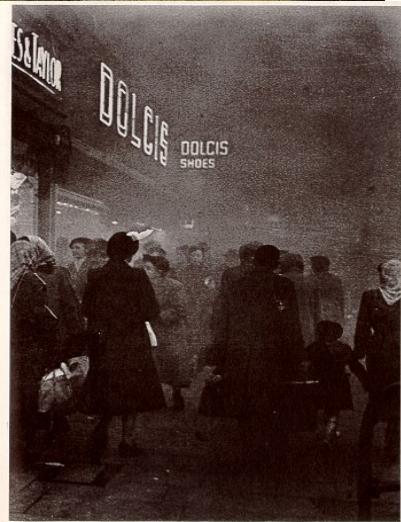


What We Know About Air Pollution and Its Health Impacts

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Ambient (Outdoor) Air Pollution

- Clean Air Act
 - Air monitoring, fuel and emissions standards
 - Major classes of pollutants regulated:
 - 187 hazardous air pollutants (air toxics)
 - 6 criteria air pollutants
 - Ozone-depleting pollutants



Air Toxics

- Hazardous Air Pollutants (HAPs)
- 187 chemicals
- “Pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects” - EPA
- E.g., benzene, polycyclic aromatic hydrocarbons (PAHs), formaldehyde, 1,3-butadiene, perchloroethylene, arsenic, mercury, etc.
- Fuel (diesel and gasoline) combustion, industrial processes, oil refineries, smelters



US EPA Criteria Pollutants:

SO₂

Sulfur Dioxide

NO_x

Nitrogen Oxides

CO

Carbon Monoxide

PM

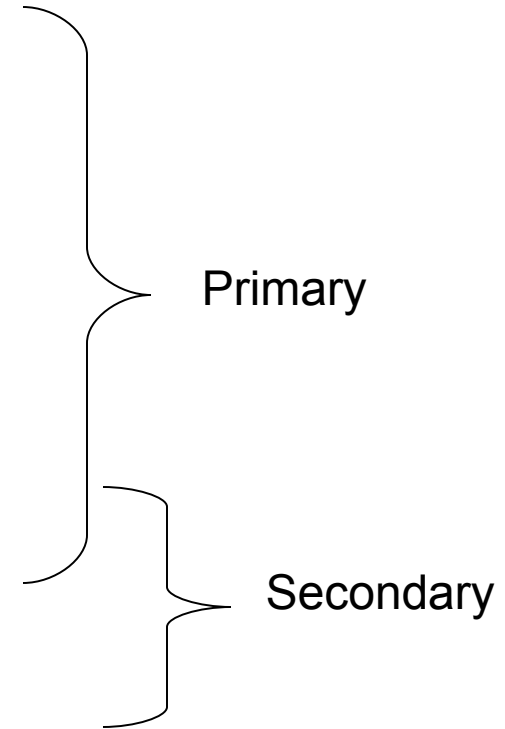
Particulate Matter

O₃

Ozone

Pb

Lead



Ozone formation

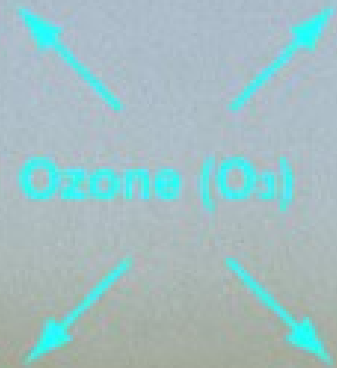
Sunlight



Oxygen (O_2) +
Volatile Organic Compounds (VOC) +
Nitrogen Oxides (NO_x)



Ozone (O_3)

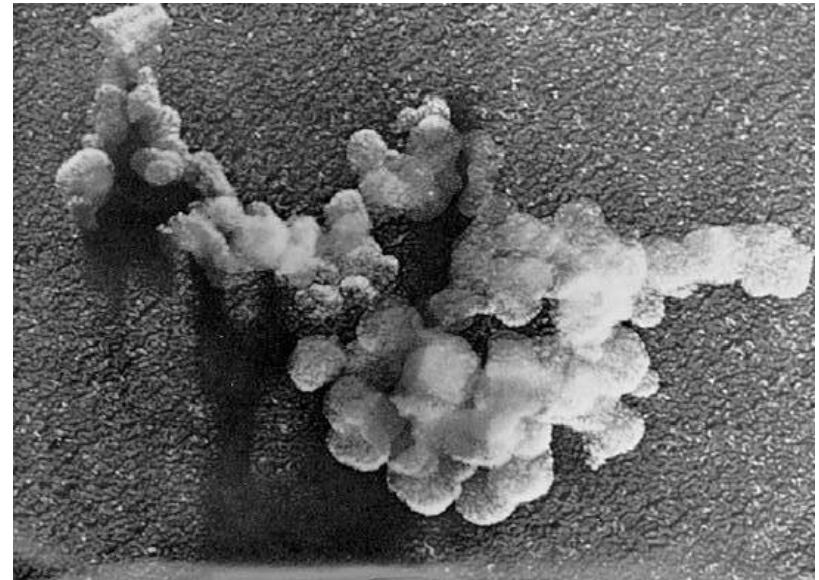


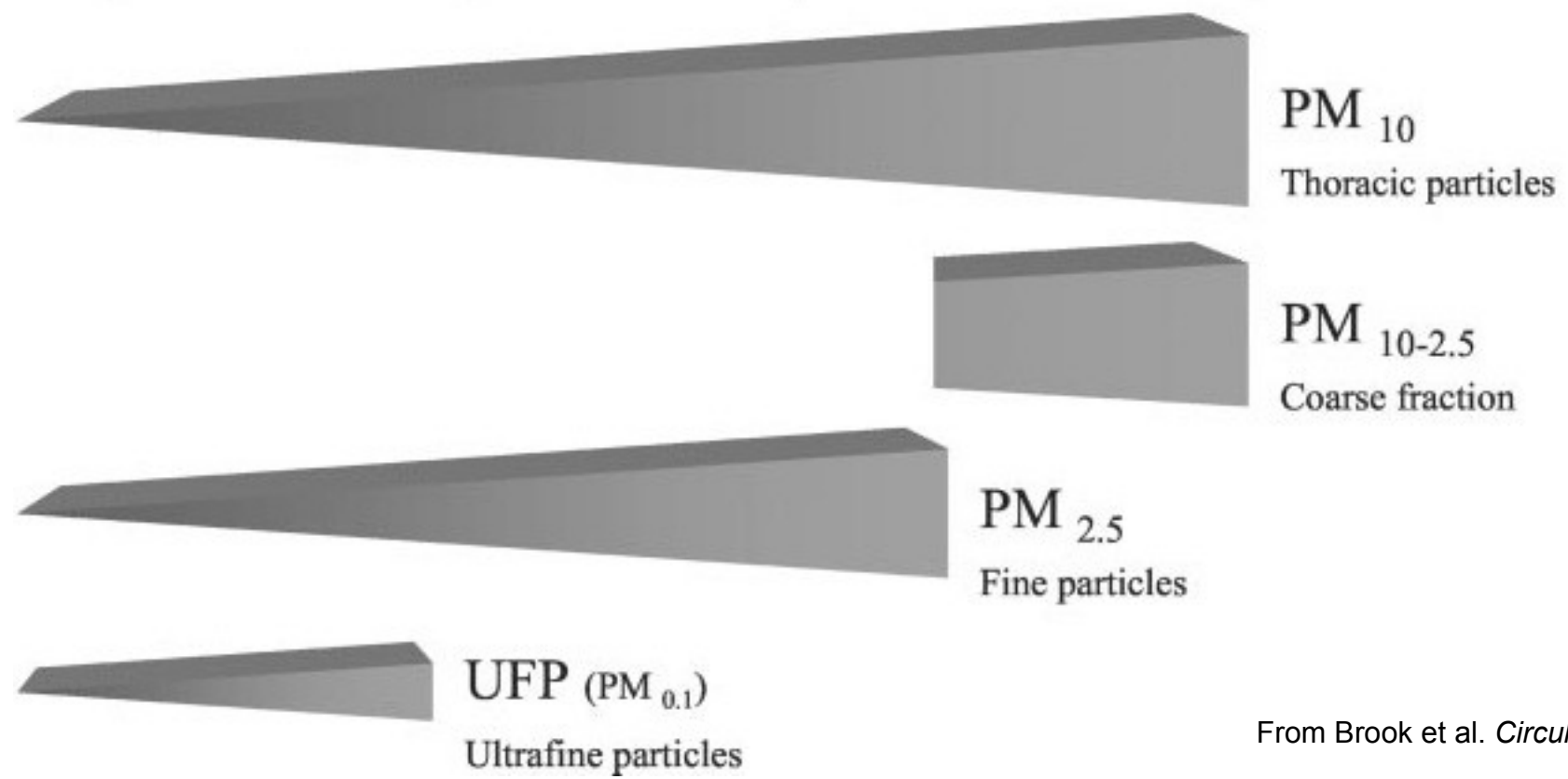
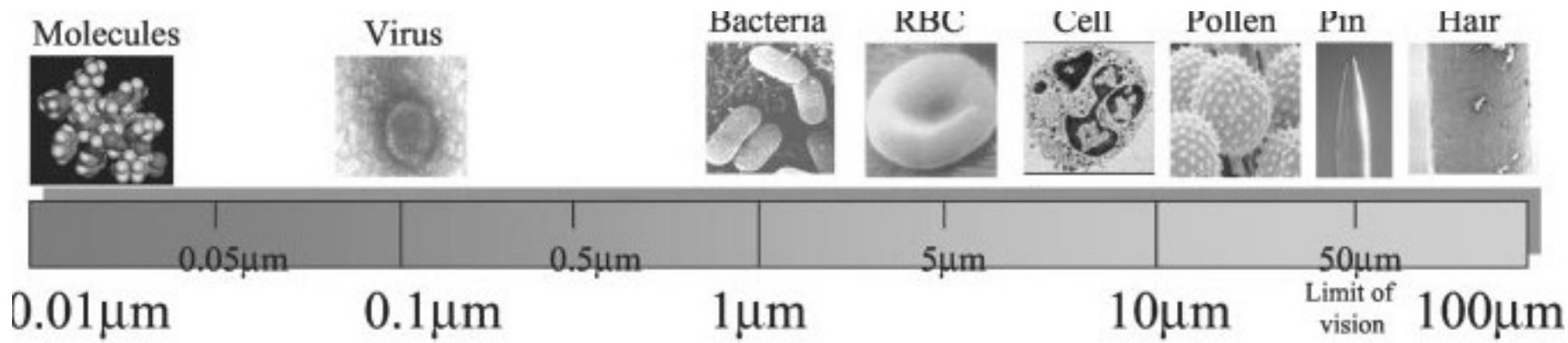
[www.greenfacts.org/ air-pollution/ozone-o3/](http://www.greenfacts.org/air-pollution/ozone-o3/)



Particulate Matter (PM)

- A mixture of solid and liquid particles/droplets
- Natural sources
 - Erosion, forest fires
- Anthropogenic sources
 - Industrial processes, fuel combustion, fugitive dust (paved, unpaved roads, construction, agriculture)





From Brook et al. *Circulation* 2004

Air pollution health effects

Respiratory

Coughing, wheezing,
reduced lung function

Reduced resistance
to infection

Exacerbation of
asthma, COPD

Lung cancer

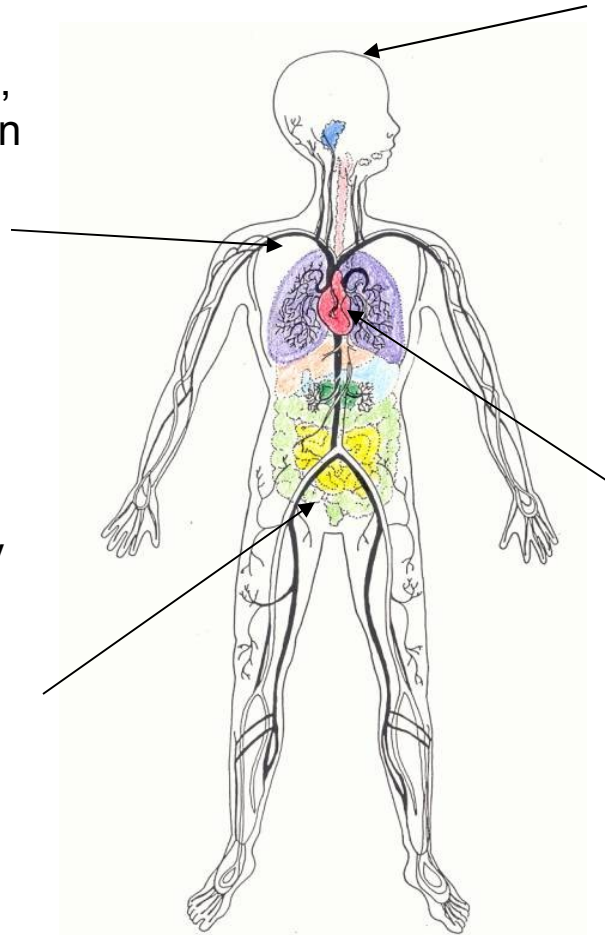
Respiratory mortality

Reproductive

Low birth weight

Preterm births and
intrauterine growth
retardation (?)

Birth defects (?)



Central Nervous

Cerebrovascular
impairment

Stroke

Neurodegenerative
disease?

Cardiovascular

Systemic inflammation

Autonomic system disorders

Atherosclerosis

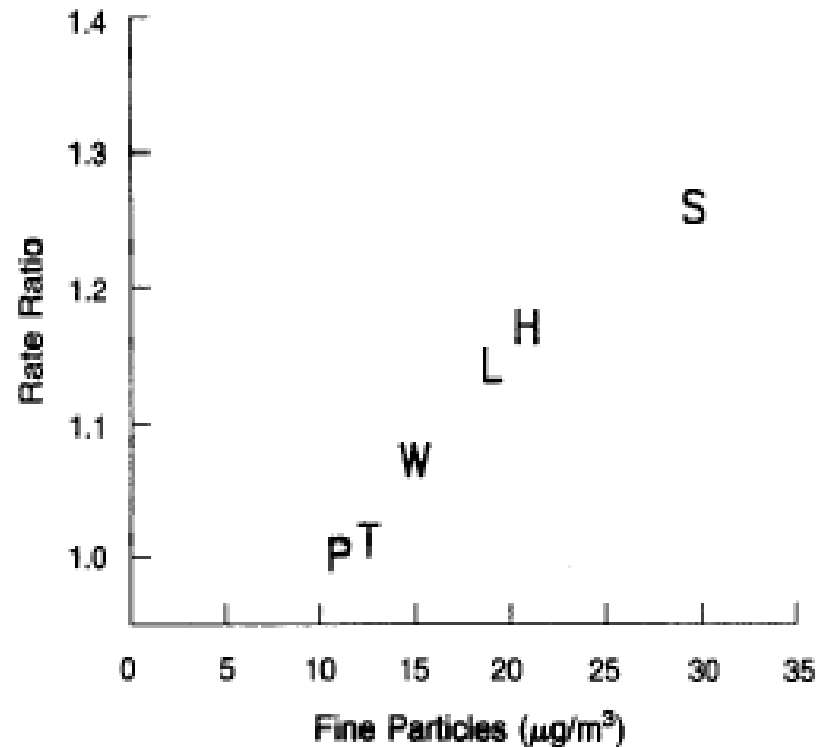
Myocardial infarctions

Cardiovascular mortality



Chronic Health Effects: Harvard Six Cities Study

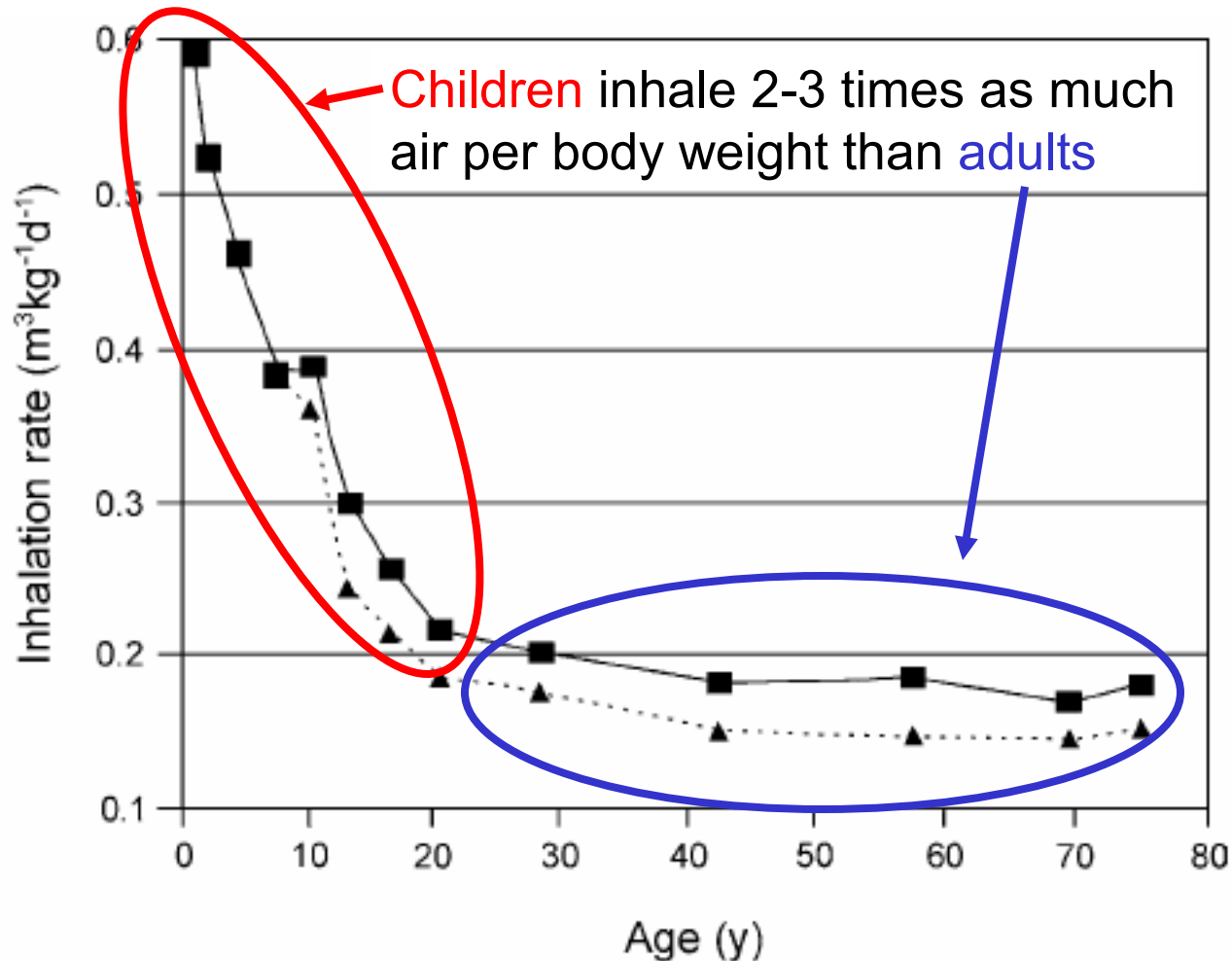
- Premature mortality
- 26% higher risk in Steubenville, OH vs. Portage, WI
- Shortened life expectancy 1-2 years



Dockery et al 1994



Children Are More Susceptible to Air Pollution



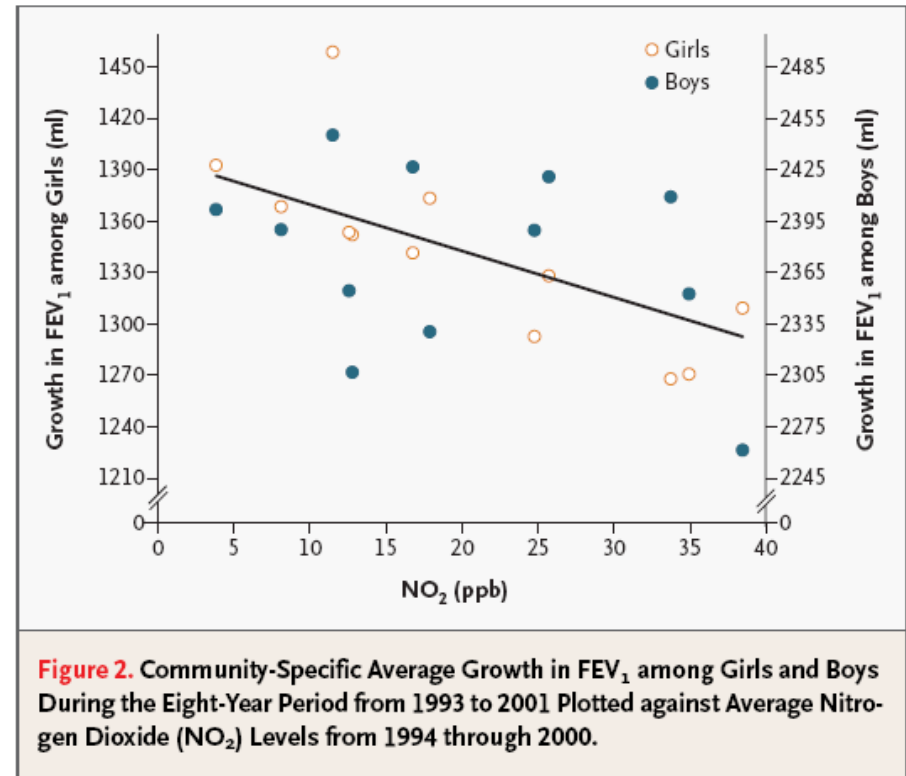
Source: EPA

Figure 9-23. Inhalation rates on a per body-weight basis for males (■) and females (▲) by age (Layton, 1993).



Chronic Health Effects: Lung development and pollution

- Children's Health Study
 - Children in California
 - 12 communities
 - Followed for 8 years
- NO₂ and fine PM related to deficits in FEV₁ growth



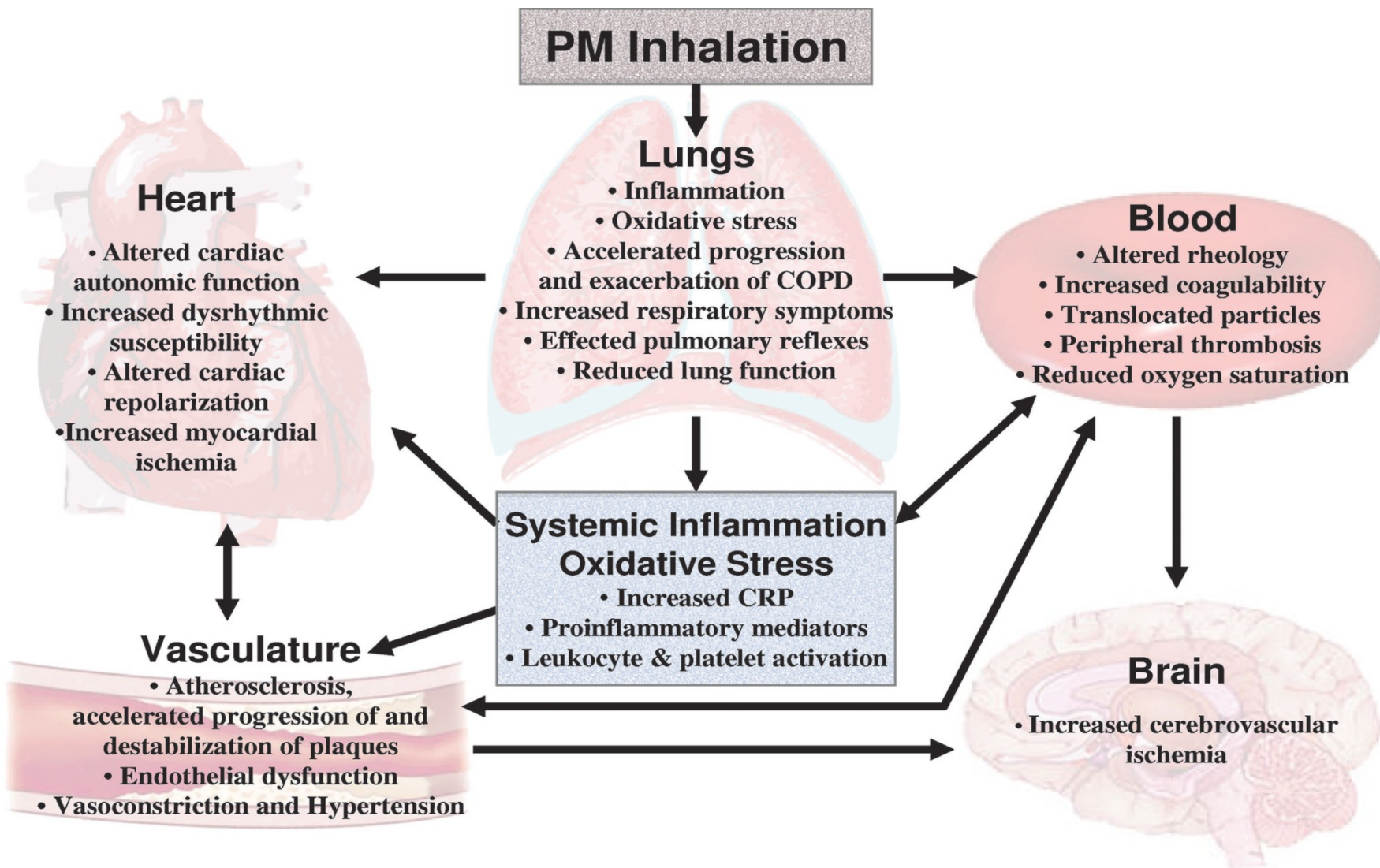
Gauderman et al 2004 NEJM



Air Pollution and Development of Asthma, Allergy and Infections

- Brauer et al. Eur Resp J 2007
- Assessed development of asthmatic/allergic symptoms and respiratory infections in first 4 years of life in relation to traffic-related pollutants in 4000 children in the Netherlands
- Observed 20-30% increased risk of wheeze, doctor-diagnosed asthma, and ear/nose/throat infections, for children with higher cumulative lifetime exposure to pollution



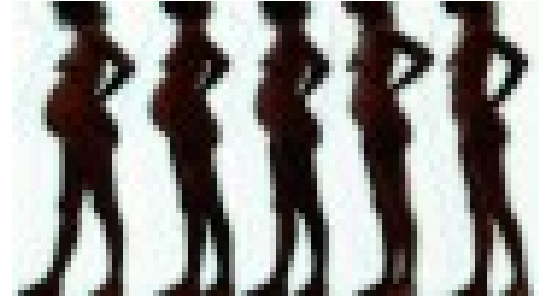


From Pope and Dockery 2006



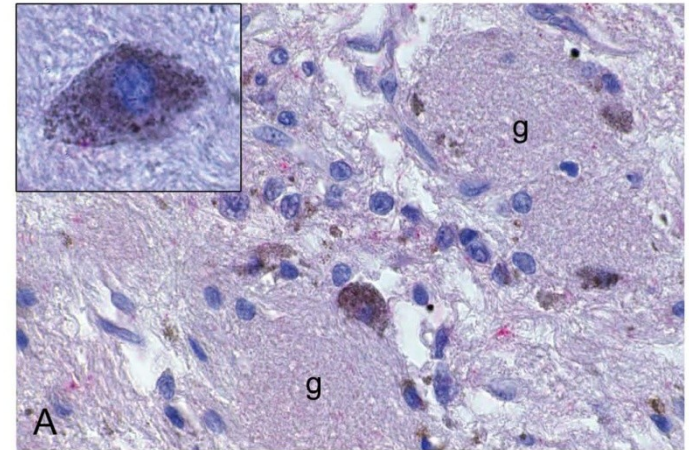
Adverse Reproductive Outcomes

- Pregnancy may be a time particularly susceptible to environmental toxins
- Increased air pollution associated with preterm birth, low birth weight, birth defects, post-neonatal mortality, SIDS
- Growth and development in utero can have long term impacts
 - Heart disease, diabetes in adults; developmental issues



Neurological Effects

- PM (ultrafine PM) may enter brain
 - Transported along nerves in the nasal passages
 - Translocated from lungs to bloodstream; reach multiple organ systems
- Evidence of chronic inflammation (systemic inflammation originating in lungs)
- Higher levels of black carbon (PM) associated with decreased cognitive function in children (Sugilia et al. 2008)



Calderon-Garciduenas et al. 2007



Diesel, Traffic, and Near Roadway Effects



- Vehicles emit substantial levels of 4 criteria pollutants and nearly 100 toxic pollutants
 - Diesel: emissions linked to respiratory and eye irritation, headache, inflammatory changes, enhanced reaction to allergens, cancer, COPD
- CA Children's Health Study: Children living <500m of freeways have deficits in lung growth and development at age 8 compared to those >1500m away (Gauderman et al. 2007)
- Traffic density related to hospital visits, asthma exacerbations, decreased lung function, and asthma development in children and adults





Trucking and Railroad Industry Workers

- Railroad workers with diesel-exhaust exposure at increased risk of lung cancer and COPD mortality compared to those without diesel exposure
(Hart et al. 2006; Garshick et al. 2004)
- Trucking industry workers with regular exposure to diesel at increased risk for lung cancer compared to workers with lower exposure
(Garshick et al. 2008)



Air Toxics

- Cancer (lung, leukemia)
- Adverse reproductive effects
- Mortality
- Reduced fertility
- Immune system damage



PAHs and IQ

- Perera et al. (2009)
- Higher prenatal exposures to PAHs associated with lower IQ scores at age 5 (4 points lower) after adjusting for other important factors

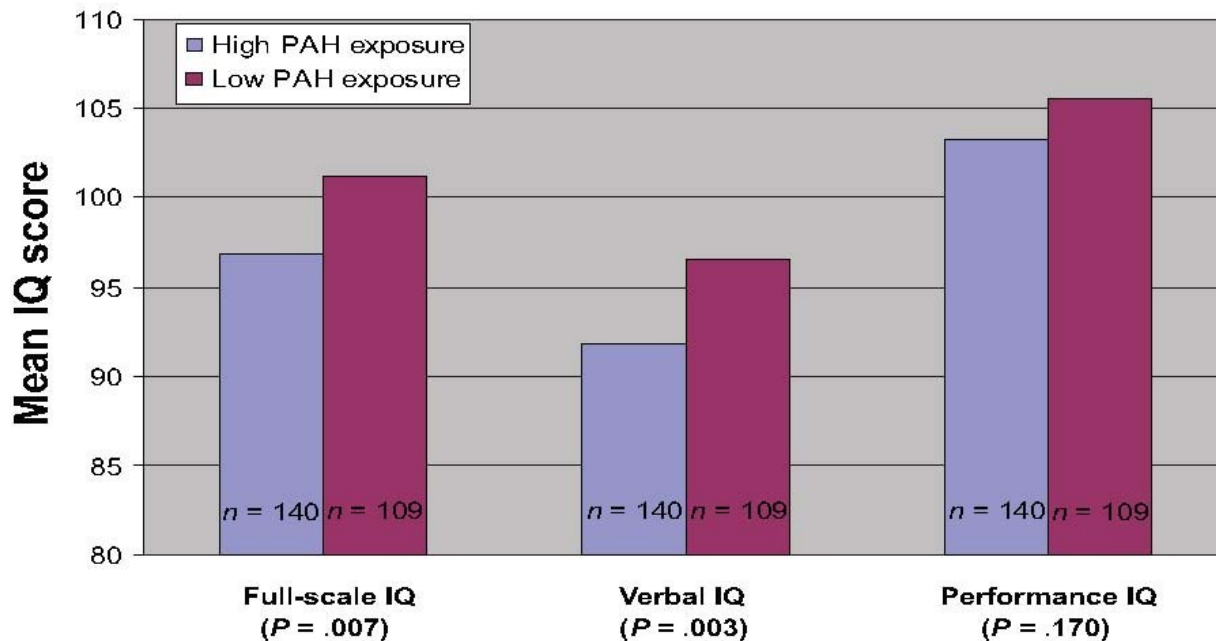


FIGURE 1

Differences in full-scale, verbal, and performance IQ scores associated with high levels of prenatal PAH exposure ($N = 249$). Mean IQ scores were adjusted for ETS exposure during pregnancy, child's gender, ethnicity, mother's intelligence (TONI-3), mother's education, and quality of the home care-taking environment (HOME inventory).



Summary

- Increased ambient air pollution and air toxic levels associated with numerous short and long term health effects
- Observed health effects are typically for the general population at ambient levels
 - Pollution levels often much higher near sources
- While not assessed routinely, studies have not provided evidence of safe threshold level of pollutants





Department of
Environmental and Radiological Health Sciences

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