Air Pollution and Our Children’s Health
What air pollution does to kids

Drives the inception of asthma in first year
What air pollution does to kids

Triggers asthma exacerbations
What air pollution does to kids

Contributes to chronic lung damage
What air pollution does to kids

Affects all mucous membranes
What air pollution does to kids

Damages the stratum corneum
Environmental Exposures:

- Environmental Exposures:
  - Allergens, Infections, Tobacco Smoke

Genetic Factors:
- Atopy, Airway Hyperreactivity

Normal Lung Function → Inception of Asthma → Mild Asthma → Severe Asthma

“Triggers”
**Th-1 & Th-2 Phenotypes**

**Default Pathway**

- Undifferentiated T Helper Cell
- Environmental Exposures
- IL-12

**Th-2 Phenotype**

- IL-4
- B Cell Activation / IgE Production
- Eosinophil Activation
- IL-5

**Th-1 Phenotype**

- IL-12
Environmental Exposures as Switching Agents:

- Rural Environment
  - Crowded living conditions
  - Older siblings present
  - Early on in day care
  - Early exposure to animals
  - TB, Hep A, Measles infection

- Urban environment
  - Air pollution
  - Maternal smoking
  - Western lifestyle
  - Antibiotic exposure
  - Dust mites, cockroaches

Busse, NEJM 344:350-362, 2000
Childhood Asthma Rates on the Rise

1 in 3 in Fresno County

Fresno County is the Asthma Capital of the state

www.Fresno Bee.com
Childhood Asthma Rates on the Rise

More than 1 in 5 children in the valley have asthma—the highest level in the state

www.fresnobee.com
Childhood Asthma Rates on the Rise

13% nationwide

National Center Healthcare Statistics
MMWR Report, 2005
Childhood Asthma Rates on the Rise

Up 247% in U.S. 1980-2005

National Center Healthcare Statistics
MMWR Report, 2005
Let’s review the pollutants
Federal Clean Air Act 1990

- The Fed’s set the standards for harmful pollutants
- 188 listed
- All affect respiratory system
- Many are carcinogens
some examples…

Asbestos
Beryllium
Mercury
Benzene
Coke Oven Emissions
Vinyl Chloride
Radionuclides - Radioactive Elements
National Ambient Air Quality Standards

• PM – Particulate Matter
  – PM Coarse 2.3-10 µg
  – PM fine <2.5

• Ozone (O₃) = NO₂ + VOCs + Sunlight

• CO – fossil fuel burning

• SO₂ – petroleum, coal

• Pb – great progress
• NO2 - fossil fuel burning emissions
• VOCs - gases from fossil fuel
• ethane (cattle)
• lacquer, paint, particle board, glue, carpeting
Ground-level Ozone

\[ \text{VOCs} + \text{NOx} + \text{Sunlight} = \text{Ground-level Ozone} \]
Air Pollution and Our Children's Health

VOC Emissions: 334 tons per day

- Farming Operations, including tilling, harvesting, & animal waste, 52 tpd
- Petroleum Production & Marketing, 35 tpd
- Consumer Products, 24 tpd
- Pesticides and Fertilizers, 22 tpd
- Other Sources, 76 tpd
- Off-road Mobile, 54 tpd
- On-road Mobile, 72 tpd
NOx Emissions: 470 tons per day

- Heavy Heavy Duty Diesel Trucks, 192 tpd
- Other on-road mobile, 83 tpd
- Other sources, 36 tpd
- Fuel Combustion for Stationary Sources, 42 tpd
- Trains, 20 tpd
- Farm Equipment, 42 tpd
- Off-road equipment, such as industrial, lawn, oil drilling, construction, & mining equipment, 56 tpd
Air Pollution and Our Children’s Health

Directly Emitted PM2.5: 79.0 tons per Day

- Ag. Burning & Forest Management, 9 tpd
- Fireplaces & Woodstoves, 8 tpd
- Heavy Heavy Duty Diesel Trucks, 8 tpd
- Other Sources, 18 tpd
- Road Dust (paved & unpaved), 9 tpd
- Fugitive Windblown Dust, 7 tpd
- Other Mobile Sources (On & off road), 11 tpd
- Farming Operations, including tilling, harvesting, & animal waste, 8 tpd
<table>
<thead>
<tr>
<th>AQI</th>
<th>Description</th>
<th>Health Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>moderate</td>
<td>sensitive affected</td>
</tr>
<tr>
<td>100</td>
<td>unhealthy</td>
<td>normal kids affected, not adults</td>
</tr>
<tr>
<td>150</td>
<td>unhealthy</td>
<td>everyone stay indoors</td>
</tr>
<tr>
<td>200</td>
<td>very unhealthy</td>
<td>everyone has symptoms</td>
</tr>
<tr>
<td>300</td>
<td>hazardous</td>
<td>everyone stay indoors</td>
</tr>
</tbody>
</table>
Ozone Level Effects

- 0.06 ppm – rats can’t clear asbestos fibers
- 0.08 ppm – subjects tested in chamb 5 – 6 hrs
  - inflam mediators released in lungs
  - PFTs show ↓ lung function
- 0.15 ppm - shortening of pulm cilia
  - necrosis of pulm epithelium & cilia
- 0.15 ppm - Calif Health Advisory
- 0.20 ppm - Stage I Smog Alert

AAP Com Envir Health - Ped, Jun 1993
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• necrosis of pulmonary epithelium & cilia  
• California Health Advisory |
| 0.20 ppm            | • Stage I Smog Alert |

AAP Com Envir Health - Ped, Jun 1993
Ozone Damage Pathophysiology

Air Pollution ➔ Ozone (O₃)

1. Direct oxidative injury to cell membranes

2. Expression of adhesion molecules and infiltration with neutrophils

3. Increase in bronchial hyperreactivity
Ozone Damage

- Inflam airways - ↑ reactivity of airways
- ↓ FEV₁
- ↑ sensitivity to allergens
- ↑ epithelial permeability & mucous
- ↑ bronchoconstriction
- ↑ cough, wheezing, SOB
- Symptoms may begin up to 24 hrs later
- Lasts up to 7 days after exposure to ↑ ozone

AAP Com Envir Health – Ped, Jun 1993
Chronic Ozone Damage

- Remodeling – irreversible lung tissue damage
- \(\downarrow\) Lung growth postnatally

AAP Com Envir Health – Ped, Jun 1993
Ozone health effects

- Headaches
- Nausea
- Malaise, fatigue
- ↓ exercise performance
- ↓ resistance to infection
- synergistic with acidic air causing ↑ damage to lung tissue.

AAP Com Env Health – Ped, Jun 1993
- Smog complex
Ozone

- Increased illness related school absences

Gilliland FD et al., The Effects of Ambient Air Pollution on School Absenteeism due to respiratory illness." Epidemiology 2001: 12; 43-54
Ozone

- Associated with increased risk of the occurrence of new onset asthma

Ozone

- Associated with ↑ cough, wheeze, phlegm. Greater effect in men than women

GALIZIA, A., & KINNEY, P.L. "Long-Term residence in areas of high ozone: associations with respiratory health in a nationwide sample of nonsmoking young adults." *Environ Health Perspectives* 107: 675-679; 1999520
Ozone in Atlanta

2 weeks
Ozone in Atlanta

- Surge in public transport
- Traffic congestion down 22%
- Ozone ↓28%
- Acute asthma visits down 42% in kids (Medicaid population)

Particulate Matter (PM)

- PM 10 microns - no damage
- PM 2.5 to 10 - deposit into airways and deep into lungs/alveoli
- PM 2.5 or less - penetrate aveoli cross membrane into blood stream
- PM 0.1 or less - penetrate cells
What is Particulate Matter?

PM10 = particles 10 micrometers and smaller

Hair cross section (60 \( \mu \text{m} \))

Human Hair
(60 \( \mu \text{m} \) diameter)

PM10
(10 \( \mu \text{m} \))

PM2.5
(2.5 \( \mu \text{m} \))
PM Takes Several Forms and Comes From Many Sources

- Directly Emitted -- Primary
- Formed in Atmosphere -- Secondary
PM Is A “Grab Bag” Of Pollutants

• A Complex Mixture
• Elements & Compounds

• Composition Varies
• Depends on Sources

Smoke

Soot

Dust

Carbon (C)

Salts (Na, Cl)

Sulfates
{SO\textsubscript{x} + oxidants \Rightarrow H\textsubscript{2}SO\textsubscript{4} + NH\textsubscript{3} \Rightarrow NH\textsubscript{4}HSO\textsubscript{4} + NH\textsubscript{3} = (NH\textsubscript{4})\textsubscript{2}SO\textsubscript{4}}

Aerosols

Heavy Metal (Fe, Pb, Cd)

Organics (ROG, PAHs)

PM10

Nitrates
{NO\textsubscript{x} + oxidants \Rightarrow HNO\textsubscript{3} + NH\textsubscript{3} = NH\textsubscript{4}NO\textsubscript{3}}

PM10
Particulates affect lungs

- Cleared by alveolar macrophages
- Cytokines released (IL-8) – attract neutro
- Local inflammatory reaction
- Damage is worse if particulates acidic from SO$_2$ and NO$_2$ in air
- ↑resp symptoms and ↓PF

Ped Pulm 31:106-113, 2001
PM & Cardiopulmonary Health

Ultrafine particles lead to loss of anti-inflammatory properties of HDL → contributes to atherosclerosis

PM & Cardiopulmonary Health

Associated with incidence of cardiovascular disease and death in women (76% ↑ risk of cardiovascular mortality)

PM & Cardiopulmonary Health


Trigger ↑ release of cytokines
PM & Cardiopulmonary Health

- Vasoconstriction
- ↑ BP
- ↑ Risk sudden cardiac death
- ST depression in adults

Who is at greater Risk

- We all are -------but especially:
- Children <14 yrs
- Elderly > 55 yrs
- Pregnant women
- People with Asthma, CF COPD, HTN, CVD
- Other chronic diseases (diabetes)
- This group is 51% of Fresno Co. population
Particulates
Children are more Affected

- Run outside - ↑resp rate - ↑air volume
- Mouth breathe when exercising
  - bypass nasal filter
- ↑ pollutants per body weight
- ↑ time outdoors
- Airways are narrower
  - inflam → faster bronchoconstriction → mucous → swelling

Ped Clinics N.A. 10/2001
Summary of Chronic Effects

• ↓ lung dev and growth early in life
• ↓ lung function long-term- chronic bronchitis in adults (smog simulates ongoing smoking)
• airway remodeling in kids
• dev chronic obstructive lung disease
Quality of Life Issues

- Outdoor activities restricted
- Sports practice cancelled
- Missed school days
- Missed days at work for parents
- Healthy people get “smog complex” symptoms
- Borderline asthmatics get asthma
- Inhalers, steroids, Dr visits, hospitalizations
- Can’t see our beautiful Sierras
What can we do for Kids?
Your advice to parents, teachers, and coaches

- Winter - don’t run in early am or after 5pm (Particulates)
- Summer - exercise before noon (Ozone)
  - May - Sept
- Football practice - not in hot afternoon (Ozone)
- Unhealthy days - double inhaled steroids (Ozone and Particulates)
AAP Advises: What Health Professionals Can Do

- Be informed
- Realize the danger to high risk kids
- Advise schools & public agencies about smog alerts and outside activity
- Educate parents about smog
- Call or write Policy makers
- Educate local officials

Teague, Ped Clinics N.A., Oct 2001 pg 1179
Community Involvement

• Local medical society - committee on Air Pollution
• Local Hearing on Air Pollution
• Visit Air Pollution Control District Office
• MAHA - Medical Advocates for Healthy Air.
Does pushing for change work?

- Tobacco smoke banned from public buildings & vehicles
- Lead removed from paint & gasoline
- Car seats for kids
- L.A. changed gasoline leaf blowers to electric vacuums
- It takes informed voices + legislation
Changes Seen

- Leaf blowers - letter to School District Superintendent
- Educated a developer (daughter has asthma)
- Health Care Providers can impact:
  - school coaches
  - school parents education
  - research locally
  - the local Air Pollution Control District
What our Valley needs

• More trees in parking lots
• Less city sprawl to decrease miles driven
• Excellent safe clean mass transport
• More and safer bicycle lanes
• Clean up the mobile and stationary diesel engines/machinery
• Cut open burning
What can you do for Healthier Air?

- Trade in your gasoline mower, blower, edger, chain saw for electric
- Change wood fireplace and BBQ to natural gas
- Avoid spray cans that use CCF propellants
What can you do for Healthier Air?

• Maintain your car
• Easy acceleration
• Don’t idle at drive-up window
• Carpool, bicycle, walk
• Combine errands into one trip
• Buy an electric-gas car like Dr. Scholefield
Website Resources

• [www.healthandcleanair.org](http://www.healthandcleanair.org)  
  – California Air Resources Board

• [www.wri.org](http://www.wri.org)  
  – World Resource Institute for Study of Health and the Environment

• [www.healtheffects.org](http://www.healtheffects.org)  
  – Health Effects Institute USA

• [www.calkleanair.org](http://www.calkleanair.org)  
  – Central Valley Air Quality Coalition  
  – compilation of studies and news
Website Resources

- [www.arb.ca.gov/airways/ccaqs.htm](http://www.arb.ca.gov/airways/ccaqs.htm)
  - Central California Ozone Study and California Regional Particulate Air Quality Study

- [www.valleyair.org](http://www.valleyair.org)
  - San Joaquin Valley Air Pollution Control District

- [www.epa.gov](http://www.epa.gov)
  - US Environmental Protection Agency (EPA)

- [www.arb.ca.gov](http://www.arb.ca.gov)
  - California Air Resources Board
Thank You
References


4. Teague WG, Outdoor Air Pollution – Asthma and Other Concerns: Pediatric Clinic N.A. 48:5 pg 1167-1184, 2001
References


References


