Outdoor Air Pollution: How Does It Affect Our Children's Health?

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IT'S IN THE AIR WE BREATHE!!

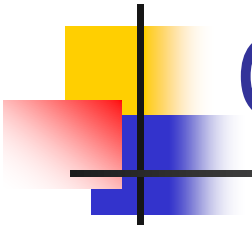

STOP
ATLANTIC EXPRESS


SARCO

PRE-LECTURE QUESTION 1

- ?Which of the following are sources of outdoor air pollution in the US-Mexico border region and border states?
- a) Emissions from vehicles running their engines at border crossing stations
- b) Emissions from smelters and mine tailings (blown by the wind) in the region
- c) Air blown in from Africa, the Middle East and Asia
- d) Answers a and b only
- e) All of the above (a through c)

PRE-LECTURE QUESTION 1: CORRECT RESPONSE



- e) All of the above (a through c)

PRE-LECTURE QUESTION 2

- ?Which of the following are sources of lead exposure for children living in the El Paso/Cuidad Juarez border region?
- a) Ingestion or inhalation of settled dust in homes and communities from past emissions from vehicles burning leaded gasoline (until 1976-1980)
- b) Ingestion of lead from use of lead-glazed Mexican bean pots and ingestion of lead-contaminated chapulines (grasshoppers) and Mexican candies
- c) Ingestion or inhalation of settled dust in homes and communities from past emissions from smelters, in particular ASARCO smelter in El Paso which operated from 1887 to 1999
- d) Answers a and c only
- e) All of the above (a through c)

PRE-LECTURE QUESTION 2: CORRECT RESPONSE

- e) All of the above (a through c)

OVERVIEW OF CHILDREN'S ENVIRONMENTAL HEALTH (CEH) & HOW AIR POLLUTION AFFECTS OUR CHILDREN

- "Children are not little adults"-why children are more susceptible due to greater exposure and greater vulnerability
- Environments where children can get exposed: homes, child care, schools, work (in older kids) and community
- Air pollution: Specific pollutant chemicals and asthma triggers in the environment
- Adverse health effects of selected pollutants

OVERVIEW OF CHILDREN'S ENVIRONMENTAL HEALTH (CEH) & HOW AIR POLLUTION AFFECTS OUR CHILDREN (CONTINUED)

- Airborne (mostly) lead exposure and its consequences
- Air pollution issues in the US-Mexico border area
- EPA's BORDER 2020 and other border initiatives
- What health care providers, public health professionals and parents can do to prevent children's exposure to toxic air pollutants

CHILDREN ARE NOT LITTLE ADULTS!

- Children have vulnerable periods of development: fetal period, early infancy into childhood with development of nervous, pulmonary, reproductive and other organ systems
- Have increased metabolism: Per unit of body weight, children eat more, drink more and breathe more than adults
- Have behaviors predisposing them to environmental exposure : hand-to-mouth, low to the ground, etc.
- Have longer “shelf life” for latent effects to present
- Younger children cannot make good decisions about safety

Determinants and Characteristics of Air Pollution

- Geography: Chihauhuan Desert/ La Frontera (especially El Paso/Ciudad Juarez and El Paso del Norte region); global vs regional vs local
- Types of Pollutants
  - EPA's 6 criteria pollutants (NAAQS)
  - Hazardous air pollutants (HAPS)
- Types of Sources
  - Mobile (vehicles) versus Point Sources (smelters, mines, factories, etc.)
- Anthropogenic vs "Natural"
  - Industrial, Agricultural, Energy, Transportation
  - Surface Minerals/Soil, Plants, Bodies of Water

Composition of Pollutants

- Physical properties –aerodynamic diameter, surface reactivity
- Biological materials and organisms (allergens)
- Vapors
- Aerosols and Particulates
- Chemical species- Organics, metals, minerals, metalloids (arsenic, antimony), non-metallic inorganics

EPA CRITERIA AIR POLLUTANTS

EPA CRITERIA AIR POLLUTANTS		
Pollutant	**Sources**	**Health and Environmental Effects**
Ozone (O_3) Ground-level A colorless gas that forms as a result of chemical reactions between volatile organic compounds (VOCs), nitrogen oxides (NO_x), and oxygen in the presence of heat and sunlight.	Motor vehicles, electric utilities, factories, landfills, industrial solvents, and miscellaneous small sources such as gas stations, lawn equipment, etc.	Causes coughing, chest tightness, wheezing and can inflame and damage lung tissue. Aggravates asthma and can even be a cause of asthma. Irritates the respiratory system, reduces lung function and makes it more difficult to breathe. Aggravates chronic lung diseases and may cause permanent lung damage. May reduce yield of agricultural crops and damages forests and other vegetation.
Carbon Monoxide (CO) An odorless, colorless gas resulting from incomplete fossil fuel combustion.	Motor vehicles (the majority of CO in NH), small engines, some industrial processes, boilers and incinerators. High concentrations can be found in confined spaces like parking garages, poorly ventilated tunnels, or traffic intersections especially during peak hours.	Impairs the ability of blood to deliver oxygen to vital tissues affecting the cardiovascular, pulmonary, and nervous systems. Symptoms include dizziness, headaches, nausea, fatigue, memory and visual impairment, and decreased muscular control.
Nitrogen Dioxide (NO_2) A brownish gas that forms quickly when fuel is burned at high temperatures. Contributes to the formation of ground-level ozone and fine particle pollution	Motor vehicles, electric utilities, industrial boilers, and off-road equipment.	Irritates the lungs, may cause lung damage and lower resistance to respiratory infections such as influenza. May adversely affect terrestrial and aquatic ecosystems through regional transport and deposition.

EPA CRITERIA AIR POLLUTANTS

Particulate Matter (PM) Mixture of solid particles and liquid droplets in the air; particles may be visible or microscopic.	Formed directly from windblown dust, crushing and grinding operations, unpaved roads and construction, fuel combustion (from motor vehicles, power plants, industrial facilities), wood stoves, and agriculture (plowing, burning off fields). May also be formed in the atmosphere from gases such as SO_2 and NO_x.	Causes eye, nose and throat irritation, decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease. Serves as a carrier for toxic metals, damages human-made materials, and is a major cause of reduced visibility in many parts of the U.S.
Sulfur Dioxide (SO_2) A highly reactive colorless gas, odorless at low concentrations, but pungent at very high concentrations.	Formed when fuel containing sulfur (mainly oil and coal) is burned in industrial, institutional, utility, and residential furnaces and boilers. Other sources include petroleum refineries, smelters, paper mills, and chemical plants.	May cause breathing problems, respiratory illness, alterations in the lungs defenses, aggravation of existing cardiovascular disease, and permanent damage to lungs. Forms acid aerosols and sulfuric acid, which are associated with acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility.
Lead - A heavy metal found naturally in the environment and in manufactured products.	Soil, dust, paint, etc., transportation sources using lead in their fuels, coal combustion, smelters, car battery plants, and combustion of garbage containing lead products.	Elevated levels can cause brain and other nervous system damage and adversely affect kidney function, blood chemistry, and digestion if ingested or directly inhaled. Children are at special risk due to cumulative effects even at low doses. Lead can also harm wildlife through deposition onto leaves which are a food source for grazing animals.

NAAQS FOR 6 CRITERIA POLLUTANTS

National Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Primary Standard	Secondary Standard	Regulation Allowance
Ozone (O_3)	8-hour average concentration 0.075 parts per million	Same as primary	3-year average of the annual fourth-highest daily maximum concentration at or below the standard.
Carbon Monoxide (CO)	8-hour average concentration 9 parts per million	N/A	Not to be exceeded more than once per year
	1-hour average concentration 35 parts per million	N/A	Not to be exceeded more than once per year
Nitrogen Dioxide (NO_2)	1-hour average concentration 100 parts per billion	Same as primary	3-year average of 98th percentile concentration at or below the standard
	Annual Arithmetic Mean 53 parts per billion	Same as primary	Annual Mean
Particulate Matter (PM_{10})	24-hour average concentration 150 micrograms per cubic meter	Same as primary	Not to be exceeded more than once per year on average over a 3-year period.
Particulate Matter ($PM_{2.5}$)	24-hour average concentration 35 micrograms per cubic meter	Same as primary	3-year average of 98th percentile concentration at or below the standard
	Annual Arithmetic Mean: 15 micrograms per cubic meter	Same as primary	3-year average at or below the standard
Sulfur Dioxide (SO_2)	1-hour average concentration 75 parts per billion	Maximum 3-Hour concentration 0.5 parts per million	3 year average of 99th percentile of 1 hr daily maximum conc. at or below standard (primary). Not to be exceeded more than once per year (secondary)
Lead	Rolling 3 month average 0.15 micrograms per cubic meter	Same as primary	Not to be exceeded.

For the most up to date NAAQS table please visit: www.epa.gov/air/criteria.html

The Health Effects of Air Pollution

MORBIDITY AND MORTALITY FROM AIR POLLUTION

World Health Organization: In 2014 the World Health Organization (WHO) released new estimates of premature death linked to air pollution.

"WHO reports in 2012 around 7 million people died- one in eight of total global death as a result of air pollution.

- This doubles previous estimates; Confirms that air pollution is the world's largest single environmental health risk"
- The WHO estimated in 2006 that nearly 25 percent of all deaths and the total disease burden globally can be attributed to environmental exposures

(REF: WHO, 2014 and 2006)

US Healthy People 2020 Goals for Air Quality:

EH-1 Reduce the number of days the Air Quality Index (AQI) exceeds 100, weighted by population and AQI

EH-3 Reduce air toxic emissions to decrease the risk of adverse health effects caused by mobile, area, and major sources of airborne toxics

ADVERSE MEDICAL EFFECTS OF OUTDOOR AIR POLLUTION ON CHILD (& ADULT) HEALTH

- Adverse birth outcomes
- Neurodevelopmental outcomes
- Cardiovascular (adults; strokes and ischemic heart disease)
- Pulmonary effects (acute and chronic)
  - Irritant effects
  - Impaired lung function and growth
  - Infection
  - Asthma: new onset and exacerbation
  - Chronic Obstructive Pulmonary Disease (COPD; adults)

Acute Symptoms/Problems Caused by Air Pollution

- Irritation of mucous membranes of eyes, nose and throat
- Cough, wheeze, chest tightness
- Increased AHR (airway hyper-reactivity) to allergens in sensitized individuals
- Tracheobronchitis
- Exacerbations of asthma
- Death

Chronic Symptoms/Problems Caused by Asthma

- Long term reduction in lung function
- Chronic tracheobronchitis
- Airway remodeling
- Increased susceptibility to COPD

Adverse Health Effects of Air Pollution

- There is a consistent association between air pollution and hospital admissions, emergency department visits and visits to the doctor for asthma in children
- Studies show that exposure to high concentrations of Ozone or Particulate Matter significantly increases the risk of respiratory symptoms and asthma medication use while diminishing lung function as measured by PEF and FEV1.
- Ozone and Particulate Matter have been implicated as providing a significant effect in asthma sick visits
- Nitrogen Dioxide has most recently been found to be strongly related to hospital or emergency visits for asthma

ADVERSE HEALTH EFFECTS OF OUTDOOR AIR POLLUTANTS (OAPs)

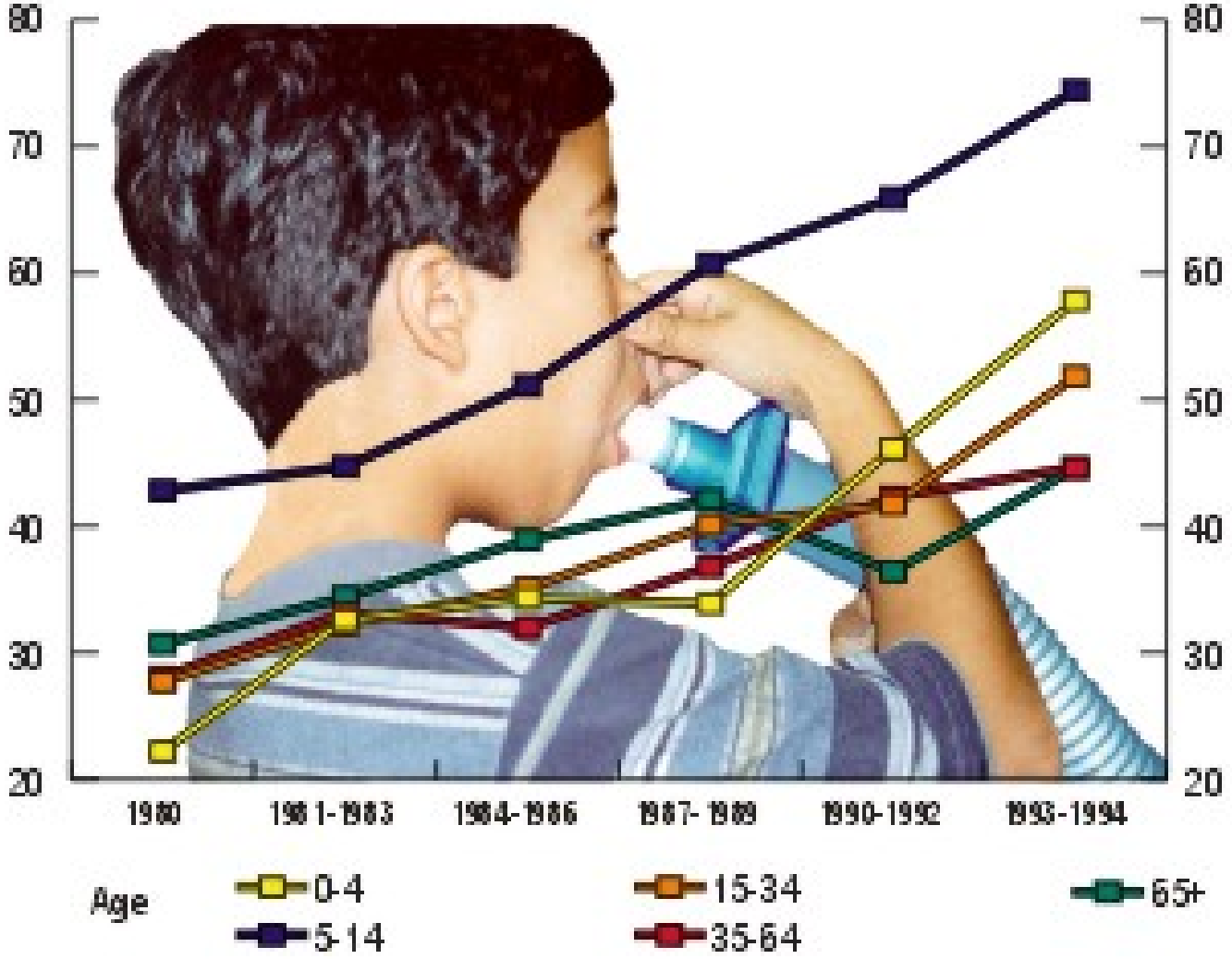
- **General adverse outcomes:** some studies link OAP but not specific agents (See Leventer-Roberts and Campbell)
- **General asthma outcomes:** OAP linked to asthma exacerbations and hospitalizations
- **Sulfur dioxide (SO2):** irritates upper airway
- **Oxides of Nitrogen**: (Nox; No2 and others)
  - Respiratory disease admissions in children aged 1-4 and 5-14 years associated with NO_2 concentrations
- **Particulate matter:** (PM 2.5 and PM 10)
  - ↑ emergency room visits by asthmatic children
  - ↓ lung function

REF: Séguin J 2008. Human Health in a Changing Climate. Health Canada

PEDIATRIC ASTHMA

- Increased incidence and mortality in US and other industrialized countries; pediatric mortality has doubled
- US prevalence in children 8.5% (2001-2003 data; CDC) vs. 6.7% in adults; 10.3% in poor vs. 6.4-7.9% in non-poor
- Leading cause of hospital admission for urban children
- Many environmental triggers: some induce allergy, some are irritants

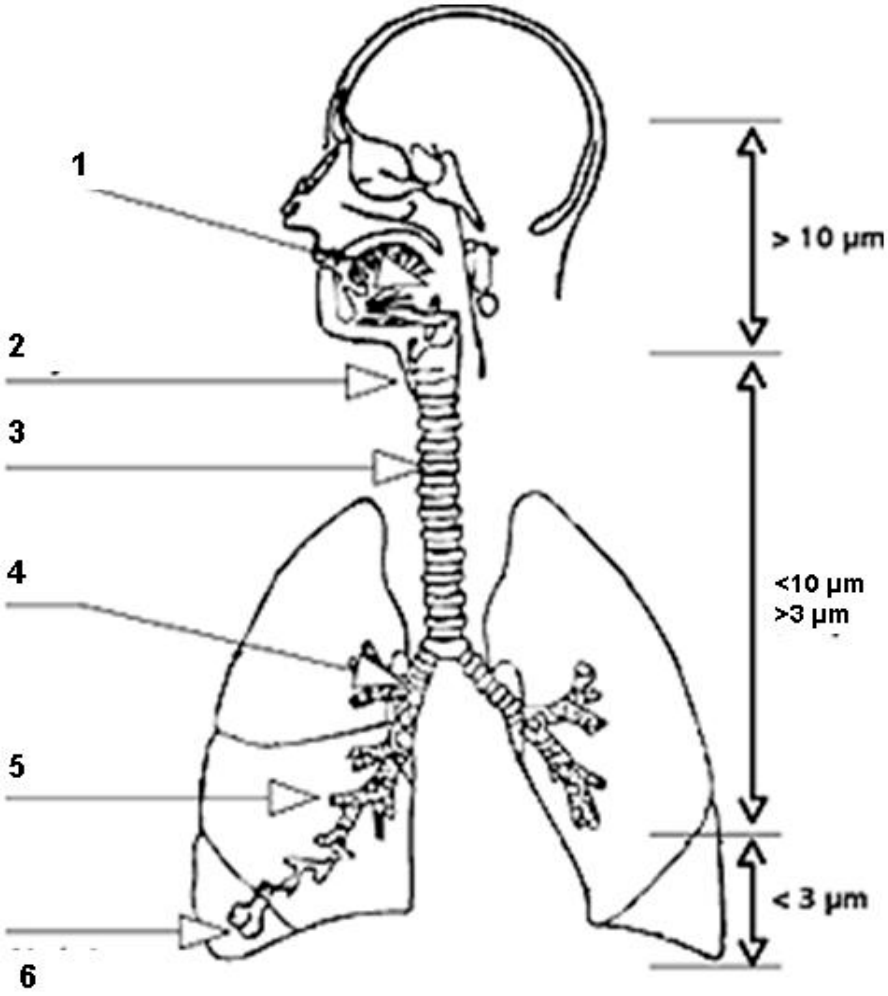
Asthma Prevalence by Age
United States, 1980-1994



Source: National Health Survey, 1980-1994

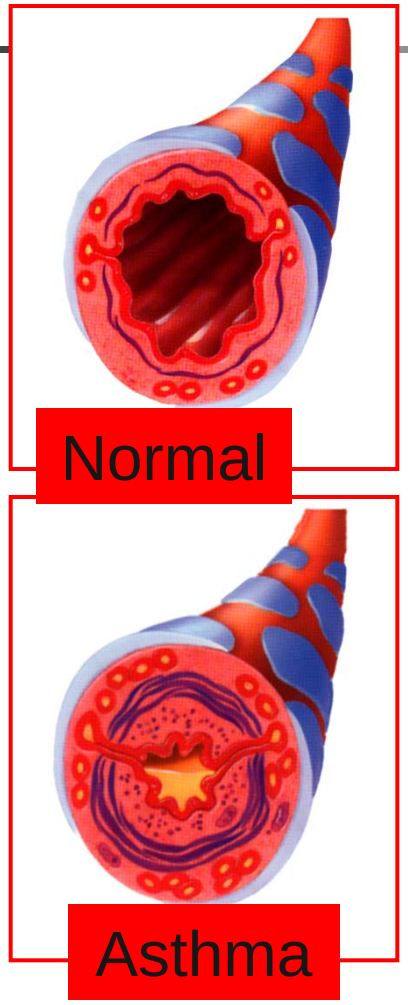
Asthma Pathophysiology

- Asthma is a chronic inflammatory disorder
- Pathophysiology includes inflammatory cell infiltration of airways
- Airway inflammation triggers hyper-responsiveness and airway obstruction
- Airway becomes narrow due to 3 factors: inflammation, mucus production and bronchospasm



- 1: Pharynx
  2: Larynx
  3: Trachea
  4: Bronchus
  5: Bronchioles
  6: Pulmonary Alveoli

Asthma Pathophysiology



- Most common chronic childhood disease
- Characterized by airway inflammation, hyper-responsiveness and mucous production

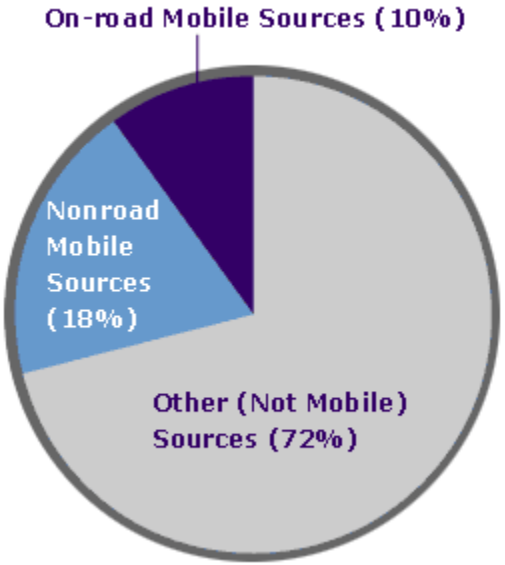
What is particle pollution?

The particles in particle pollution are so small, you can't see just one of them …

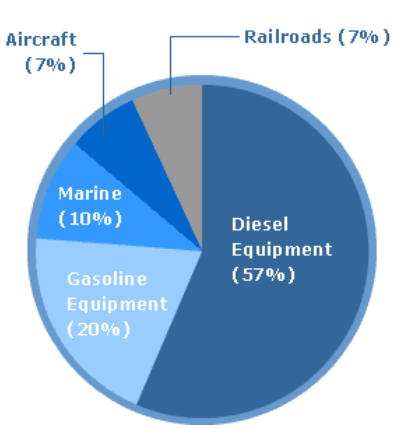
An average grain of table salt is 100 micrometers across (100 µm)

- **Particle pollution** is a complex mixture of extremely small particles and liquid droplets; is formed from particular pollutants on the surface and in the air of a specific geographic location
- Particulate matter called PM 10 and PM 2.5 are commonly monitored/measured
- Some of these particles – called **fine particles – are just 2.5 micrometers in diameter**. That's 40 times *smaller* than the average grain of table salt!
- The size of particles is directly linked to their **potential for causing health problems**; PM2.5 is "respirable", able to reach the lung sacs (alveoli)
- Contributes to **reduced visibility, or haze**

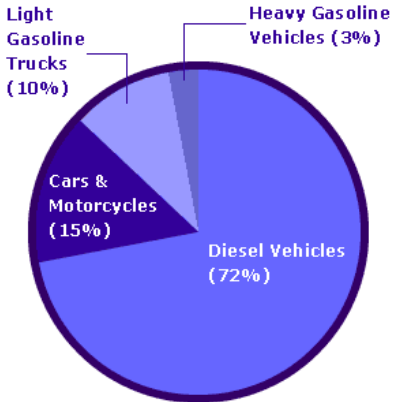
Particulate Matter 2.5 μm



Non-road mobile sources



On-road mobile sources

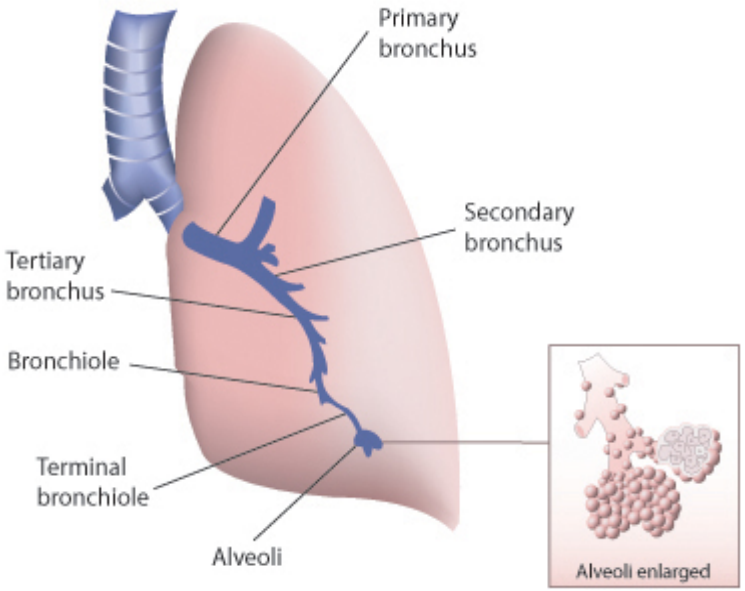


www.epa.gov/.../overview/pollutants/pm.htm

Many sources of Particulate Matter; occurs year-round

- **Particle pollution comes from a variety of sources,** including:
  - wind-blown dust (larger particles)
  - combustion sources
    - **cars and trucks**
    - **industry**
    - **power plants**
    - **fires**
- Fine particles can be **emitted directly** into the air, or they can **form from gases** that react in the atmosphere.
- **Particle pollution can occur year-round** -- and may be worse in the fall and winter, depending on where you live**.**

Lung Effects of Particle pollution



Particle pollution can penetrate into the part of your lungs known as the alveoli, which deliver oxygen to the bloodstream.

You are exposed to particle pollution simply by breathing polluted air.

Exposure increases when you exercise, because you breathe more vigorously and deeply than usual.

People exposed to particles may experience a number of respiratory symptoms, including: **airway irritation; cough; phlegm; decreased lung function; airway inflammation; asthma attacks; and chronic bronchitis**

Facts about Particulate Matter (PM)

- Level in the ambient air varies from day to day
- Particulate matter between 2.5 µm and 10 µm are respirable and deposit on the lower resp surface area.
- Higher fine PM levels are associated with asthma and are more likely to be found in urban homes using solid fuel. (China, Kenya and US
- Some PM_{10} may be more acidic containing high levels of sulfuric acid or nitric acid
- Associated with increased respiratory symptoms, reduced lung function and increase use of asthma meds at high ambient concentrations
- While not all studies have linked PM to increased risk of exacerbation, the weight of evidence indicates that ambient PM does adversely affect children with asthma.

Effects of Diesel Fuel Emissions

- Tremendous world-wide increase in number of motor vehicles has resulted in air-polluting emissions from cars, especially those with diesel engines.
- In urban areas with high pollutants- most common are PM, NO_2 O_3
- Diesel fuel combustion results in production of diesel exhaust particles (DEPS)- include fine or ultrafine particles

Air Pollution Effect On Asthma and Allergies

- Epidemiological studies have demonstrated that urbanization, high levels of vehicle emissions and westernized lifestyle are correlated to an increase in frequency of pollen-induced respiratory allergy
- Meteorological factors (temp, wind speed, humidity) alone with their climatological regimes can affect both the biological and chemical components of this interaction
- By inducing airway inflammation, air pollution overcomes the mucosal barrier priming allergen-induced responses.

D'amato

HEALTH EFFECTS OF GROUND-LEVEL OZONE

- NO_x + VOCs + sunlight/heat → O_3
- Major component of (photochemical) smog
- Impaired lung function
- Symptoms: Severe coughing, SOB, pain when breathing, eye irritation
- Increased risk of hospital admissions & ER visits for asthma
- Increased risk of cardiovascular complications in at-risk populations
- Communities with high ozone conc.- relative risk of developing asthma in children playing 3 or more sports = 3.3 (95% CI 1.9-5.8) compared with children playing no sports

REF Am J Respir Crit Care Med 1998; 158(2):538-46; REF: USEPA www.rtpnc.epa.gov/naaqsfin/o3health.htm

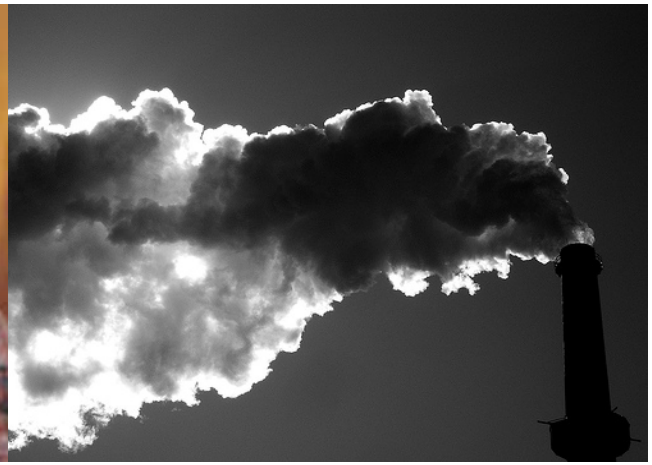
AIR POLLUTION EFFECTS OF GLOBAL CLIMATE CHANGE

- Intergovernmental Panel on Climate Change (IPCC): UNEP and WMO; putting out periodic reports; Progress reports coming out in XXXX
- Warming of global climate is unequivocal and 95% is extrinsic
- Greenhouse gas production is largely due to human activities. Most GHGs are carbon dioxide (from burning fossil fuels), then nitrous oxide and methane.
- Global climate change expected to result in increased burden of respiratory disease
  - Due to changes in distribution, quantity and quality of pollens; changes in the timing and duration of pollen season; interaction between heavier pollen loads and increased air pollution;
  - Thunderstorms and extreme precipitation events;
  - Worsening heat-related ground-level ozone pollution;
  - Increased ambient air pollution from natural and anthropogenic sources; including from wildfires.

Climate Change: Increased Ozone and Poor Air Quality

Ben Amstutz, Flickr

WHO, HCWH



Senor Codo, Flickr

- More warm days → more smog → more power generation without decreased emission of GHGs → more severe GHG emission problem
- Increased risk of ER visits and hospital admissions for respiratory illness
- Increased risk of asthma onset and exacerbations, cardiac arrhythmias, myocardial infarction and total mortality

Climate Change: Pollen and Natural Air Pollutants


Arvind Balaraman, freedigitalphotos.net


Wikimedia Commons, Sue Sweeney


CDC


Yarenis Boen van Oostrom

- Increased temperatures and ground-level CO_2 will increase plant metabolisms and pollen production; floods can lead to mold formation
- Longer and earlier pollen seasons
- Increase in allergic rhinitis and respiratory diseases such as asthma and chronic obstructive pulmonary disease (COPD)

Why do we worry about children's susceptibility to air pollution?

- Children's immune system and lungs are not fully developed, and their airways are smaller and less rigid
- Relative to size, oxygen requirements are much higher in young than older people
- Children also have increased respiratory rate and breathe in more toxins per body weight than adults; playing vigorously for long time periods (MV minute ventilation of 400 vs. 150 ml/kg)
- Children are considered to be more sensitive to air pollution than adults; asthmatic children are particularly vulnerable to the adverse health effects of air pollution

Why do we worry about children's susceptibility to air pollution?

- Between 4-9 years children have transient tonsillar and adenoidal hypertrophy that results in relative narrowing of the posterior pharyngeal airway, therefore more likely to mouth breath exposing the LRT(lower respiratory tract) to large particles and irritants that normally affect the nasal mucosal surface
- Children spend more time outside where levels of pollution from traffic power plants and other sources are generally higher; older children play outdoor sports breathing in more air than adults who are not exercising
- Effects of air pollutants on lung function depend on the environmental concentration of the pollutant, the duration of the exposure and the total ventilation of the exposed person

ENVIRONMENTAL TRIGGERS FOR ASTHMA

- **INDOOR ALLERGENS-NOT COVERED**
- **INDOOR AIR POLLUTION SUMMARY:**
- **Chemical exposures:**
- Environmental tobacco smoke
- Irritant chemicals and fumes: from off-gassing of building materials and home furnishings (carpet, furniture), with chemicals such as formaldehyde, other VOCs (volatile organic compounds) such as benzene, toluene, pesticides, phthalates, etc.
- Products from combustion devices such as gas ranges, kerosene or gas space heaters and fireplaces/stoves (CO, NO2, Particulate matter 10 and 2.5, SO2); similar to outdoor air pollution sources

ADVERSE HEALTH EFFECTS OF CHEMICAL INDOOR AIR POLLUTANTS

- Volatile organic compounds:
- Examples: BTEX: benzene, toluene, ethylbenzene, and xylene
- Variable adverse health effects including damage to nervous system, liver and kidneys; eye/respiratory tract irritation (trigger asthma); carcinogenic (cancer-causing); headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reactions, nausea, and memory impairment.

Air Quality Index (AQI) Basics

- **What Is The Air Quality Index?**
- The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health .Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.
- **How Does the AQI Work?**
- Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

Air Quality Index (AQI) Basic

- **How Do You Interpret the Daily AQUI?**
- An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy-at first for certain sensitive groups of people, then for everyone as AQI values get higher.
- **Where do you find the AQI?**
- This is published in newspapers (generally on the weather page); it may be announced on radio, and should be available on websites. (Go to www.airnow.gov and http://www.airnow.gov/index.cfm?action=airnow.intlpartners to find the AQI for your city or county, the general one and specific for ozone, PM, sulfur dioxide and carbon monoxide)
- **Understanding the AQI**
- The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six categories: see chart on next page
- **(REF: US EPA; http://www.airnow.gov/index.cfm?action=topics.about_airnow)**

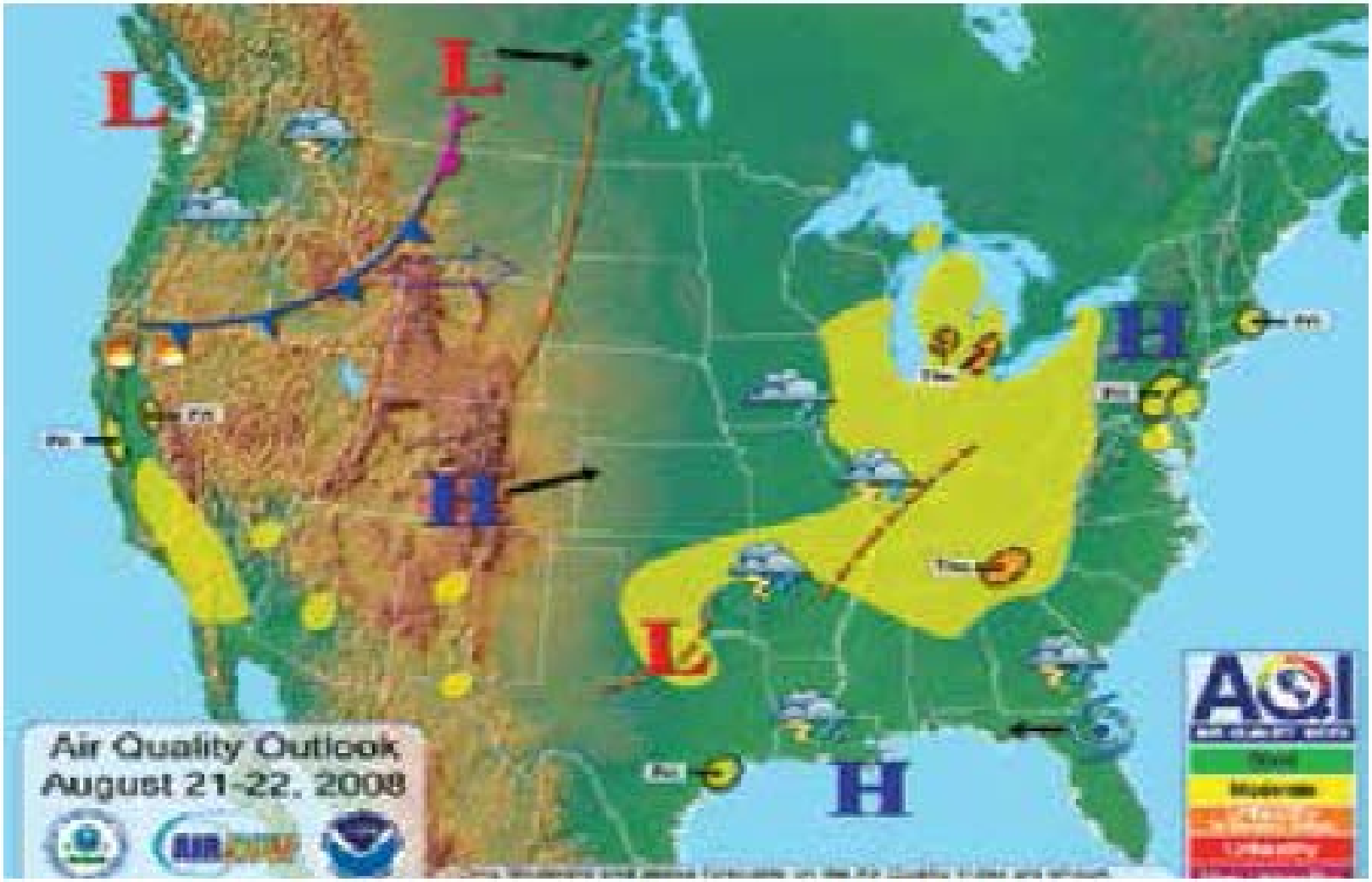
What do the AQI values mean?

The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six levels of health concern:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

AQI Value	Actions to Protect Your Health From Ozone
Good (0–50)	None
Moderate (51–100*)	Unusually sensitive people should consider reducing prolonged or heavy outdoor exertion.
Unhealthy for Sensitive Groups (101–150)	The following groups should reduce prolonged or heavy outdoor exertion: • People with lung disease, such as asthma • Children and older adults • People who are active outdoors
Unhealthy (151–200)	The following groups should avoid prolonged or heavy outdoor exertion: • People with lung disease, such as asthma • Children and older adults • People who are active outdoors Everyone else should limit prolonged outdoor exertion.
Very Unhealthy (201–300)	The following groups should avoid all outdoor exertion: • People with lung disease, such as asthma • Children and older adults • People who are active outdoors Everyone else should limit outdoor exertion.

* An AQI of 100 for ozone corresponds to an ozone level of 0.075 parts per million (averaged over 8 hours).



Example of a national AQI map available on the AIRNow Web site.

AIRBORNE LEAD EXPOSURE

Environmental Exposures to Lead

- Lead is released into the environment from:
  - Factory and automobile emissions
  - Contamination from mining and smelting
  - Lead-based paint (LBP) exposure with deterioration, demolition or renovation of pre-1978 buildings; release of lead dust and debris into the air with improper remediation/renovation/demolition
  - Incineration of lead-containing waste
  - Much of lead produced today is recovered from secondary sources of lead scrap
  - Battery recycling and electronic waste e-recycling are potentially big exposure sources that are important in some developing countries

HOUSING-RELATED LEAD SOURCES FOR U.S. CHILDREN

- OLDER HOUSING—DUST, SOIL AND PAINT CHIPS
  - ESPECIALLY OLDER, LOW-INCOME, DETERIORATED HOUSING
  - ORAL, MOBILE CHILD + OLDER, DETERIORATED HOUSING WITH DEFERRED MAINTENANCE = LEAD EXPOSURE AND ELEVATED BLOOD LEAD LEVEL (=> 5 µg/dL)
- PHILADELPHIA HOUSING, 2000 Census: 590,071 occupied units; 59% owner-occupied units ; 41% rental-occupied ; ~94% built pre-1978; 75% pre-1960; 42% pre-1940
- AMERICAN HOUSING SURVEY, PHILADELPHIA COUNTY, 2009: 91.6% pre-1978; EL PASO COUNTY, 2000: 63.5% pre-1980
- US HOUSING: 2002 HUD SURVEY: 25% of US housing (24 million units) with LBP hazards: deteriorated paint, lead in dust or bare soil (Jacobs et al, 2002)

COMMON LEAD SOURCES FOR U.S. CHILDREN-OTHER (NON-HOUSING) SOURCES

- INDUSTRY CONTRIBUTION: POINT SOURCES-SMELTERS, MINES, FACTORIES- AND PARAOCCUPATIONAL EXPOSURE (FROM PARENTS)
- LEGACY (FROM LEADED GASOLINE) OF CONTAMINATION OF SOIL FROM VEHICLE EMISSIONS (MOBILE SOURCES) NEAR MAJOR ROADS AND HIGHWAYS (EPA air lead standard decreased from 1.5 to 0.15 µg/m3 in 2008)
- ETHNIC PRODUCTS: COSMETICS/REMEDIES/FOODS, CERAMIC COOKWARE--IMPORTANT WITH MORE DIVERSE LATINO AND ASIAN POPULATIONS
- CONSUMER PRODUCTS-TOYS, LUNCH BOXES, JEWELRY, ETC.
- WATER FROM OLDER PLUMBING SYSTEMS OR PRIVATE WELLS
- Levin et al, Environ Health Perspect 2008;116:1285-1293.

CHILDREN AND LEAD EXPOSURE-OVERVIEW

- One of the major environmental problems for U.S. children
- Acute exposure can affect many body systems, particularly the CNS; CAN BE FATAL with encephalopathy
- Children are usually asymptomatic or have subtle neurodevelopmental changes, presenting years after the lead exposure
- Thousands of studies with supportive data spanning many years, many nations and populations, and blood lead levels, etc.

CHILDREN AND LEAD EXPOSURE-OVERVIEW

- Chronic, low-level exposure can lead to subtle neurodevelopmental effects
- Sometimes not recognized until older grades requiring higher-level cognitive functions
- These can impact on children's future education and employment status (as well as lead to societal costs)
- Newer studies indicate NO THRESHOLD for effects: NO LEAD IS GOOD LEAD

Children's Health and Exposures on the US-Mexico Border

- ASARCO and past "legacy pollution"
- Mobilized surface material – from the Tularosa Basin and Rio (Bravo) Grande Valley—blown by the wind, dust storms
- Review of several studies involving border areas: see list of selected studies
- EPA'S Border 2012 and 2020

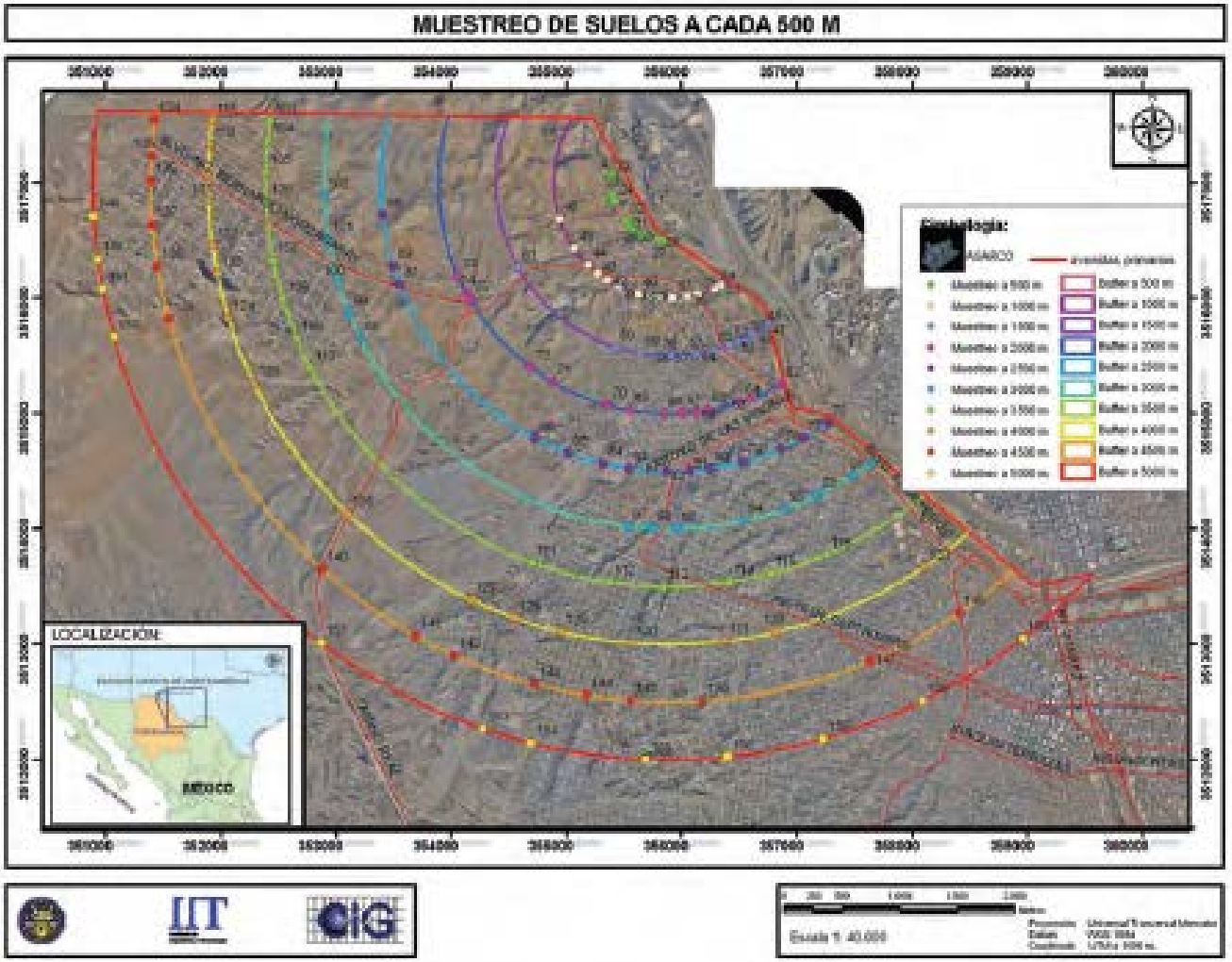
U.S.-Mexico Border Region – Región Fronteriza México-Estados Unidos

LA ESMELDA: Legacy Pollutant Point Source: ASARCO Smelter--American Smelting and Refining Company (El Paso, Texas plant)

- Operated from 1887-1999, known as “Smeltertown”
- Smelted lead, then copper, zinc and antimony (separated metals from the raw ore)
- Funded by EPA’s Border 2012, UACJ experts studied 320 soil samples from the Mexican side of the Rio Bravo (Grande)
- Found (legacy pollutants) arsenic and lead in the soil; higher concentrations at depths below the topsoil (potential for groundwater contamination?)
- Public discussions: how best to remediate contaminated areas and limit exposure on both sides of the bi-national border? Remediation started in 2010; EPA involved


ASARCO
RUSTIC FURNITURE

Researchers Trace Lead, Arsenic to Abandoned Smelter



A map shows the location of concentric rings placed at 500-meter distances from the main chimney of the ASARCO smelter. The rings were used to organize the sampling of soils on the Mexican side of the Rio Grande.

OUTDOOR AIR POLLUTION AT THE US-MEXICO BORDER

- Describe some potential exposure scenarios to outdoor air pollution for children in the US-Mexico border region (see separate list of selected studies)
- Sarnat et al: Studied 58 asthmatic children from 2 schools in El Paso and 2 schools in Ciudad Juarez; first binational study of the impacts of air pollution on asthmatic children in this particular border region
- Looked at exhaled nitric oxide (eNO; is marker of airway inflammation) and certain indoor and outdoor pollutants (PM, black carbon, and nitrogen dioxide)
- "We observed small but consistent associations between eNO and numerous pollutant metrics..."
- Traffic and non-traffic related PM were more robust predictors of increased eNO than nitrogen dioxide
- REF: Sarnat et al, EHP 120; 2012:437-444

EPA'S BORDER 2012 and 2020 and Other Border Initiatives

- Precursor border initiatives and groups:
  - International Boundary and Water Commission (USIBWC); created in 1889
  - Commission for Environmental Cooperation (US/Mexico/Canada; http://www.cec.org; cooperative agreements since 1994
  - Border Environment Cooperation Commission (formed in 1994; headquartered in C. Juarez)
  - US-Mexico Border Health Commission; created in 2000 by Secretary of Health and Human Services of the United States and the Secretary of Health of México; http://www.borderhealth.org/
- Border 2012: SEMARNAT (Mexico) and US EPA;EPA Border 2012 activities on website

EPA'S BORDER 2020

- Border 2020 overall goals: Reduce pollution in water, air, and on land; reduce exposure to chemicals from accidental releases or terrorism; and improve environmental stewardship
- Partner groups include state health departments of Arizona, California, New Mexico,Texas (many have offices of border health); IBWC; BECC; CEC; US DEPT. OF HHS
- PDF: Toxics Releases Inventory (TRI) Update Texas Border Counties Reporting Years 2009-2011
- Website: http://www2.epa.gov/border2020

Border 2020: Region 6: Texas, New Mexico, Chihuahua, Air Regional Workgroup

- Air pollution goal 1: By 2020, promote reduction of high-emission vehicles and reduce vehicle emissions at border ports-of-entry through anti-idling and other measures
- Air pollution goal 2: By 2020, reduce pollutant emissions to approach attainment of respective national ambient air quality standards (EPA's NAAQS)

Border 2012
Accomplishments Report (2010–2012)

U.S.–Mexico Environmental Program

LEGACY POLLUTANT POINT SOURCE: ASARCO SMELTER

For more than 100 years, the ASARCO smelter on the banks of the Rio Grande in El Paso pumped contaminants into the air from a firing process that separated copper, zinc and lead from raw ore. In the late 1990s, the smelter's owners suspended operations and agreed to pay $19 million for environmental cleanup on the U.S. side of the border. At the time, little was known about the extent of contamination in Mexico. With funding from Border 2012, engineers from the Autonomous University of Ciudad Juárez and experts from Chihuahua's Centro de Investigación de Materiales Avanzados tested 320 soil samples taken from the Mexican side of the Rio Grande just across the border from ASARCO's abandoned smokestacks. To plot their findings, the researchers drew concentric rings at 500-meter distances from the smelter's main chimney and displayed the results on digital maps and satellite images. The study found that concentrations of arsenic and lead generated by the smelter remain in the soil on the Mexican side of the river in Ciudad Juárez. In some samples, arsenic and lead were measured in higher concentrations at depths below the topsoil, raising concerns about the potential for groundwater contamination. The study prompted public discussions about the best measures to remediate the contaminated areas on the Mexican side of the river and how to limit exposure to residents on both sides of the bi-national border.

Mexicali Media Campaign Targets Seasonal Fireworks, Open Burning

Seasonal contaminants pollute the air in Mexicali, Baja California.

Tijuana Colonia Reroutes Commercial Trucks to Bypass School

A street map shows areas near Tijuana's Colonia Chilpancingo that are now prohibited to commercial diesel traffic.

INTERVENTIONS WORK: Gauderman et al Study and Dockery editorial, NEJM 2015

- Gauderman et al studied 1759 10 year-old children from Southern California cities through 18 years and found that NO2, acid vapor , PM < 2.5µm and elemental carbon exposure significantly associated with diminished lung function. Similar to exposure to 2nd hand tobacco smoke.
- The authors "found that long-term improvements in air quality were associated with statistical and clinically significant positive effects on lung-function growth in children."
- Editorial "Clean Air, Bigger Lungs": Children living in in more polluted communities had lower cumulative lung growth; importance as this is "predictive of respiratory disease, coronary heart disease, and reduced life expectancy."

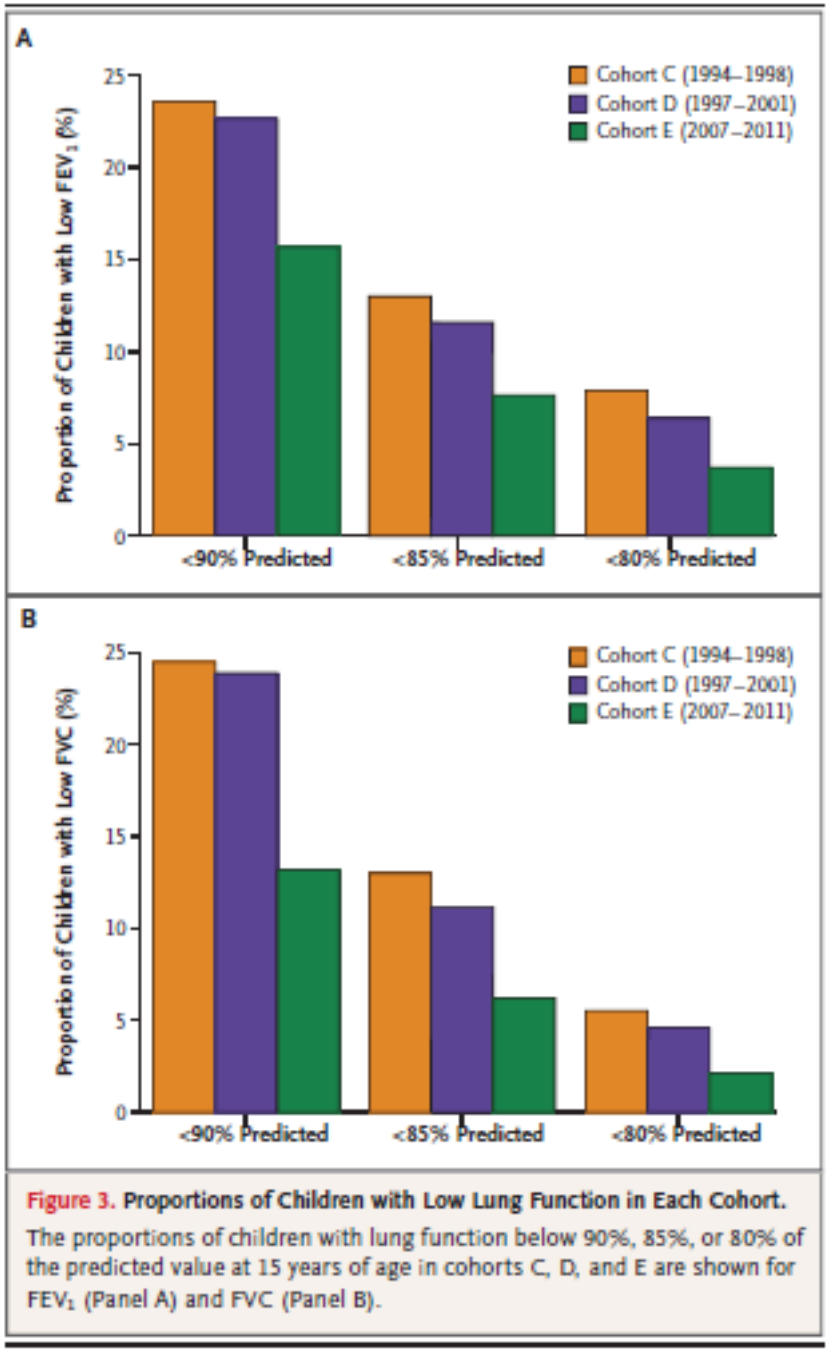


Figure 3. Proportions of Children with Low Lung Function in Each Cohort.

The proportions of children with lung function below 90%, 85%, or 80% of the predicted value at 15 years of age in cohorts C, D, and E are shown for FEV_1 (Panel A) and FVC (Panel B).

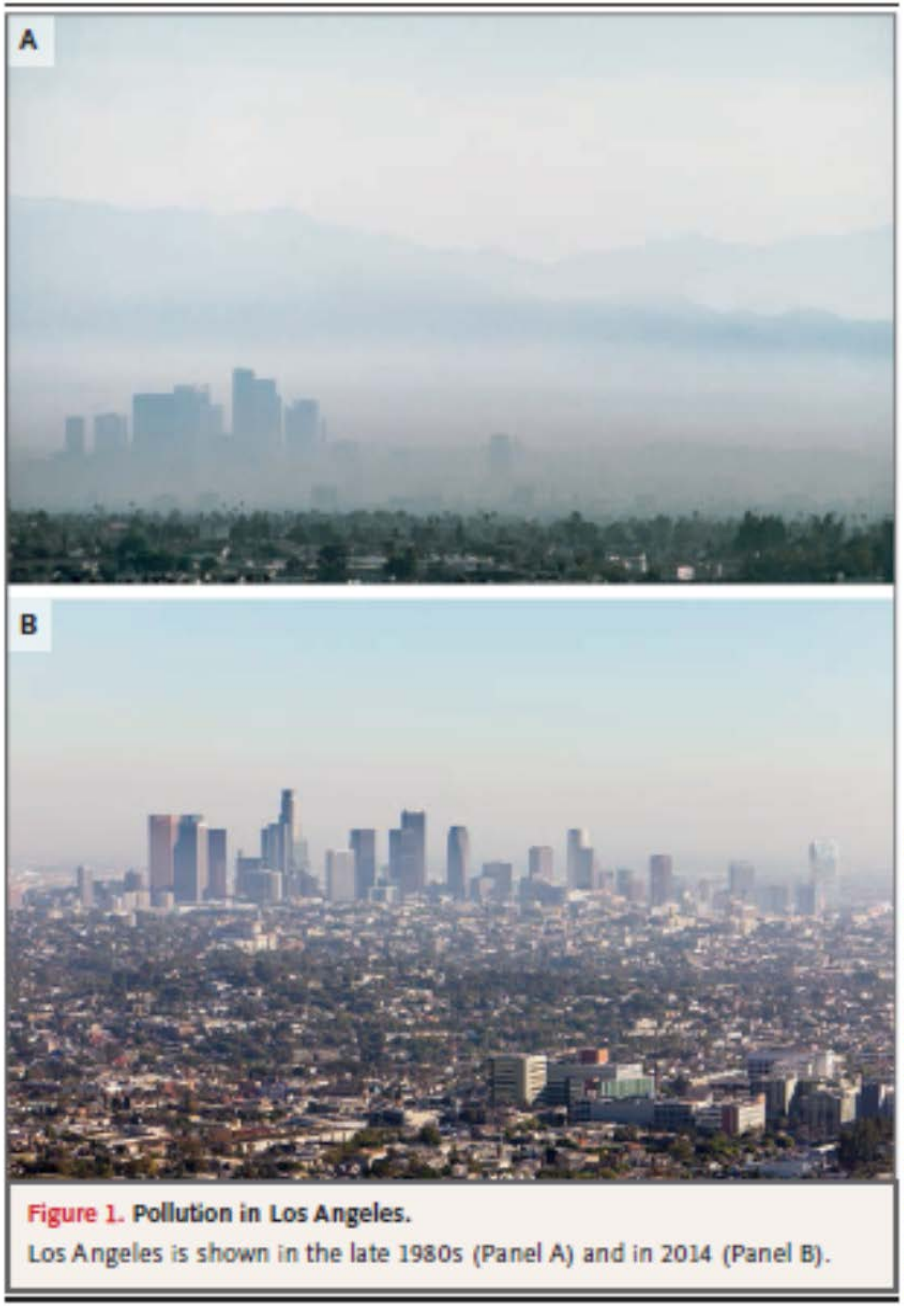


Figure 1. Pollution in Los Angeles.

Los Angeles is shown in the late 1980s (Panel A) and in 2014 (Panel B).

Ted Spiegel/Corbis (Panel A); Ted Soqui/Corbis (Panel B)

INTERVENTIONS WORK: Less Air Pollution Leads to Rapid Reduction of Airway Inflammation and Improved Airway Function in Asthmatic Children

- 37 untreated allergic children with mild persistent asthma were relocated for one week from a highly-polluted urban environment to a less-polluted rural environment
- After one week in the less-polluted setting, there was a fourfold decrease in nasal eosinophils and significant decrease in exhaled nitric oxide (eNO)
- The group observed an improvement in lower airway function (with significant increase in peak expiratory flow)
- The group concluded that "better air quality is associated with a rapid reduction in airway inflammation in allergic asthmatic children".
- REF: Renzetti et al, Pediatrics 2009;123:1051-1058

MEASURES TO REDUCE OR PREVENT EXPOSURES TO OUTDOOR CHEMICAL AIR POLLUTANTS (REDUCE GHGs)

- Advocate for public policies that promote sustainable (less-polluting) energy sources, less reliance on fossil fuel burning, and reduced energy use in general
- Decrease pollution by walking, biking, taking mass transit for transportation choices
- Monitor the daily Air Quality Index (ozone and particle pollution; 0-300 scale) if family members have asthma or other conditions made worse by poor quality outdoor air
- Parents, teachers, coaches can limit outdoor exercise/practice on days with high AIQ index and avoid student exposure to idling buses
- Close windows; use air conditioning on high AQI Index days

WHAT LEGACY WILL WE LEAVE OUR CHILDREN?

- “Children are not merely a special vulnerable group within our population but rather the current inhabitants of a developmental stage through which all future generations must pass. Protection of the health of fetuses, infants, and children is essential for sustainability of the human species.”
  - REF: Landrigan et al, 2004.
- “The test of the morality of a society is what it does for its children.”
  - Dietrich Bonhoeffer

RESOURCES FOR CHILDREN'S ENVIRONMENTAL HEALTH

- American Academy of Pediatrics (AAP): Council on Environmental Health (COEH); http://www.aap.org/visit/cmte16.htm
- and AAP Department of Federal Affairs at: FederalAdvocacy@aap.org
- American Lung Association (Mid-Atlantic)
  - http://alapa.org; 610-941-9595
- CDC, NCEH: Lead Poisoning Prevention Branch http://www.cdc.gov/nceh/lead and NCEH: Asthma Program; www.cdc.gov/asthma
- Children's Environmental Health Network (CEHN)
  - http://www.cehn.org/index.html

RESOURCES FOR CEH

- EPA-Office of Children's Health Protection:
  - http://yosemite.epa.gov/ochp/ochpweb.nsf/content/homepage.htm
- EPA-Office of Indoor Air Quality (IAQ); http://www.epa.gov/iaq/index.html and http://www.epa.gov/iaq/ia-intro.html
- Moms Clean Air Force; www.momscleanairforce.org
- National Center for Healthy Housing
  - www.healthyhousing.org; 410-992-0712
- National Institute for Environmental Health Sciences (NIEHS; NIH); National Toxicology Program (NTP) http://www.niehs.nih.gov
- Physicians for Social Responsibility (PSR); http://www.psr.org/environment-and-health/

RESOURCES FOR CEH

- Pediatric Environmental Health Specialty Units (PEHSUs): 5 centers in Eastern US through America Academy of Pediatrics and 5 centers in Western US through the American College of Medical Toxicology
- Southwest Center for Pediatric Environmental Health, PEHSU Region 6, Texas Tech University Health Sciences Center at El Paso;
- http://swcpeh.org/; 888-901-5665 in region; 915-534-3807 outside region

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Questions?