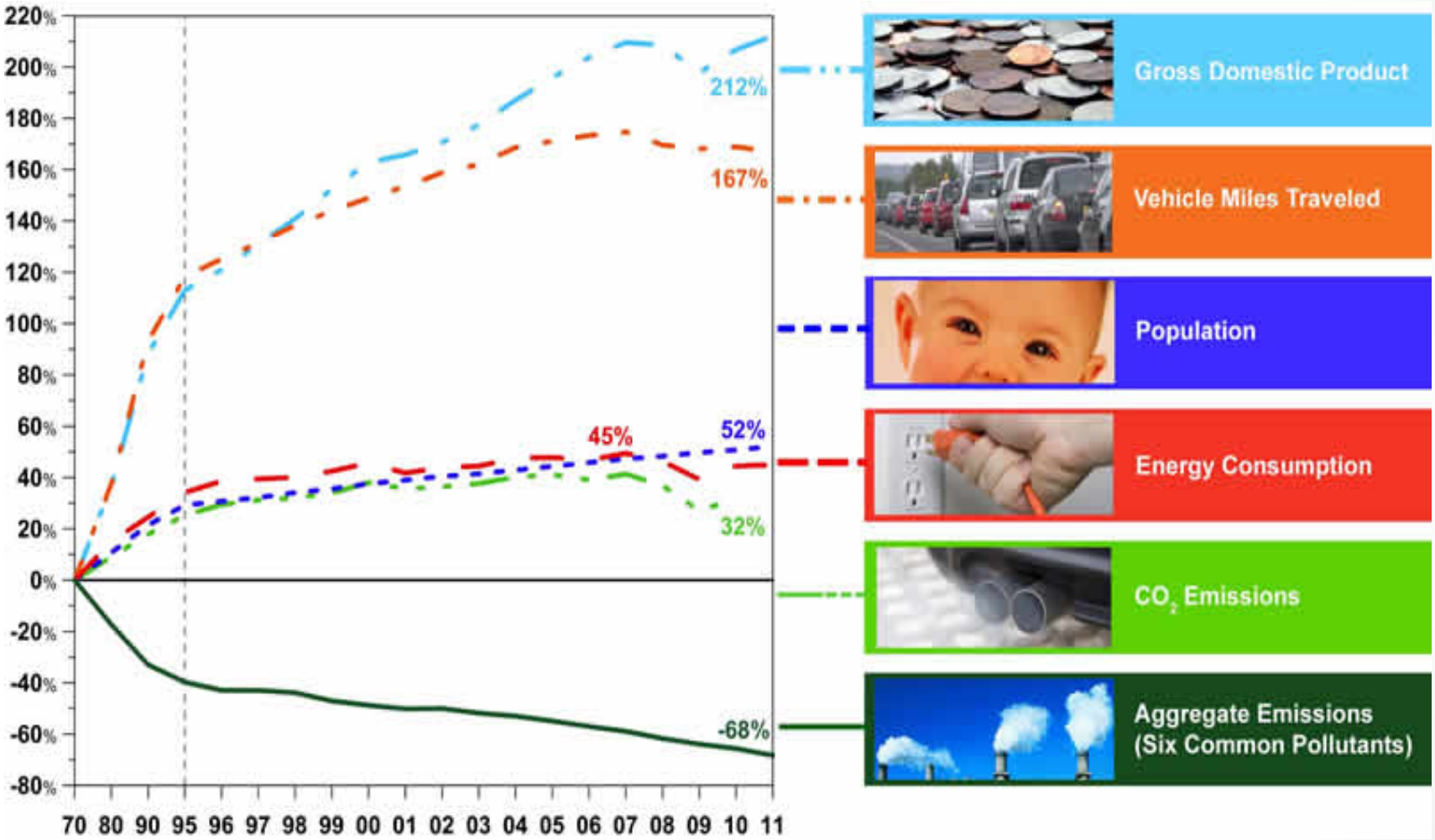
Trish Koman

I have no personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months.

Are the benefits of the Clean Air Act afforded to all at-risk groups?

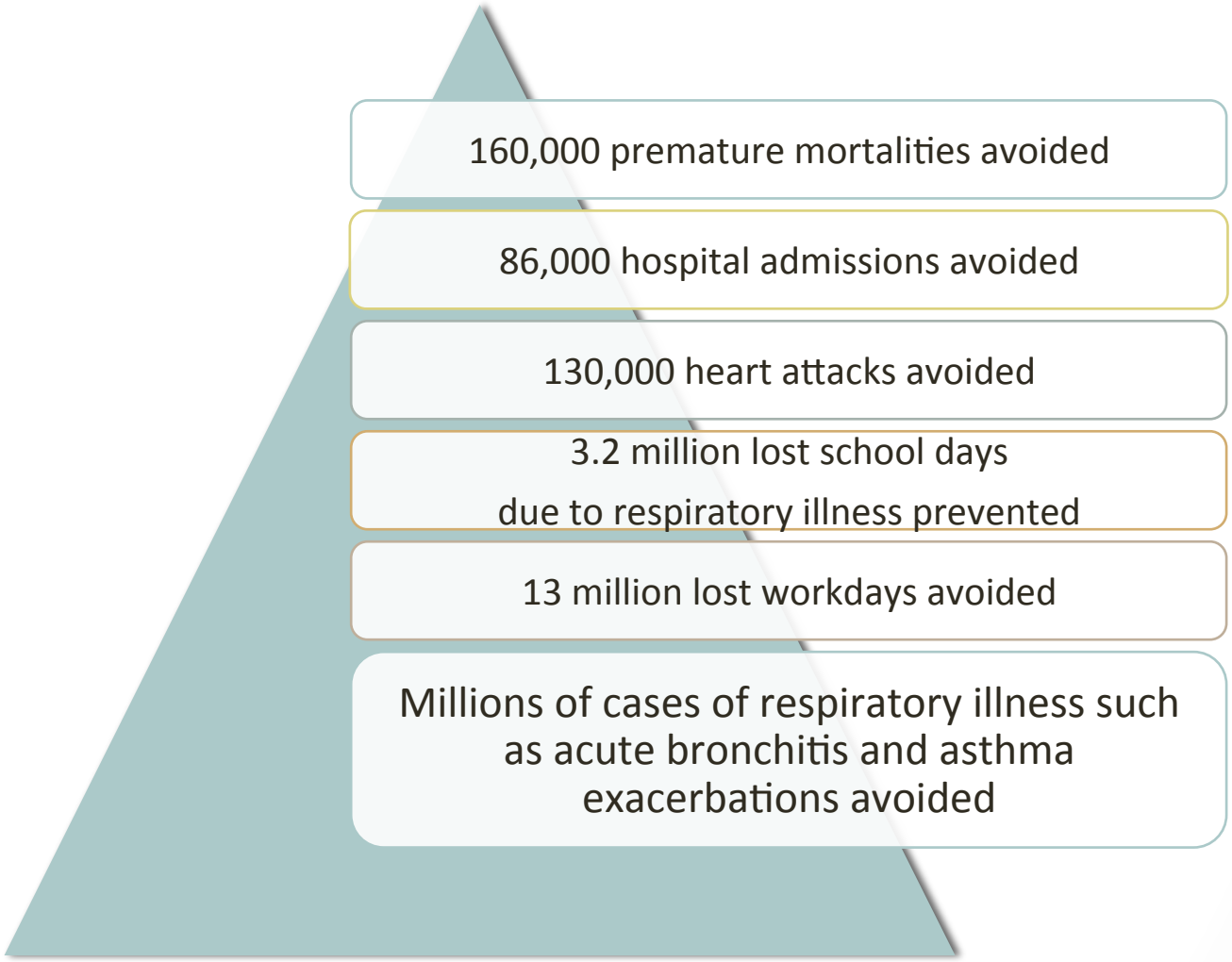
- Clean Air Act
- Expert group statements
- Obesity trends
  - Pulmonary health of obese population
- Is EPA protecting public health with adequate margin of safety?
  - Designation of at-risk

Clean Air Act Benefits



Source: U.S. EPA, *The Benefits and Costs of the Clean Air Act from 1990 to 2020: Final Report,* Office of Air and Radiation, March 2011.

Health Benefits of Clean Air Act



Source: U.S. EPA, *The Benefits and Costs of the Clean Air Act from 1990 to 2020: Final Report,* Office of Air and Radiation, March 2011.

Margin of Safety

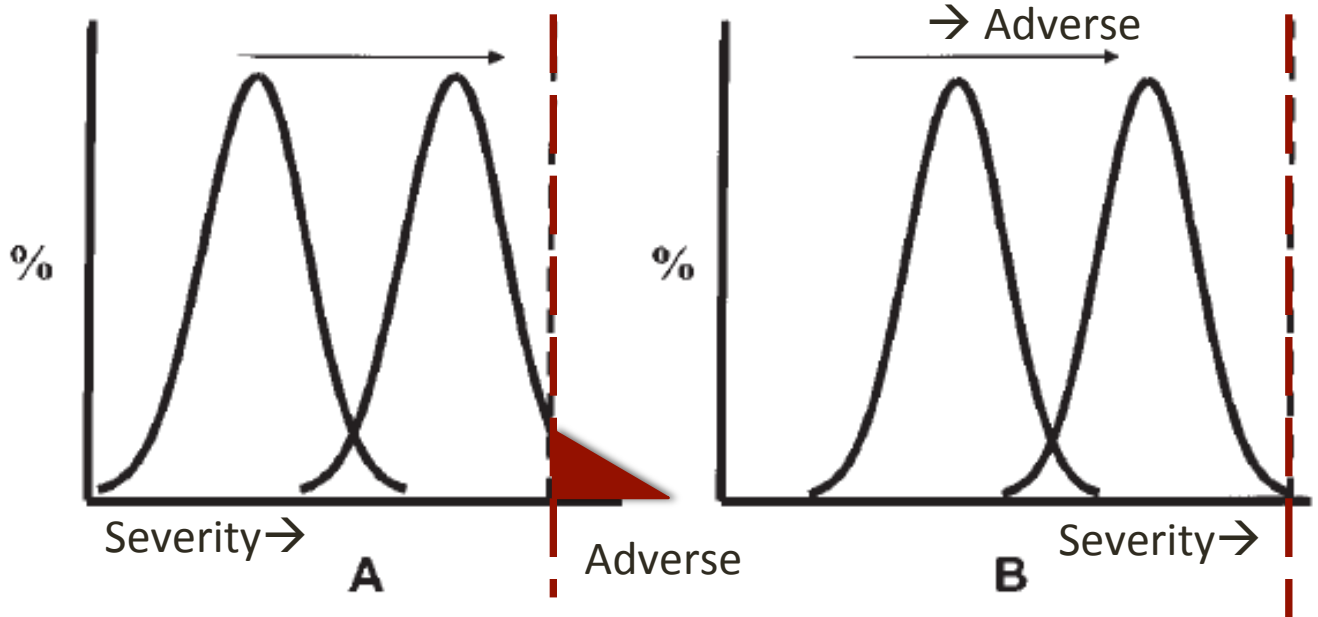
- The EPA Administrator is to consider
  - Nature and severity of the health effects,
  - Size of sensitive populations at risk, and
  - Uncertainties about the data.

- Sensitive at-risk populations are at the heart of the protection of the standards

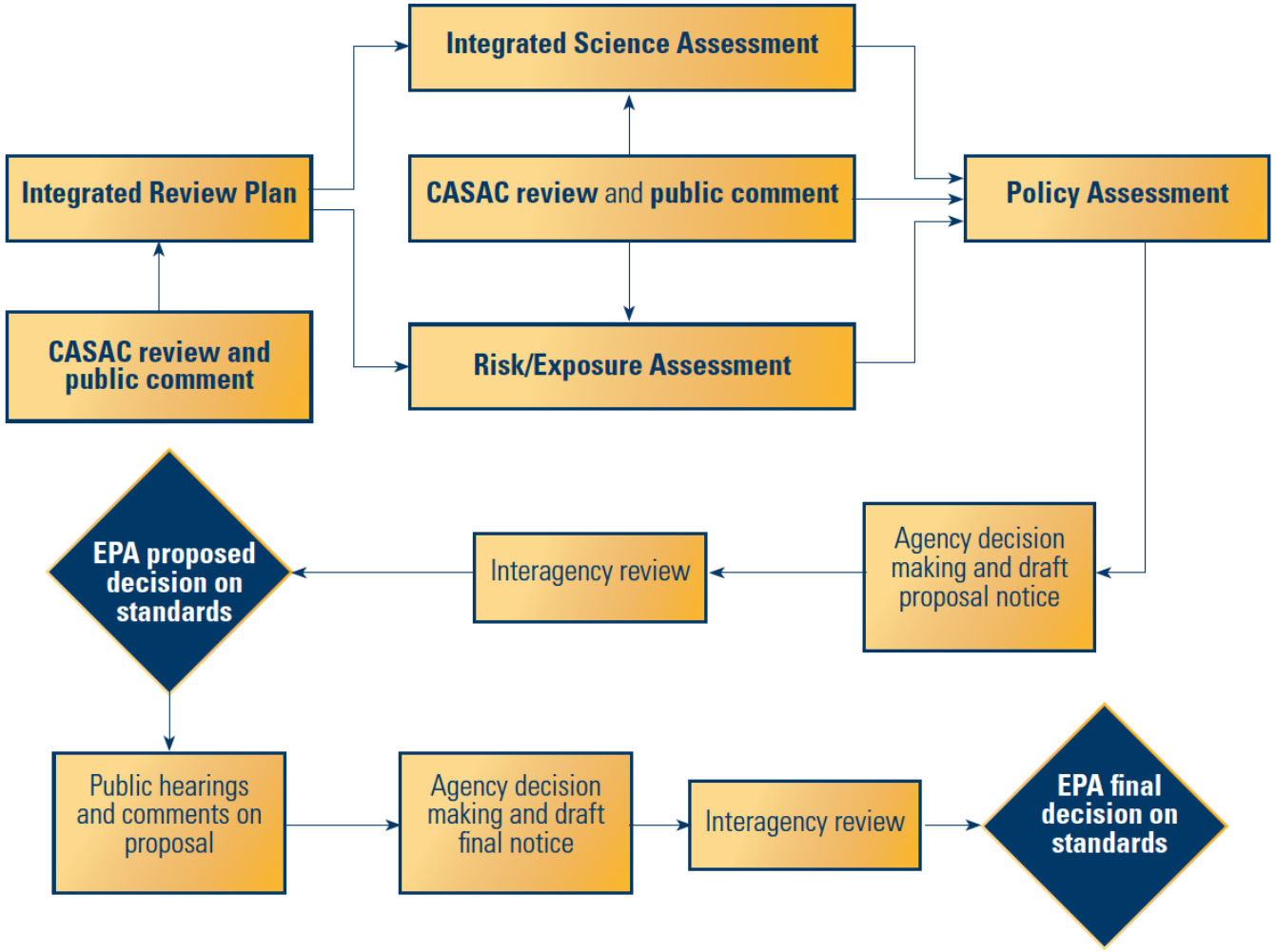
Public Health Perspective

"Exposure could also enhance risk for a population to an unacceptable degree, perhaps without shifting the risks of any particular individuals to an unacceptable level."

American Thoracic Society (2000). What constitutes an adverse health effect of air pollution? Official statement of the American Thoracic Society. *Journal of Respiratory & Critical Care Medicine*, *161*(2 Pt 1), 665–73.



EPA's NAAQS Review Process



U.S. Environmental Protection Agency Administrator Lisa Jackson memorandum, "Process for Reviewing National Ambient Air Quality Standards," May 21, 2009

"At-Risk" Population Selection Criteria

Based on the 2012 PM review, EPA presents four ways to consider an at-risk population for consideration in the margin of safety:

1. Higher exposures of pollution
2. Higher dose for a given ambient concentration
3. More responsive to the same dose or
4. Diminished reserve pulmonary function and would be at increased risk to further insult from pollution or other factors.

For Ozone 2013 and forward, only first 3 criteria are considered.

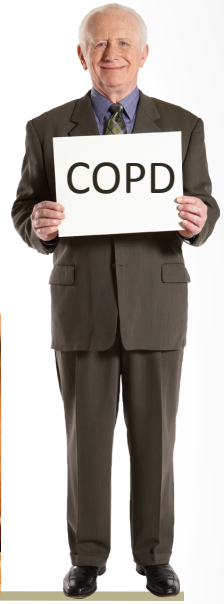
"At-Risk" Sensitive Populations

- Previous (PM 2012 & before)
  - Sensitive "at-risk" or normal

- Revised (Ozone 2013 & on)
  - Adequate evidence
  - Suggestive evidence
  - Inadequate evidence
  - Evidence of no effect

PM Sensitive Populations

- Elderly
- Pre-Existing Heart & Lung Conditions
- Children



Obese populations considered by EPA for cardiac but not pulmonary susceptibility for PM

EPA considered pregnant women, gender, race/ethnicity and socioeconomic status

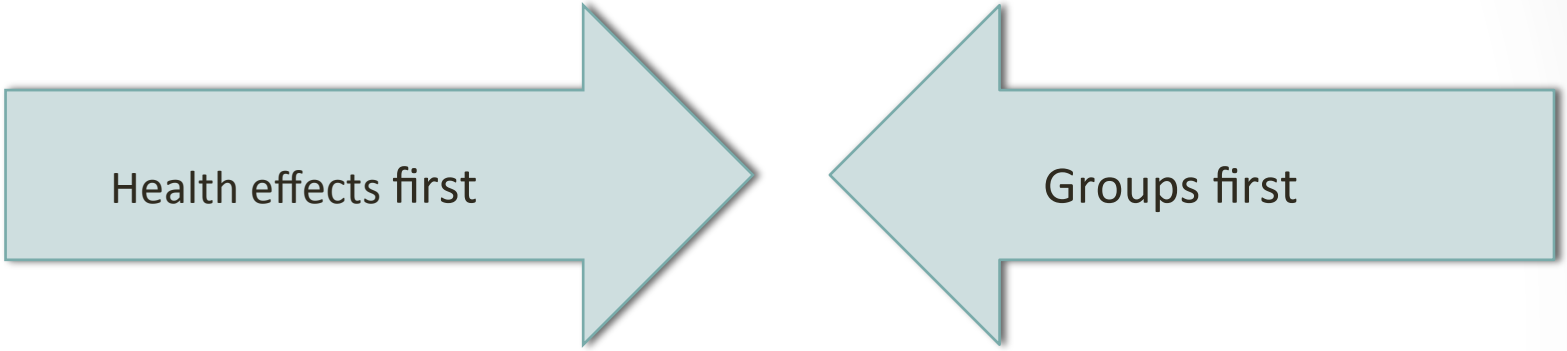
Sensitive Populations Evaluated for Ozone

- Genetic factors
- Pre-existing diseases
  - Asthma
    - COPD
    - Emphysema
    - Cardiovascular
    - Hypertension
    - Diabetes
    - Hyperthyroidism
    - Influenza/infections
- Diet

- Children
- Seniors > 65
- Smokers
- Outdoor workers (not athletes)
- Effect modifiers
  - Obesity (not overweight)
  - SES
  - Sex
  - Race/ethnicity

Adequate evidence Suggestive evidence

How does EPA identify at-risk populations?



Consider air pollution exposure & effects studies to develop candidates

Make a list of candidate sensitive groups & evaluate

First develop list of candidate "at-risk" populations

Information about population pulmonary and cardiac health status of candidate at-risk populations

Epidemiological studies of air pollution exposures and human health effects

Studies from animal models about air pollution exposures and health effects

Systematic reviews focus on air pollution studies

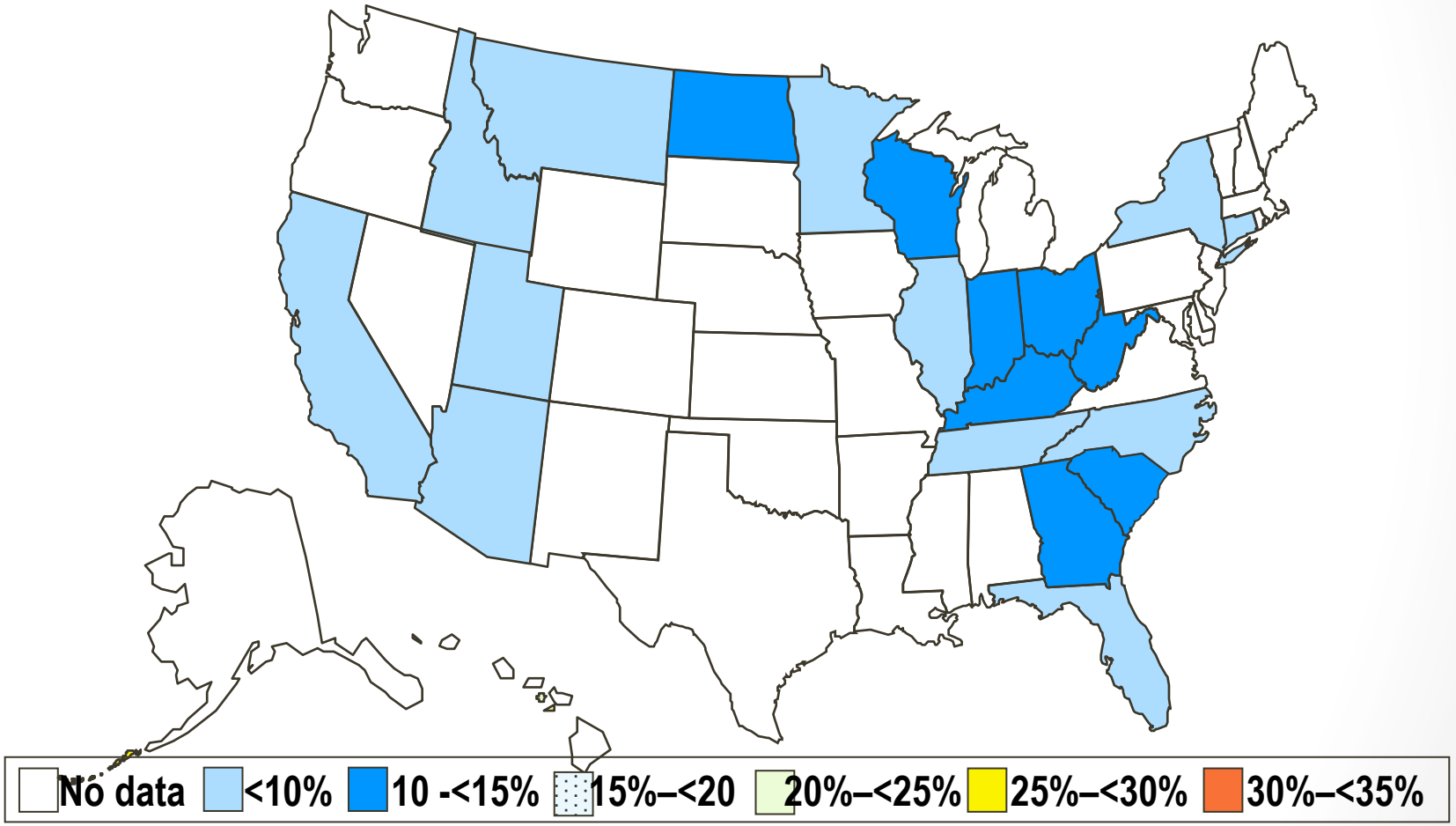
First consider health effects and then look at which groups were studied in epidemiological studies or animal models of air pollution exposures

Could miss groups that we suspect might be vulnerable to pollution but are not in the literature – e.g., pregnant women, infants, outdoor athletes, obese

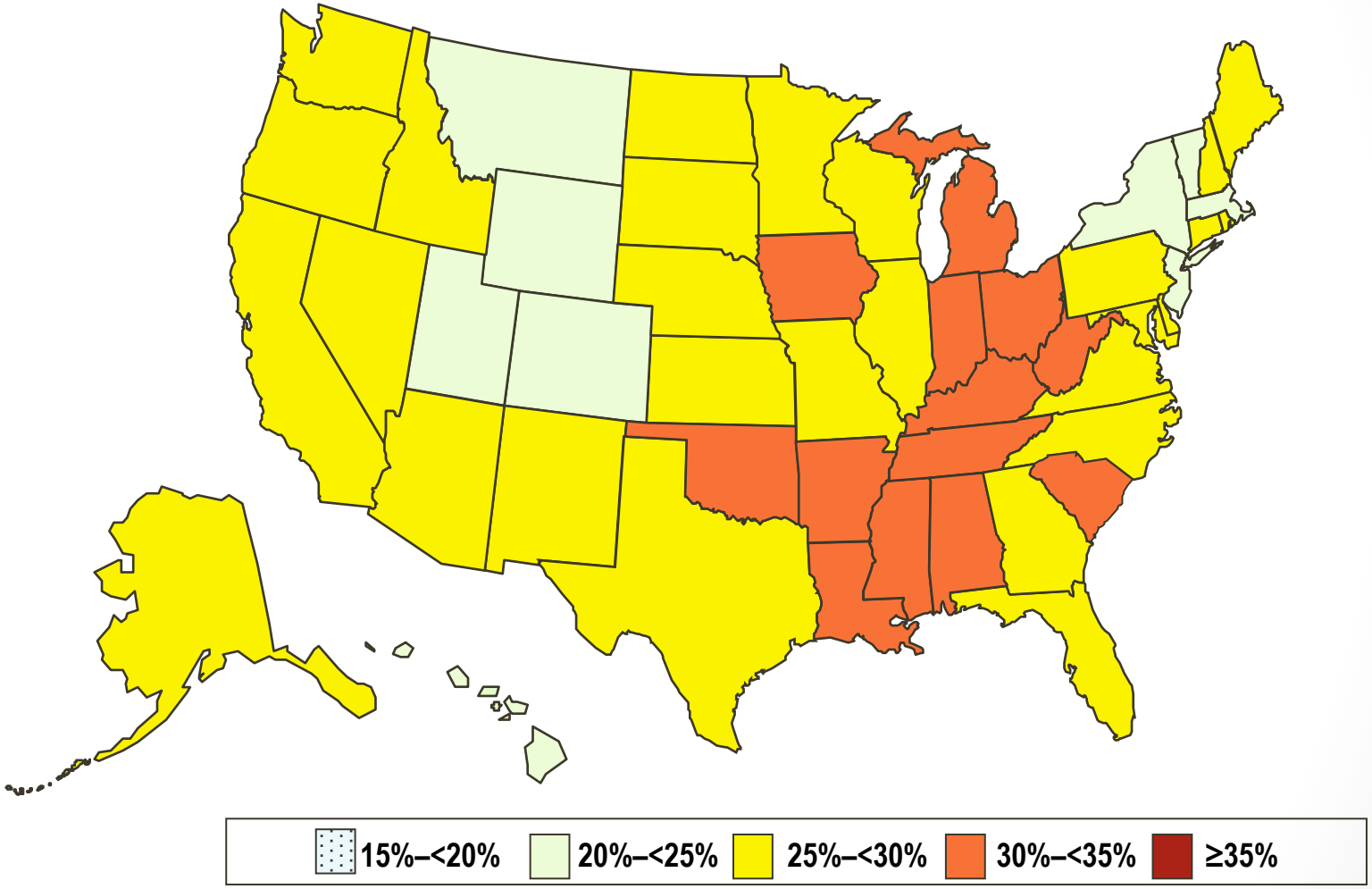
Obesity Prevalence map

OBESE POPULATION CASE STUDY

1985 Prevalence of Obesity (BMI > 30) in U.S. Adults

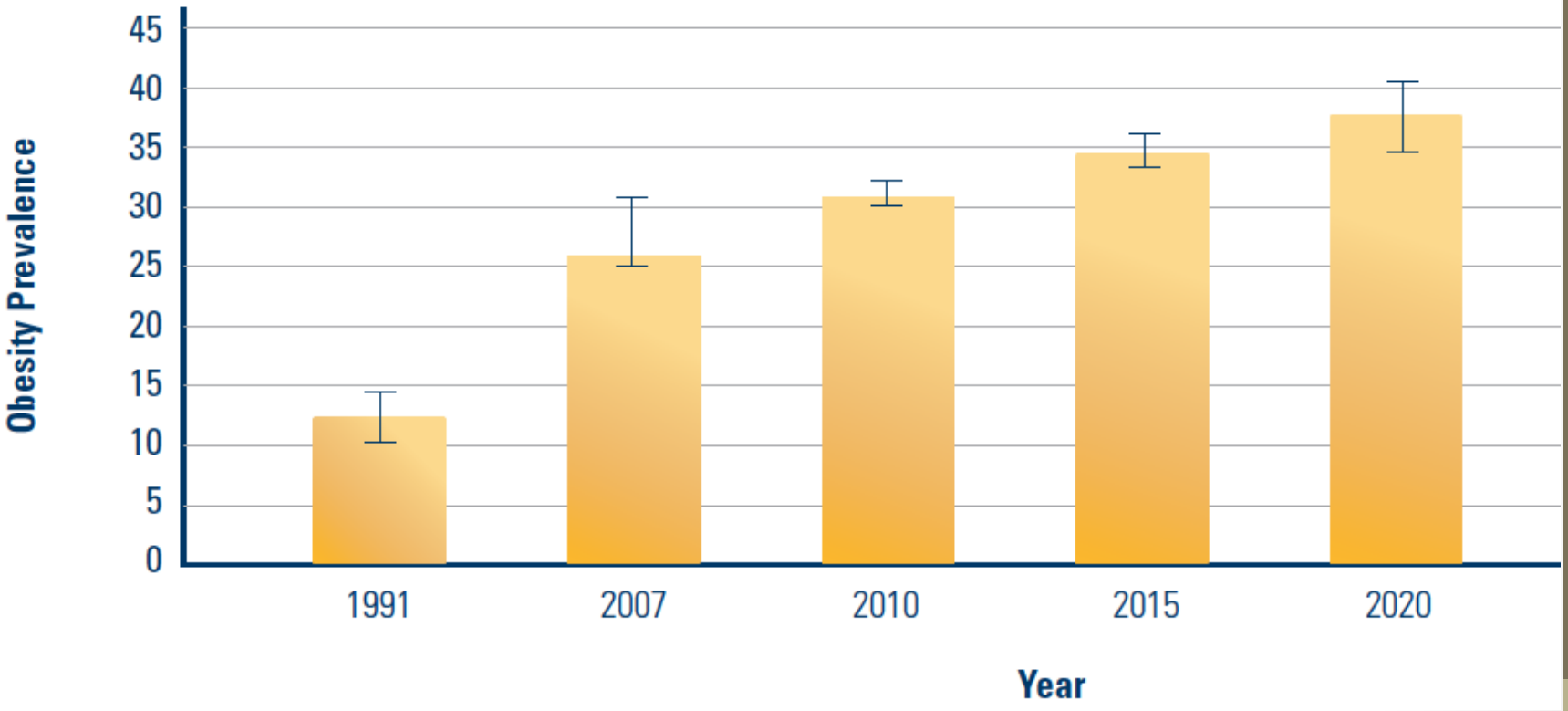


2012 Prevalence of Obesity in U.S. Adults



***Centers for Disease Control: Prevalence reflects BRFSS methodological changes in 2011, and these estimates should not be directly compared to those before 2011.**

Obesity Prevalence Trends among U.S. Adults



Sources of BRFSS prevalence data for 1991 (Mokdad & Serdula, 1999), for 2007 (Centers for Disease Control and Prevention, 2007), and for 2010, 2015, 2020 (Finkelstein et al., 2012)

Pulmonary status of obese & overweight populations

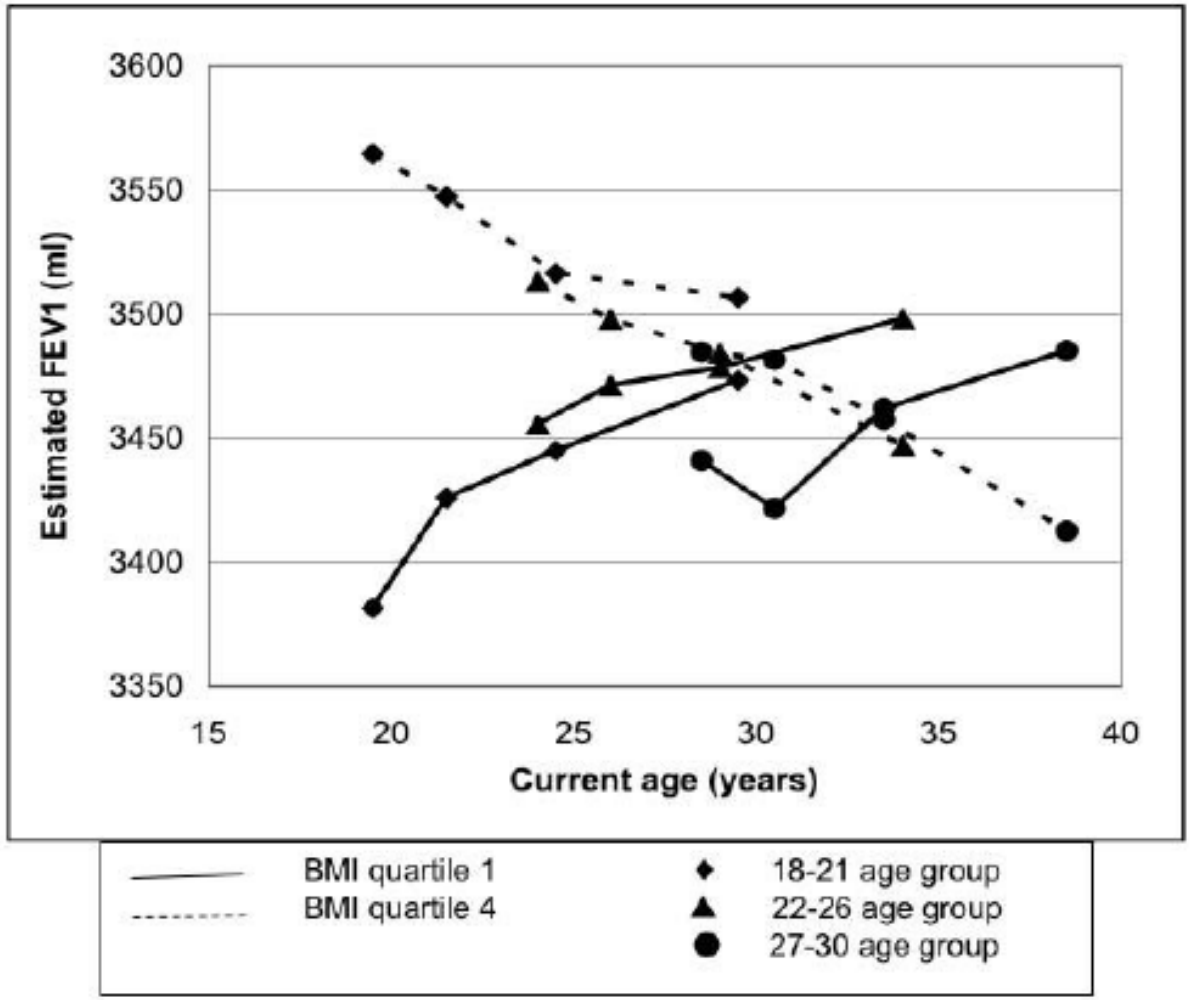
- Some obese have normal lung function
- Abdominal obesity
  - Impairs lung function
  - Effects on lung mechanics, the work of breathing and tidal volumes
- More chronic inflammation

Chen, Horne, & Dosman, 1993; Lin & Lin, 2012; Naimark & Cherniack, 1960; Thyagarajan, Jr, & Smith, 2010, Salome 2009, Wang et al 1997, Parameswaran et al., 2006; C. M. Salome, King, & Berend, 2010

Pulmonary status of obese (continued)

- Less functional residual capacity than healthy weight adults
- Negatively affects
  - Respiratory compliance
  - Lung volumes
  - Spirometric measures
  - Diffusing capacity and gas exchange
- More work required to maintain circulating oxygen levels
- Obesity linked to
  - Pulmonary embolism
  - Aspiration pneumonia
  - Asthma
  - Obstructive sleep apnea
  - Respiratory ailments

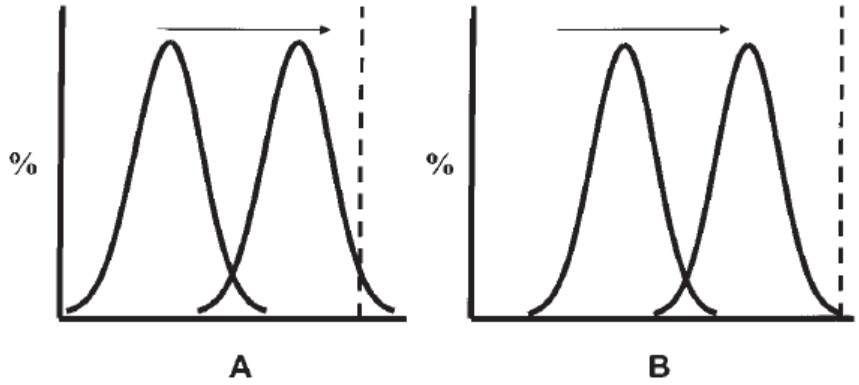
Obesity and lung health



Thyagarajan, et al. CARDIA Study, Respiratory Research 2008, 9:31

Sensitive Population Selection Criteria

1. Higher exposures of pollution
2. Higher dose for a given ambient concentration
3. More responsive to the same dose or
4. Diminished reserve pulmonary function and would be at increased risk to further insult from pollution or other factors.

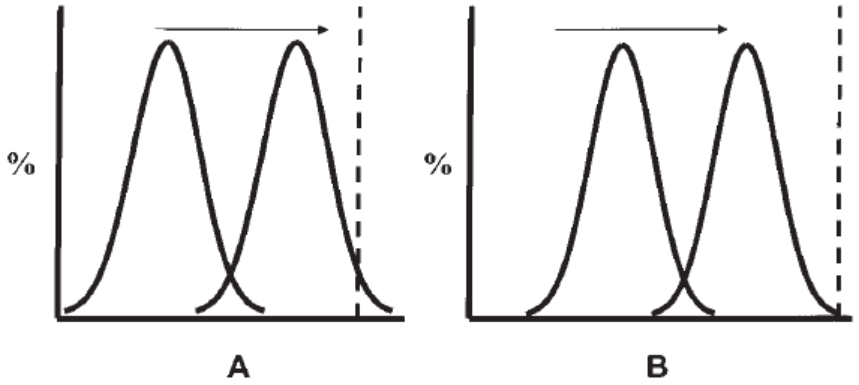


Obese: PM At-risk Population

- Independent cardiac and pulmonary risk from PM exposures
- Criteria #2: Higher PM dose rate in obese,
  - demonstrated in children (Bennett & Zeman, 2004)
  - higher tidal volume and resting minute ventilation as BMI increases (Lin & Lin, 2012, Sood, 2010)
- Criteria #3: More responsive (more severe outcome)
  - 4,664 non-elderly adults in SAPALDIA cohort (Schikowski et al. EHP 2013)
  - Normal weight improve in lung function with less PM-10
  - Obese “Little or no evidence of a beneficial effect” with less PM-10
- Criteria #4: Obese have compromised pulmonary function
  - In light of 30+ years of biomedical evidence

Ozone: Criteria for At-Risk Groups

- Existing studies evaluated by EPA against first three criteria
  - "Suggestive evidence"
- In light of 30+ years of evidence of pulmonary status of obese
- Apply ATS statement criteria



78 million adults

Conclusions

- Population public health perspective matters for Clean Air Act
  - Different conclusion of “at-risk” for PM and ozone
  - Underestimating benefits of air pollution control if concentration-response functions derived from normal weight cohorts applied to today’s population

- Next Steps
  - EPA should include American Thoracic Society criterion #4
    - Consider pulmonary status of obese populations
  - Time to update the ATS statement