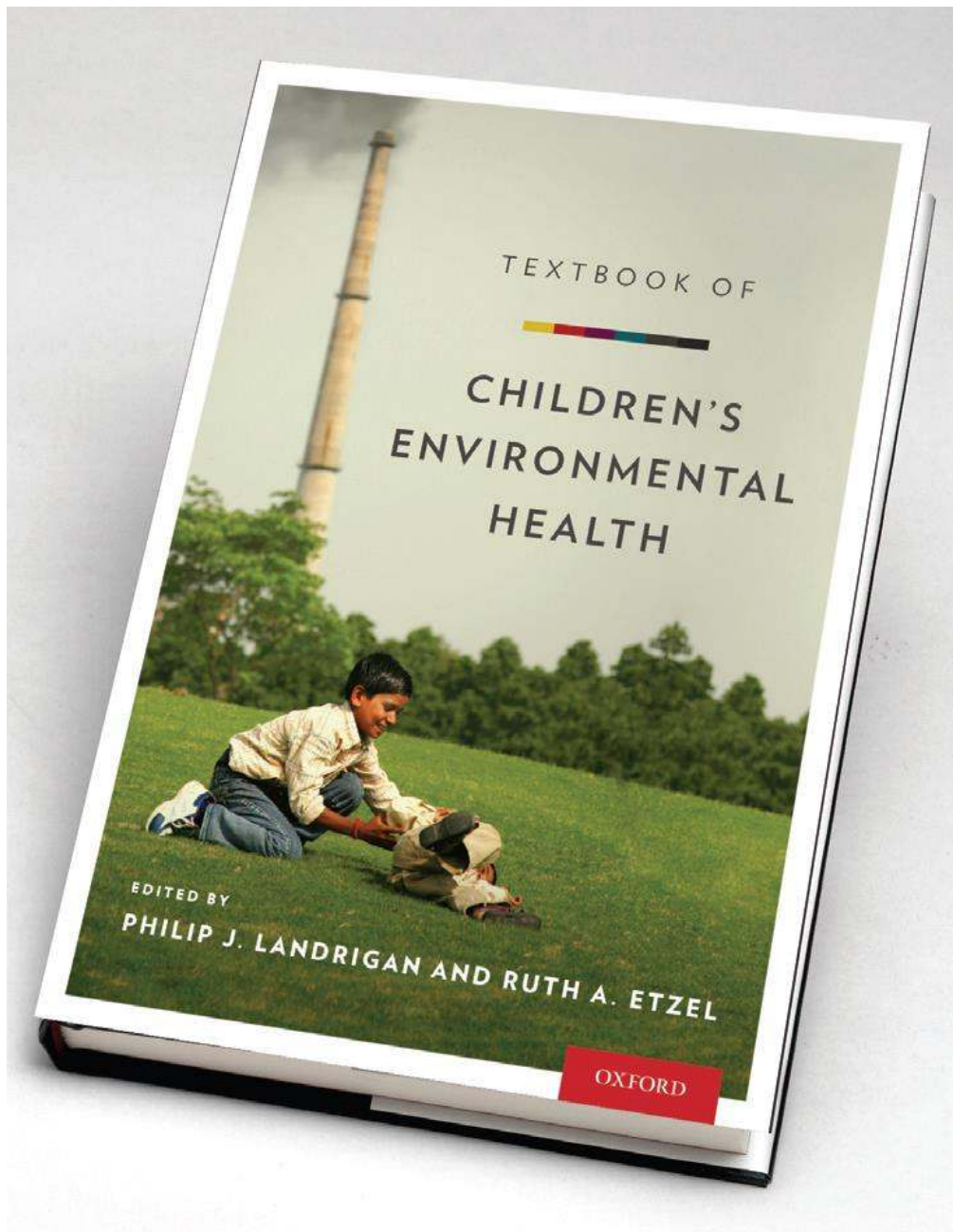


# **CHILDREN'S ENVIRONMENTAL HEALTH**

CHE-Alaska Teleconference  
March 12, 2014



# WHY WRITE THIS BOOK?

- Children's environments and patterns of disease in children have changed profoundly over the past 5 decades.
- The prevalence of autism, asthma, ADHD, obesity, diabetes, and birth defects have increased substantially in children around the world.
- At the same time, more than 80,000 new chemicals have been developed and released into the global environment.
- Today the World Health Organization attributes 36% of all childhood deaths around the world to environmental causes.

How much disease could be prevented by modifying the environment?

# WHO Environmental Burden of Disease Working Definition of Environment

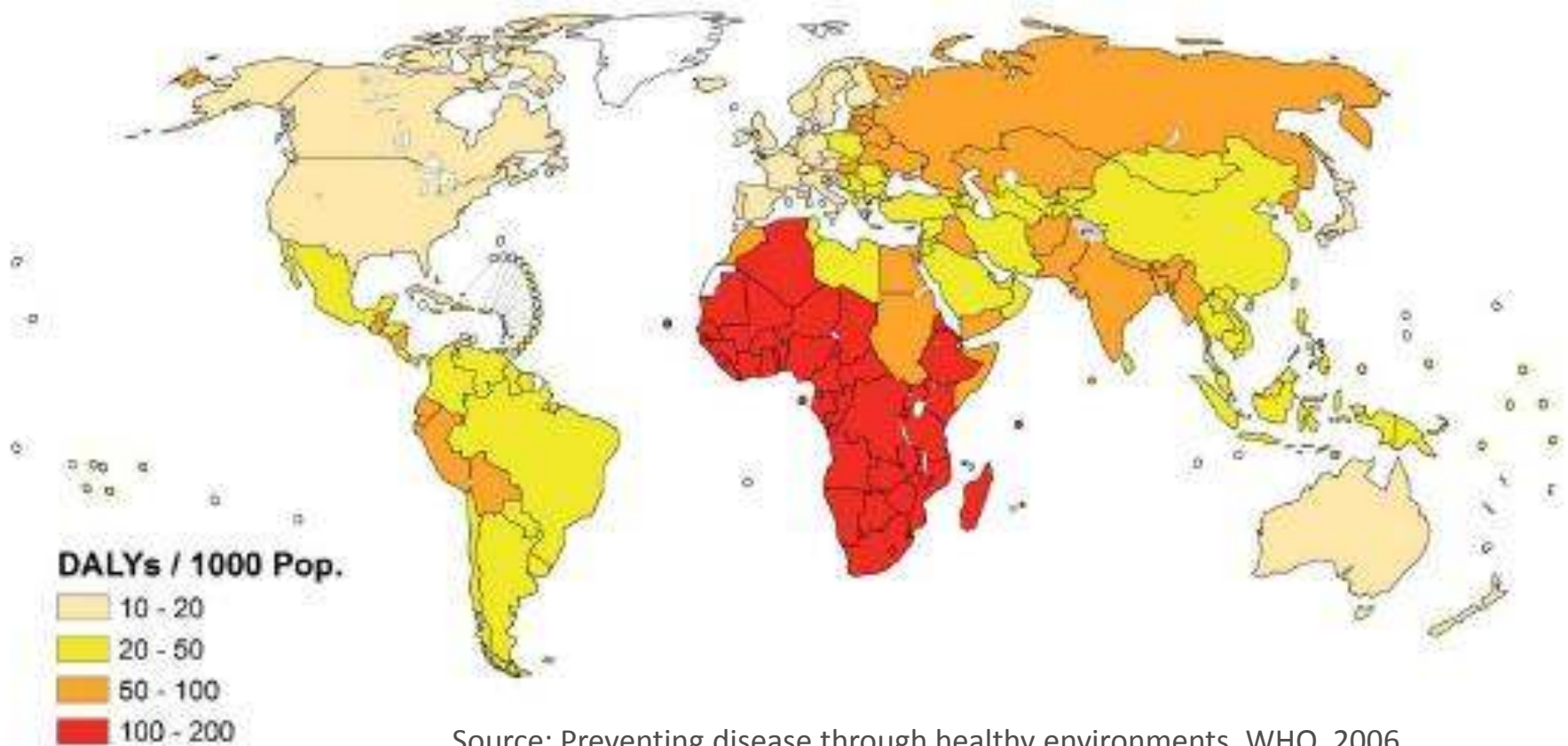
## Included:

Air, water, soil pollution  
Radiation  
Noise  
Occupational risks  
Built environment  
Agricultural methods  
Climate change  
Handwashing

## Not Included:

Alcohol, tobacco, drugs  
Diet  
Bed nets  
Unemployment  
Natural hazards  
Person-to person  
transmission

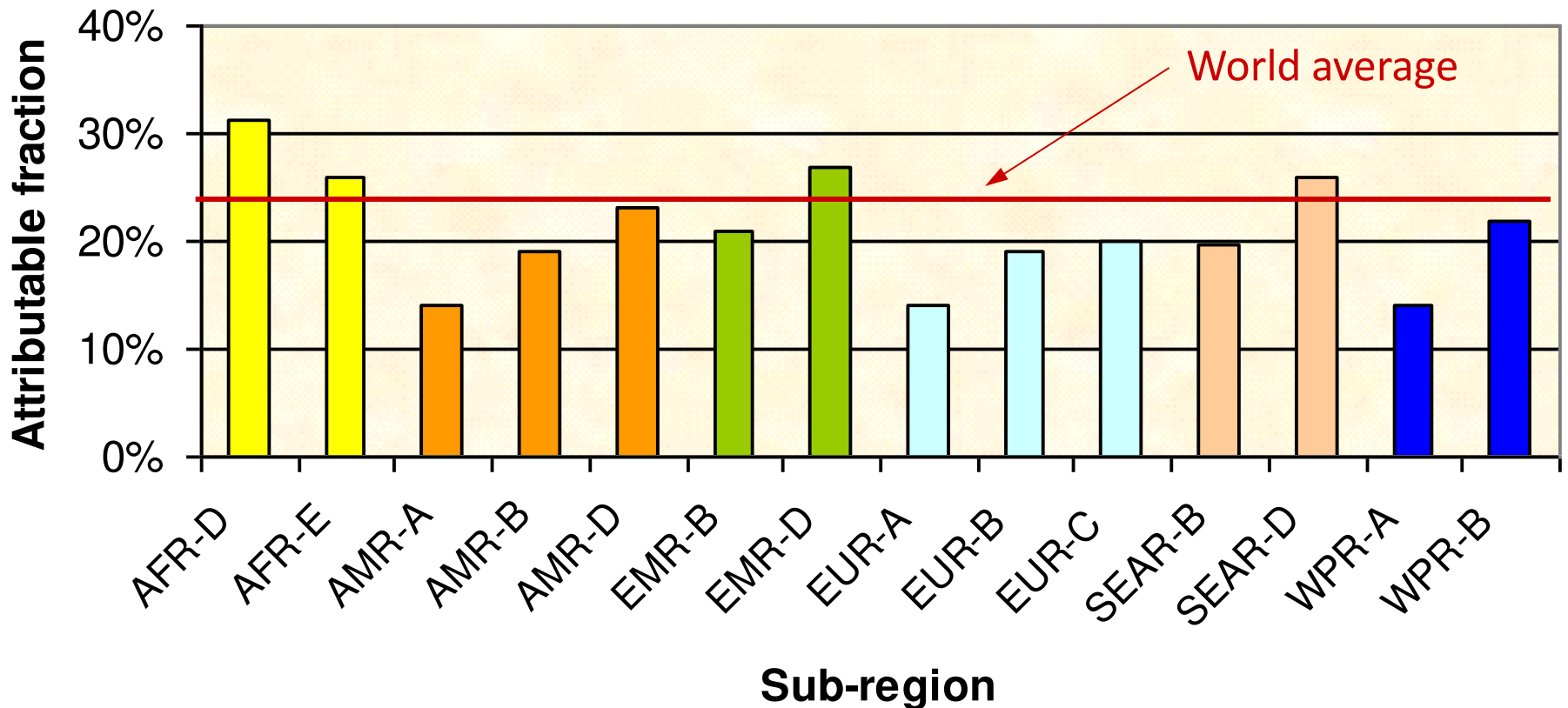
# THE GLOBAL BURDEN OF ENVIRONMENTAL DISEASE



Source: Preventing disease through healthy environments, WHO, 2006

# HOW MUCH DISEASE COULD BE PREVENTED BY MODIFYING THE ENVIRONMENT ?

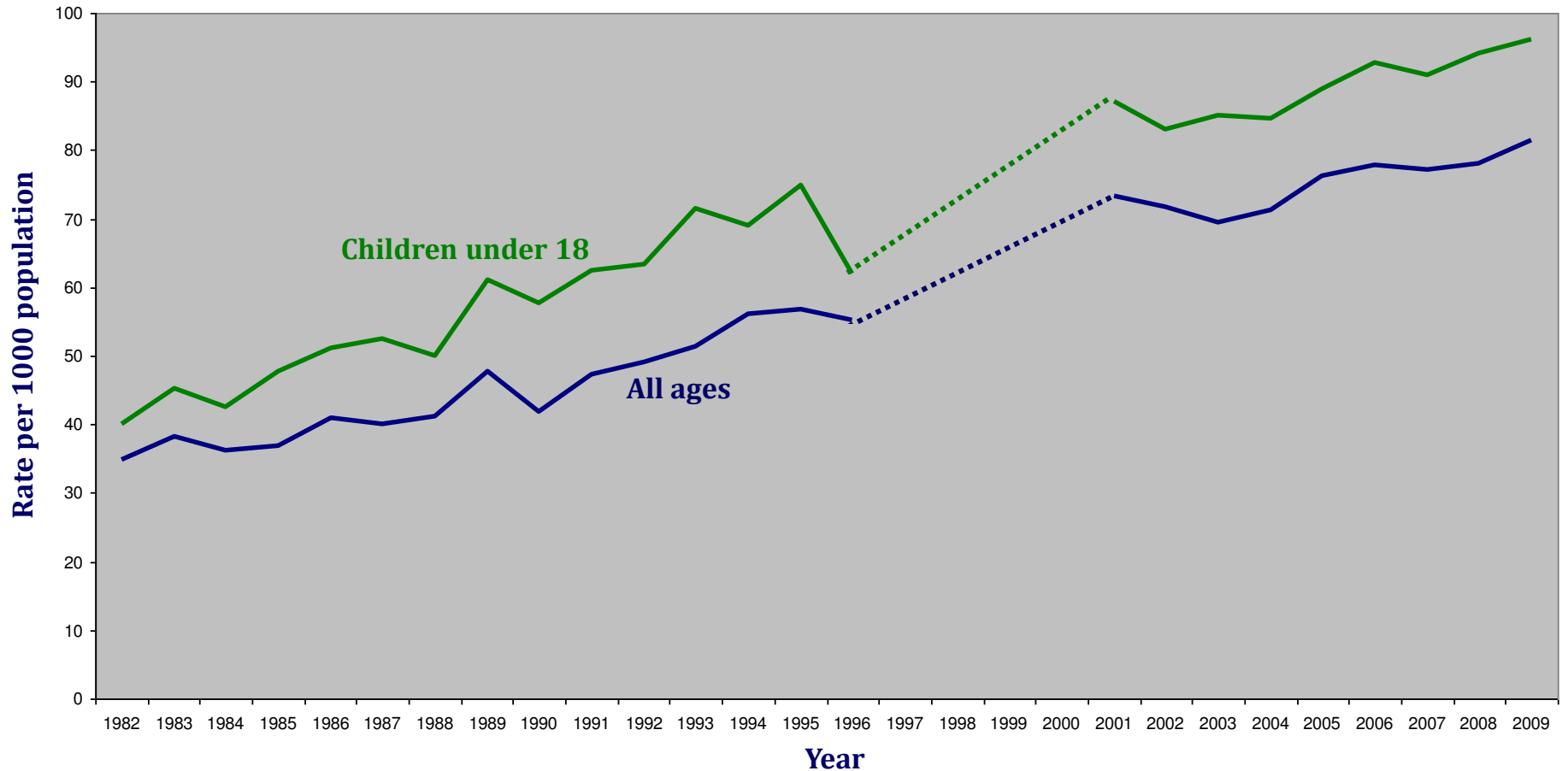
*Current evidence - best conservative estimate 24%*



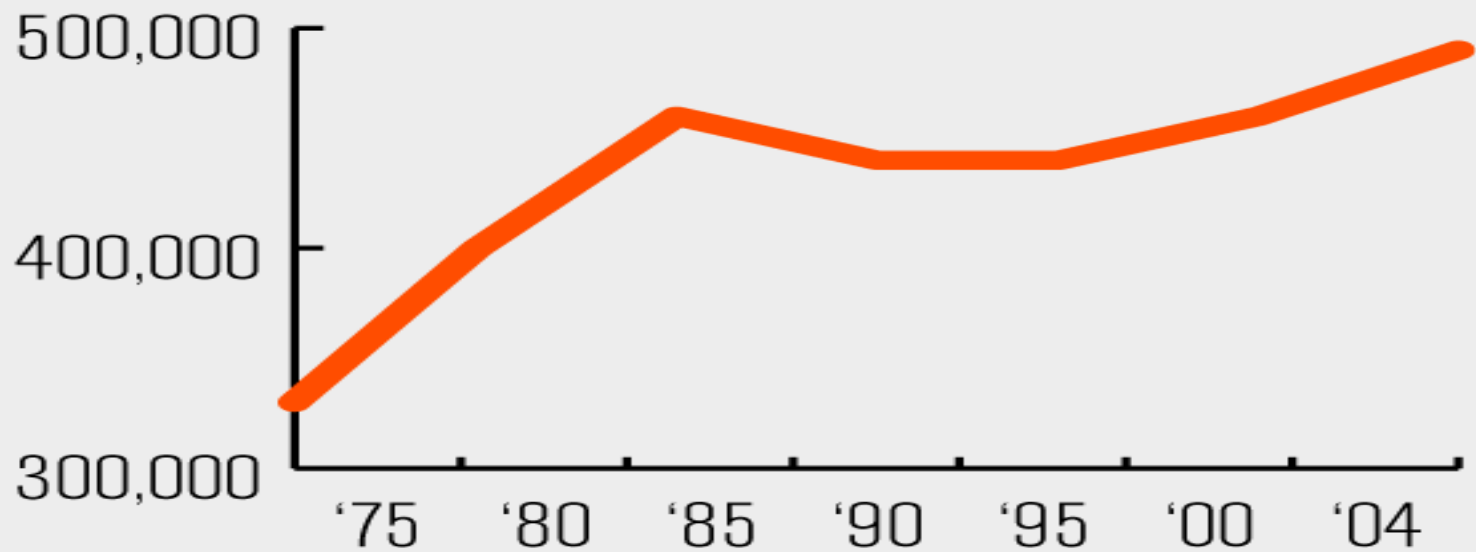
# ENVIRONMENTAL DISEASE IN NORTH AMERICAN CHILDREN

- Predominantly chronic diseases
- These diseases are on the rise

# ASTHMA – US PREVALENCE BY AGE AND YEAR, 1982–2009



# Incidence of Childhood Leukemia 1975-2004



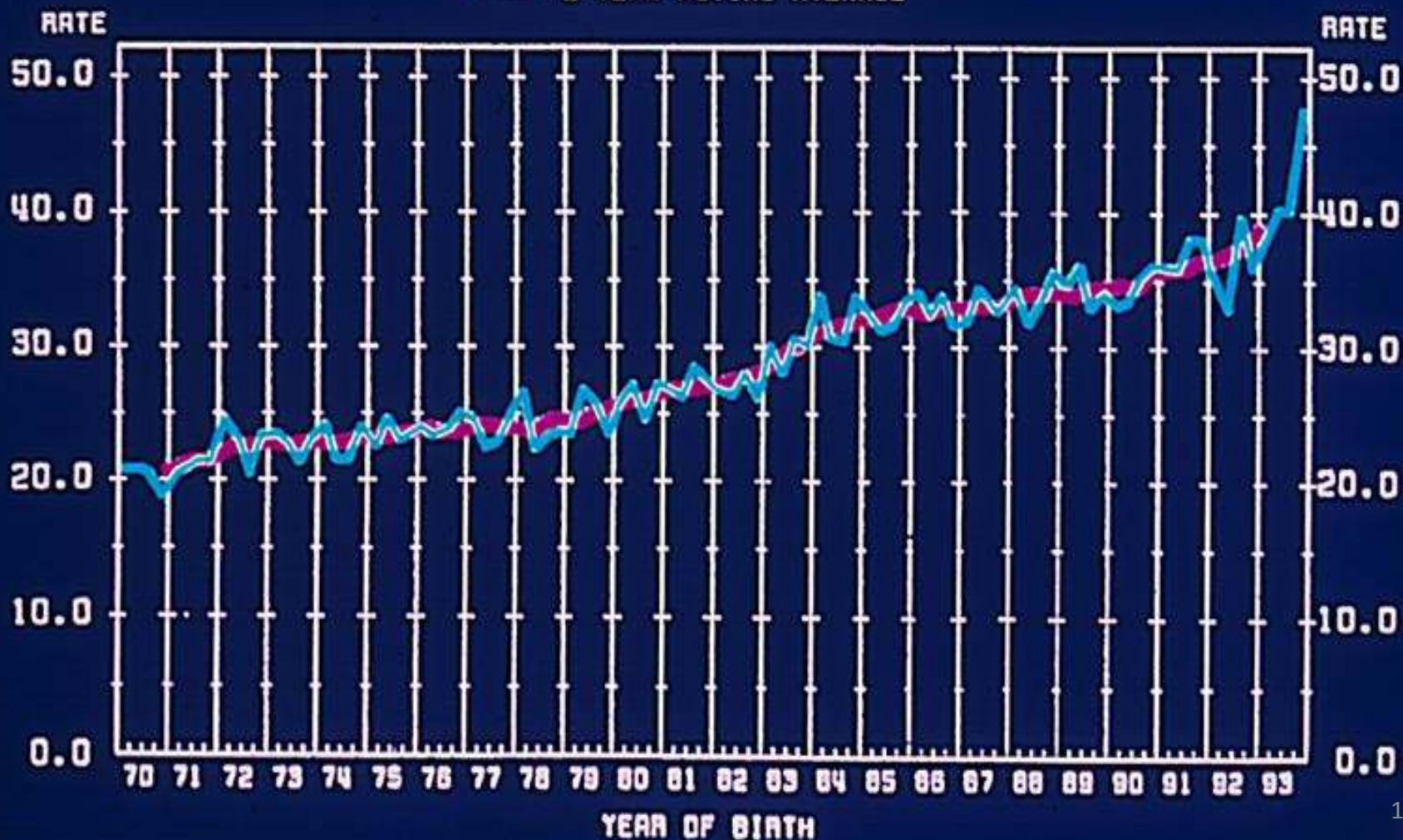
# HYPOSPADIAS/EPISPADIAS

TRENDS IN REPORTED INCIDENCE, BY QUARTER OF BIRTH,  
BIRTH DEFECTS MONITORING PROGRAM / CPHA

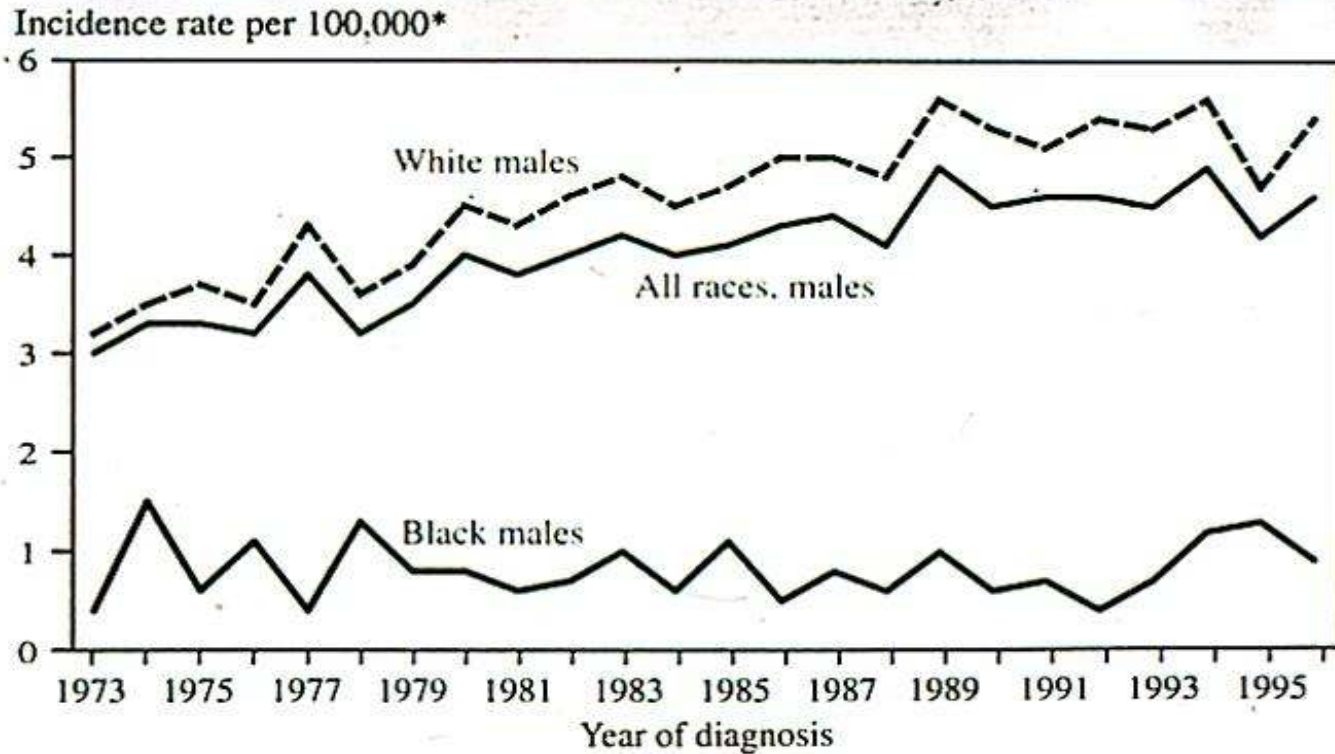
JAN 1970 - DEC 1993

(RATES PER 10,000 TOTAL BIRTHS)

— QUARTERLY RATES  
— 2-YEAR MOVING AVERAGE



# US INCIDENCE OF TESTICULAR CANCER



\*Age-adjusted to the 1970 U.S. standard population.

Sources: *SEER Cancer Statistics Review, 1973-1996* (NCI 1999) and *Cancer Rates and Risks, 4th edition* (NCI 1996); access at <http://www-seer.ims.nci.nih.gov>

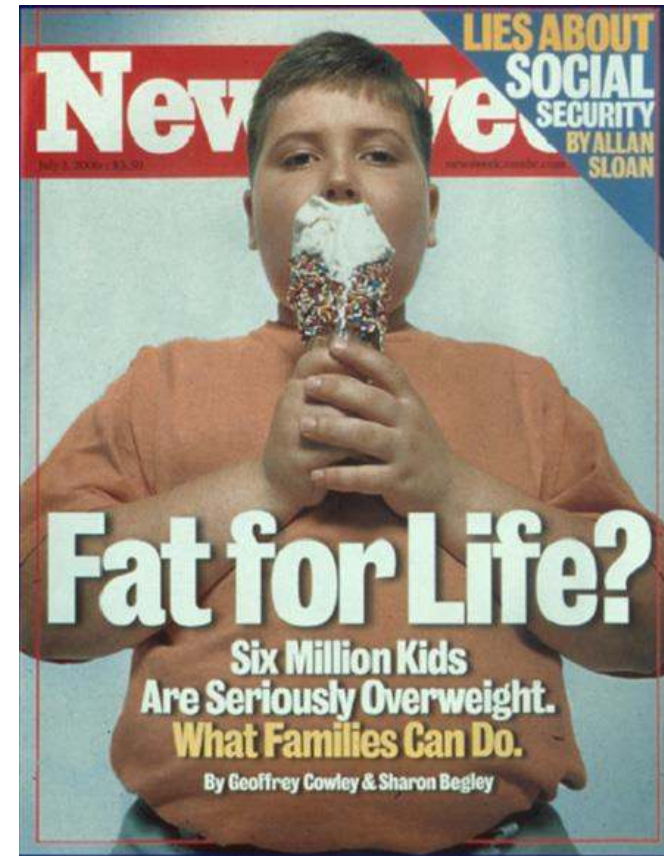
# OVERWEIGHT AND OBESITY

Prevalence has more than tripled in American children in 30 years from 5% in the 1970s to 17% today

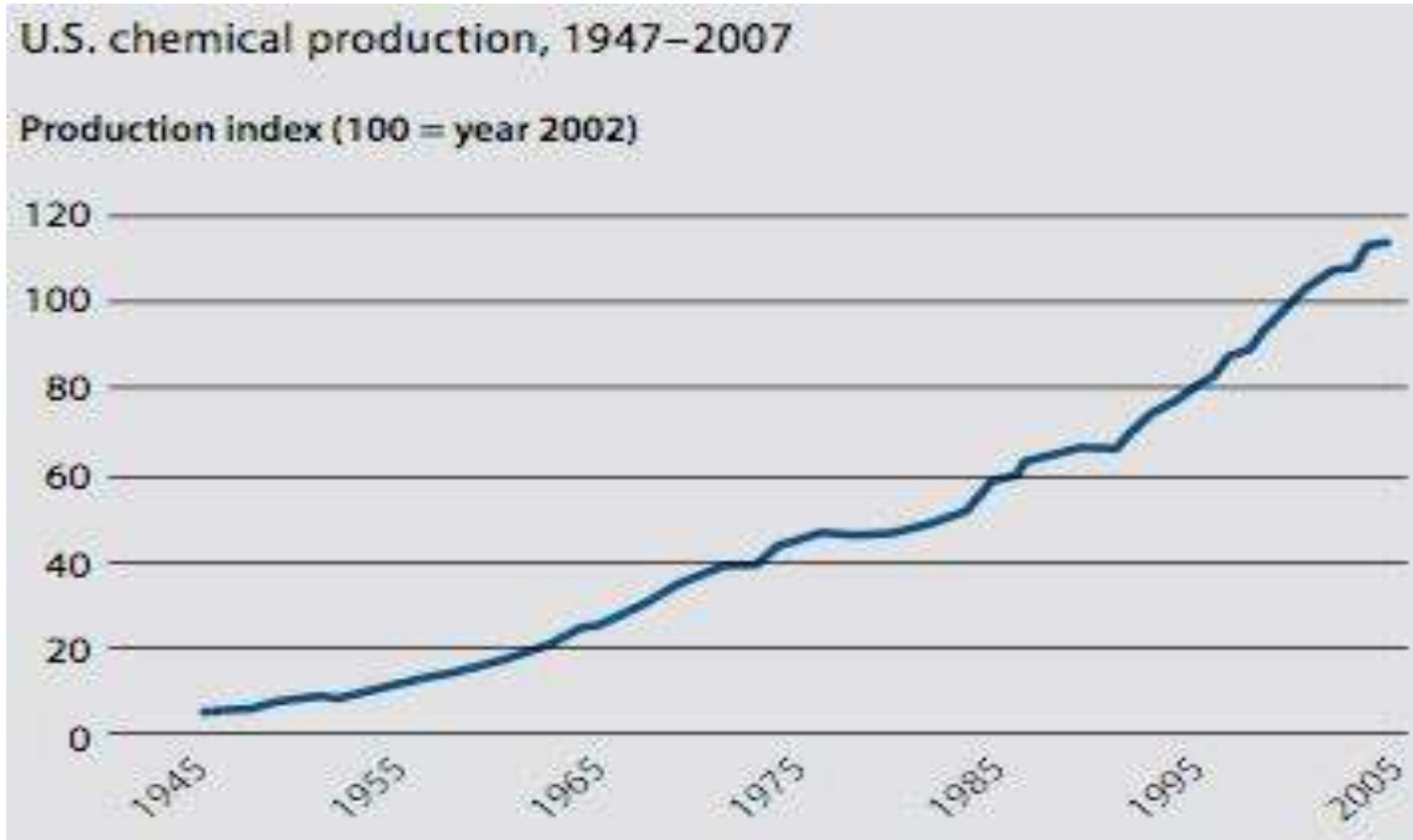
Stark disparities by socioeconomic status, race and ethnicity

Serious consequences for child health: 2.5-fold increased risk of overall mortality ; 4-fold risk of cardiovascular mortality; 5-fold risk of diabetes

Terrible demographic consequences: This could be the first generation of US children in a century to have shorter life expectancy than their parents



# CHEMICAL PRODUCTION UNITED STATES, 1947-2007



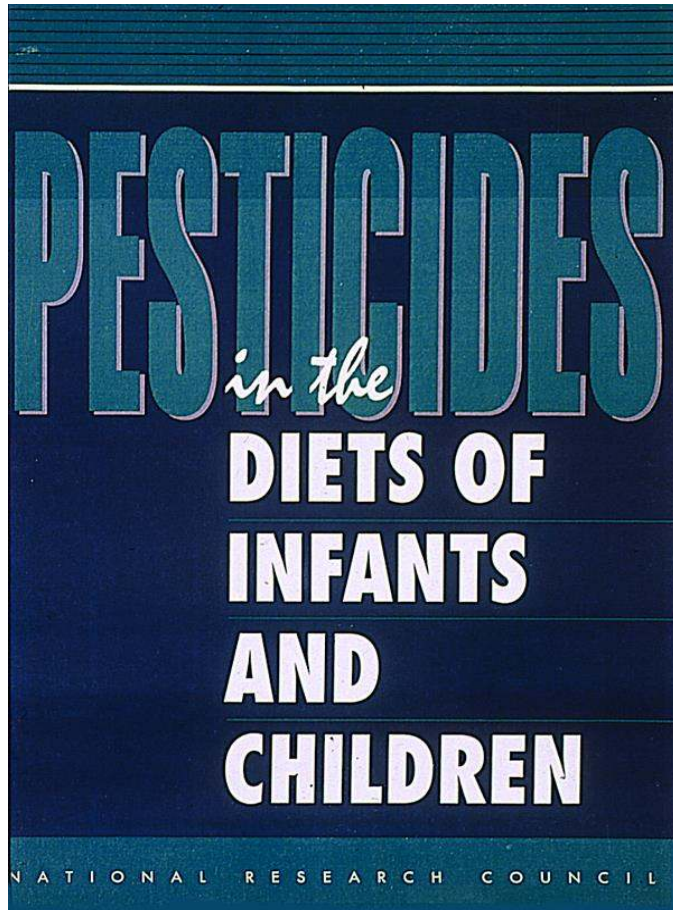
# CHILDREN TODAY ARE EXPOSED TO THOUSANDS OF SYNTHETIC CHEMICALS. MOST HAVE NOT BEEN TESTED FOR TOXICITY

- 80,000+ chemicals in commerce
- Most invented in the past 30-40 years
- 3,000 are high production volume (HPV) chemicals
- No basic toxicity information is publicly available for nearly half of HPV chemicals
- Information on developmental toxicity is available for less than 20% of HPV chemicals
- Many HPV chemicals are detectable in adult blood, breast milk and infant cord blood

# DEVELOPMENTAL DISABILITIES

- Affect 10-15% of all children
- Include: Dyslexia  
ADHD  
Mental Retardation  
Autism
- Reported incidence is increasing

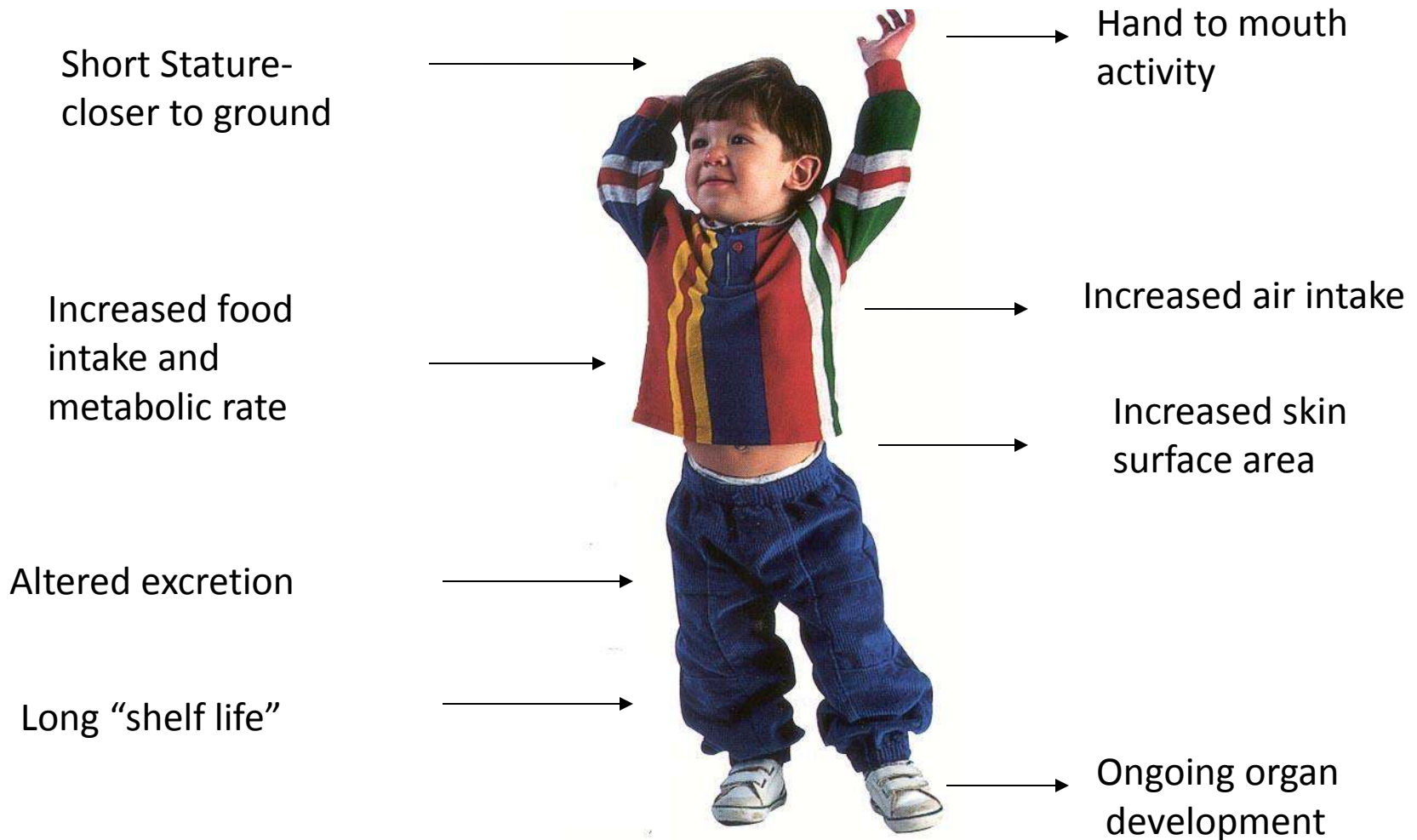
# CHILDREN ARE ESPECIALLY VULNERABLE TO TOXIC CHEMICALS IN THE ENVIRONMENT



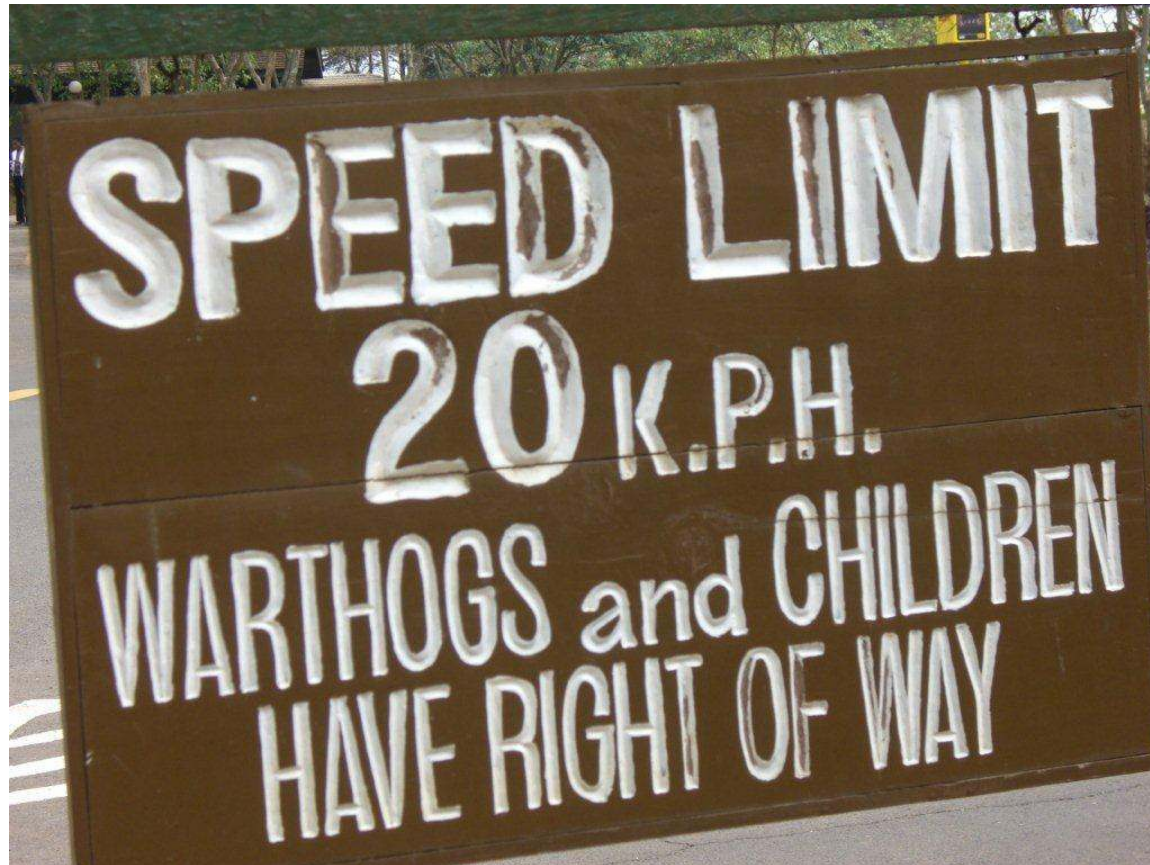
- Greater exposure proportionate to body mass—  
*7 times more water per Kg per day; Hand-to-mouth activity*
- Diminished ability to detoxify many chemicals
- Heightened biological vulnerability  
*—thalidomide, DES, fetal alcohol syndrome*
- More years of future life

**CHILDREN ARE NOT LITTLE ADULTS**

# CHILDREN ARE NOT LITTLE ADULTS



# Vulnerable Groups

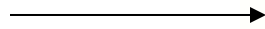


Courtesy of Dr. Jerry Nasenbeny

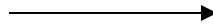
# CHILDREN LIVING WORLDS APART

## Philadelphia

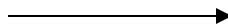
Lead in tap  
water



Pesticide residues  
in foods

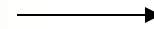


Mercury in  
sneakers

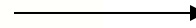


## Philippines

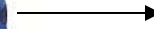
No tap for  
running water



Deaths from  
drinking pesticides



Mercury from  
small-scale gold  
mining



# STRONG AND GROWING EVIDENCE OF LINKS BETWEEN TOXIC CHEMICALS AND DISEASE

Air pollution and asthma –

Indoor and outdoor triggers

Environmental exposures and pediatric cancer –

Ionizing radiation, DES, pesticides, benzene

Endocrine disruptors and male reproductive problems –

Emerging evidence for phthalates. Still early stage

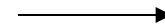
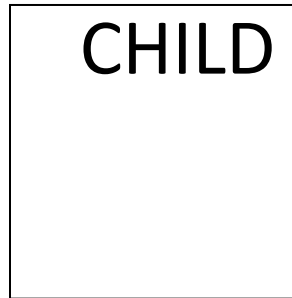
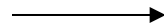
Neurodevelopmental disorders –

Lead, Methylmercury, PCBs, PBDEs, Phthalates,  
BPA, PAH, Fluoride, Solvents, Organophosphates

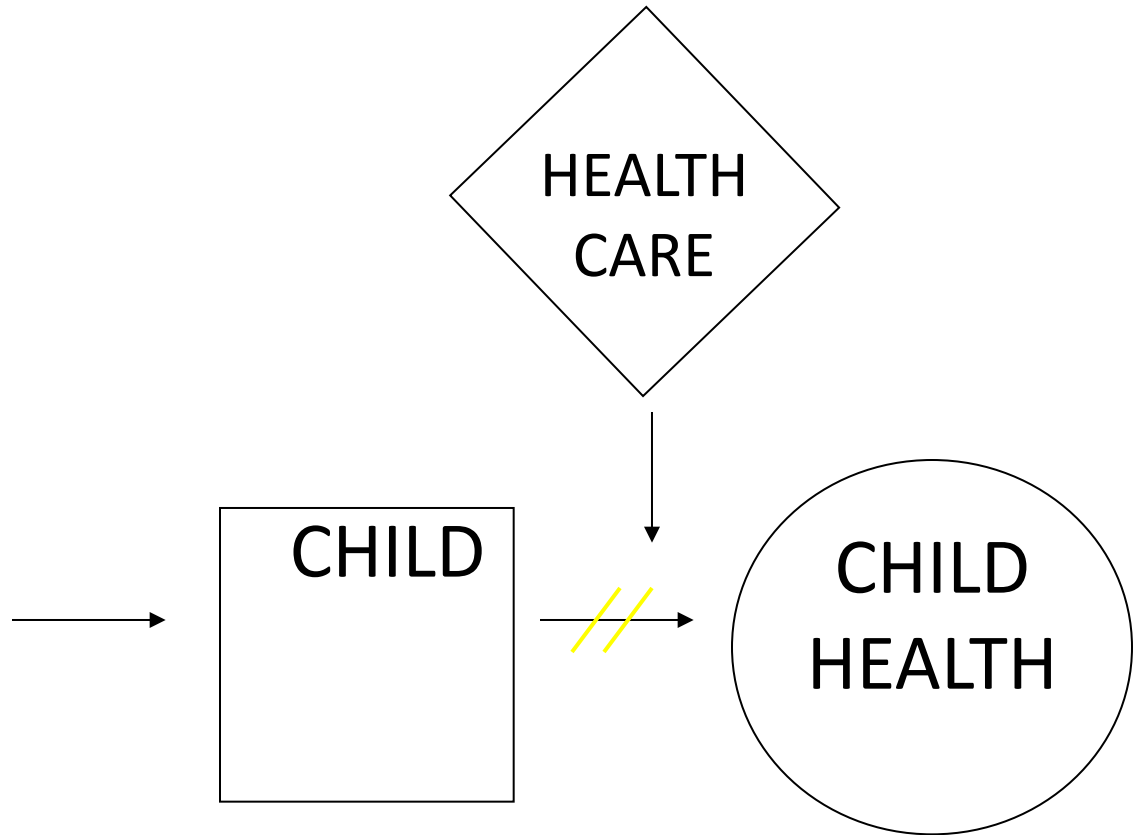
# Womb, safe womb?



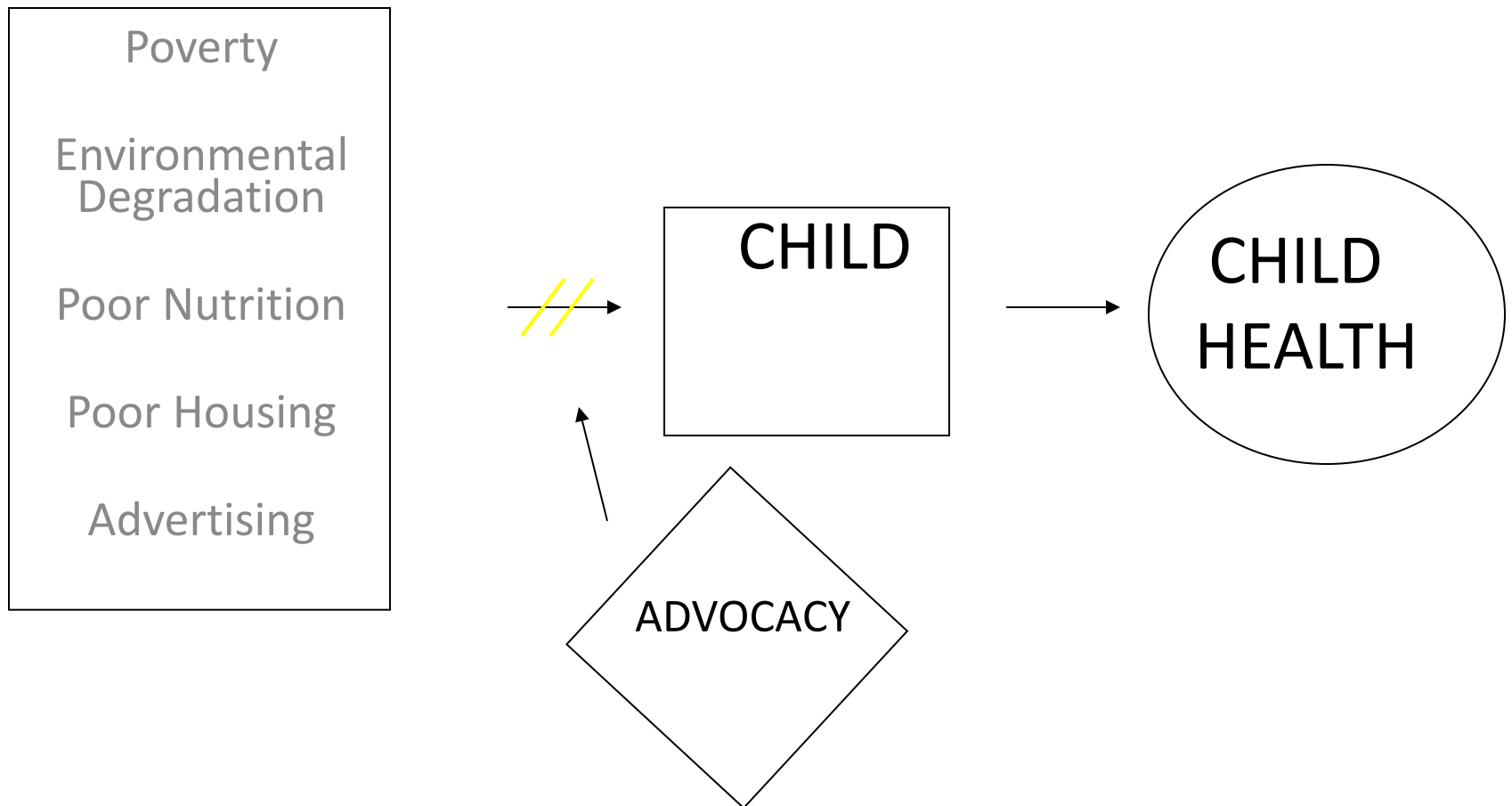
## UNDERLYING FACTORS



# UNDERLYING FACTORS



## UNDERLYING FACTORS



# ORGANIZATION OF THE BOOK

- 60 chapters by 85 authors on 5 continents
- Introductory/Overview chapters
- Chapters on children's environments
- Chapters on environmental hazards
- Chapters on the major diseases of environmental origin in children
- Chapters on prevention and control of diseases of environmental origin in children

**Home, safe home?**



# Home, safe home?

- Where does the family's water come from?
- What fuel is used for cooking?
- Is there any smoking or tobacco use?
- Does the home have any water damage or mold?
- Use of chemicals in or around home?

# MOLDS

- ❖ A frequently undetected environmental problem
- ❖ Occur in damp indoor areas
- ❖ Allergies and nonspecific symptoms are common, also rare conditions such as lung bleeding

Mold growing on a wooden headboard in a room with high humidity.



# INFANT ACUTE PULMONARY HEMORRHAGE



- **Emerging data show an association with indoor exposure to moldy home environments**
- **Mycotoxins on surface of spores may lead to capillary fragility**
- **Additional research ongoing**

# CHEMICAL AGENTS PRODUCED BY MOLDS

Mycotoxins are associated with human disease and cause acute and chronic effects

- ❖ Mycotoxins
  - Aflatoxins
  - Tricothecenes
  - Ochratoxins and citrinin
  - Hundreds of others
- ❖ Glucans (cell wall components)
- ❖ Volatile organic compounds (irritating)

# MOLD-RELATED CONDITIONS

- ❖ Airway and conjunctival irritation
- ❖ Headache
- ❖ Difficulty in concentrating
- ❖ Hypersensitivity reactions: asthma, rhinitis
- ❖ Systemic infections (immunosuppressed child)
- ❖ Acute exposure associated with pulmonary haemorrhage in infants

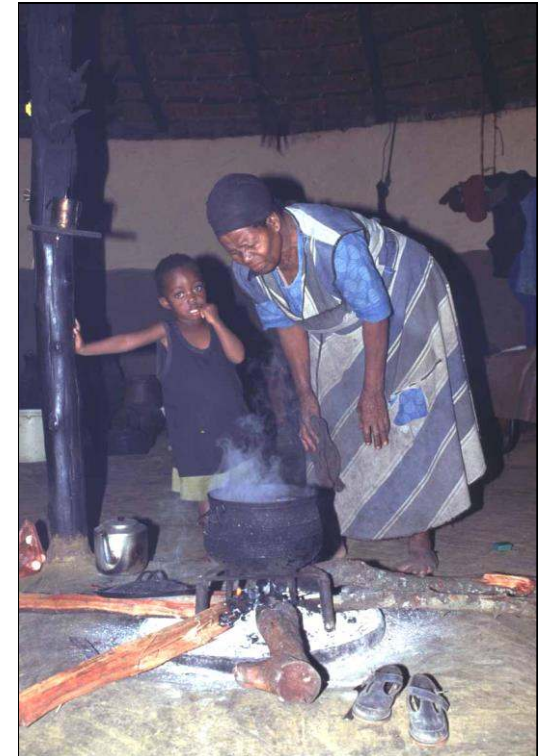
# Water-damaged home environments

- Cleaning up visible mold is not enough!
- Mold requires water
- Find out where the water is coming from
- Fix the source

# Indoor Smoke

## An Important Health Hazard for Children

- Much of the world relies on biomass fuels (e.g. wood, dung, charcoal) and coal for cooking and space-heating
- Burning such solid fuels on traditional stoves leads to high levels of indoor smoke, a complex mix of pollutants (e.g. PM, CO, carcinogens)
- Exposure doubles the risk of pneumonia among children and triples the risk of chronic respiratory diseases among women.



Courtesy of Nigel Bruce/Practical Action

# Reason for Hope: Effective and Cost-effective Solutions Exist

- More fuel-efficient and cleaner-burning stoves and cleaner fuels (e.g. gas, biogas) can reduce indoor smoke.
- These solutions can also decrease pressure on forests and reduce greenhouse gas emissions, presenting an opportunity for carbon trading.
- A switch to cleaner fuels results in a 7-fold return on investment, a switch to improved stoves to a 25- to 60-fold return on investment.
- Global Alliance for Clean Cookstoves



Courtesy of GTZ

# DATA ON PRIMARY PREVENTION INDOOR SMOKE INTERVENTION STUDY

## New evidence on health impact of interventions

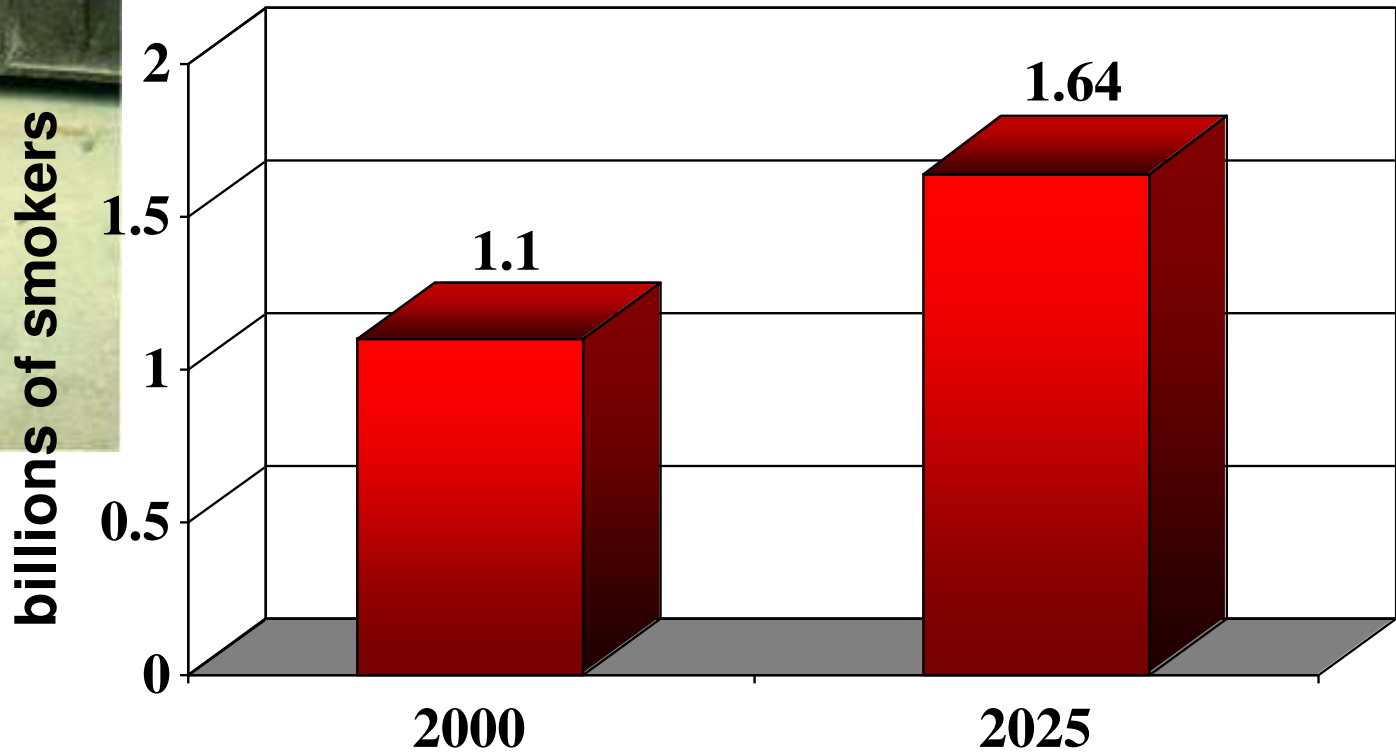
- China – 200 million improved chimney stoves
- 3 cohort studies
- Compared long-term (10+ yrs) users of improved stove vs. traditional stove
- For all 3 outcomes 25-50% reduction in risk for men and women

| Disease                   | RR   | 95% CI      |
|---------------------------|------|-------------|
| <b>COPD</b>               |      |             |
| Men                       | 0.58 | 0.49 – 0.70 |
| Women                     | 0.75 | 0.62 – 0.92 |
| <b>Pneumonia (deaths)</b> |      |             |
| Men                       | 0.49 | 0.31 – 0.78 |
| Women                     | 0.53 | 0.32 – 0.88 |
| <b>Lung cancer</b>        |      |             |
| Men                       | 0.59 | 0.49 – 0.71 |
| Women                     | 0.54 | 0.44 – 0.65 |

# The Growing Epidemic



## Rise in Smokers Worldwide



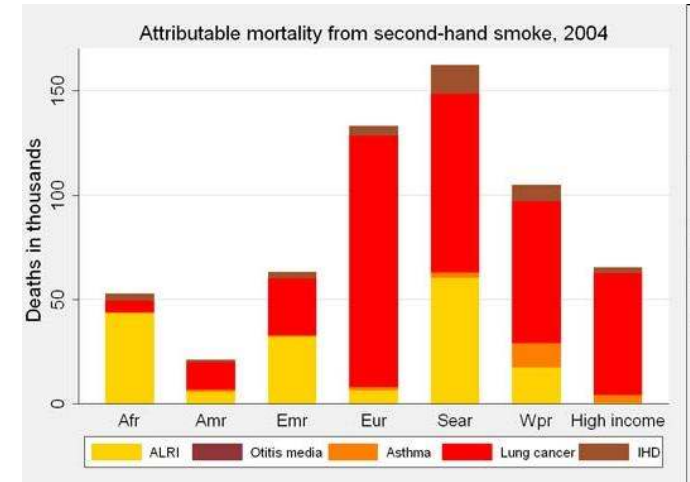
# Secondhand Smoke

~700 million (almost half) of the world's children breathe air polluted by tobacco smoke, particularly at home

- World Health Organization

# Burden of Disease Estimates: Secondhand Smoke Exposure

- Exposure to secondhand tobacco smoke caused 166,000 deaths in children in 2004.
- Cigarette smoking in homes, restaurants, other work and public places exposes children to significant levels of air pollutants.
- Policies designed to eliminate cigarette smoking in work and public settings have been shown to be effective measures for reducing exposure to secondhand smoke. Only 7.4% of world lives in areas with such laws.



## Cancer-causing Chemicals



**Formaldehyde**  
Used to embalm dead bodies



**Benzene**  
Found in gasoline



**Polonium 210**  
Radioactive and very toxic



**Vinyl chloride**  
Used to make pipes

## Toxic Metals



**Chromium**  
Used to make steel



**Arsenic**  
Used in pesticides



**Lead**  
Once used in paint



**Cadmium**  
Used in making batteries

## Poison Gases



**Carbon monoxide**  
Found in car exhaust



**Hydrogen cyanide**  
Used in chemical weapons



**Ammonia**  
Used in household cleaners



**Butane**  
Used in lighter fluid



**Toluene**  
Found in paint thinners

Tobacco smoke contains a deadly mix of **more than 7,000 chemicals**. Hundreds are toxic. About 70 can cause cancer. Here are some of the chemicals.



Kill a Cigarette and Save a Life. Yours.

# Changing Views of Tobacco

## 1944: Smoker = Glamor

1950, first epidemiologic studies demonstrating smoking as the main cause of the most common cancers



## 1969: Smoker = Villain

1969, cigarette advertising on television and radio banned in US



It took 60 years...

**PRIMARY PREVENTION** 2003: 192 Member States of the WHO unanimously adopted the Framework Convention on Tobacco Control

2010: Motion Picture Association of America included smoking as a factor in rating movies

# Doctors have come a long way



Ask your Doctor, RJ Reynolds, 1947



2013

# World No Tobacco Day – WHO



# Prohibiting Smoking in Multiunit Housing

- 32.7% of adult subsidized housing residents were current smokers in 2009 (compared to 20.6% of U.S. adults)
- Recent study estimated that \$521 million could be saved each year by prohibiting smoking
  - \$341 million in SHS-related health care costs
  - \$108 million in renovation expenses
  - \$ 72 million in smoking-attributable fire costs

King BA et al., Am J Prev Med 2013; 44:631-4.



New Albany, Indiana

# Estimated reduction in smoking-related deaths if global smoking prevalence drops from 25% to 20%

|  | Population 2006 | Number of smokers | Reduction in smokers | Premature deaths prevented |
|--|-----------------|-------------------|----------------------|----------------------------|
| <b><u>Current</u></b>  |                 |                   |                      |                            |
| Adults (age ≥ 18 years)  | 4357            | 1089              | 218                  | 73                         |
| <b><u>Future</u></b>   |                 |                   |                      |                            |
| Children (age 0-17 years)  | 2122            | 531               | 106                  | 35                         |
| Unborn (2007-2030)   | 3020            | 755               | 151                  | 50                         |
| Minimum number of smoking related deaths prevented in the 21 <sup>st</sup> century |                 |                   |                      | 158                        |

Data are estimated number (millions).

# Lead Poisoning

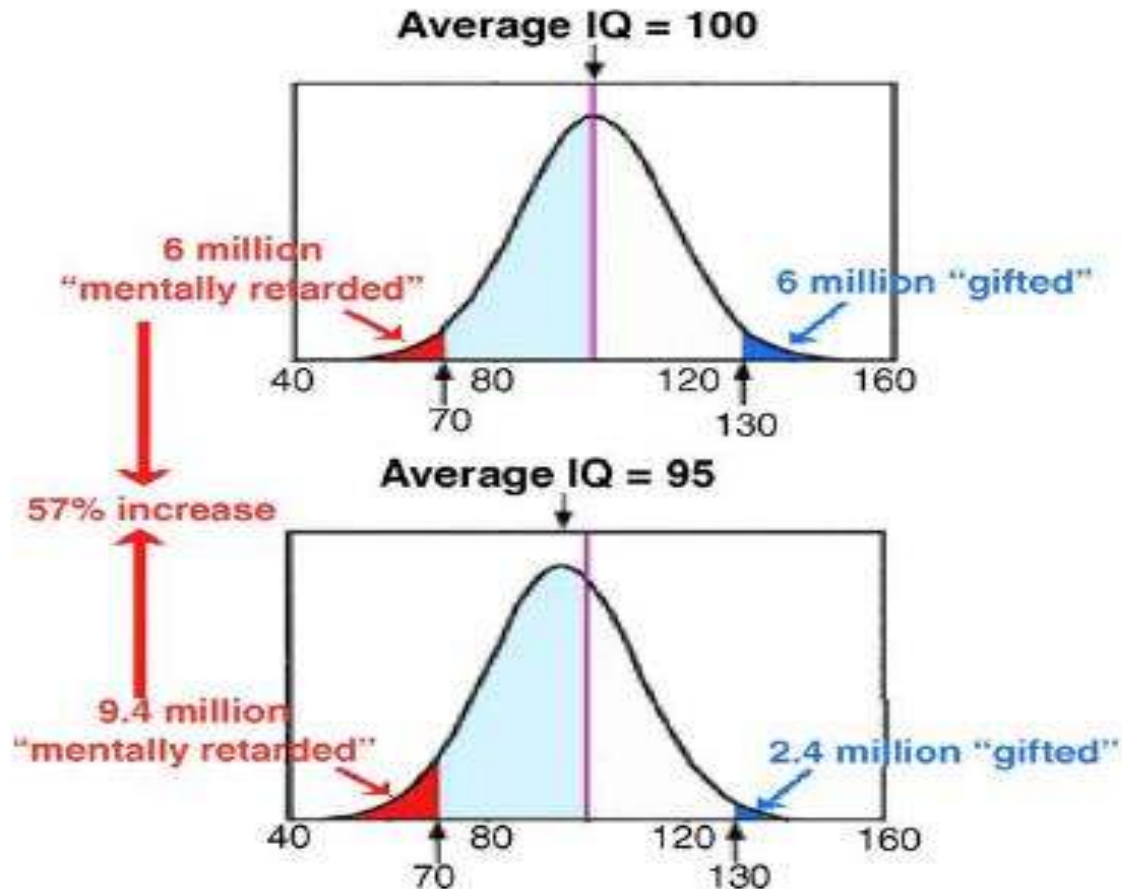
- ❖ Lead exposure accounts for about 1% of the global burden of disease and most exposure affects children in developing countries
- ❖ In developing countries as much as 15-20% of mental retardation could be caused by exposure to lead.
- ❖ Hundreds of millions of children and pregnant women are exposed to different sources of lead.

# Nigeria - 2010 poisoning epidemic

- Largest outbreak of lead poisoning ever recorded
- Estimated 10,000 persons exposed through inhalation of contaminated dust, and ingestion of contaminated water and food
- 2000 children needed chelation therapy, ~ 400 deaths
- Associated with artisanal and small scale mining activities
  - Ore processed by women and children
  - In homes, in common water sources
  - Using same instruments that were used for grinding flour, cooking, and washing



# SOCIETAL IMPACT OF A 5-POINT LOSS IN POPULATION MEAN IQ SCORE



# Reason for Hope: Primary prevention of lead poisoning

- Unleaded gasoline – a success story

## Lead in Gasoline -- History

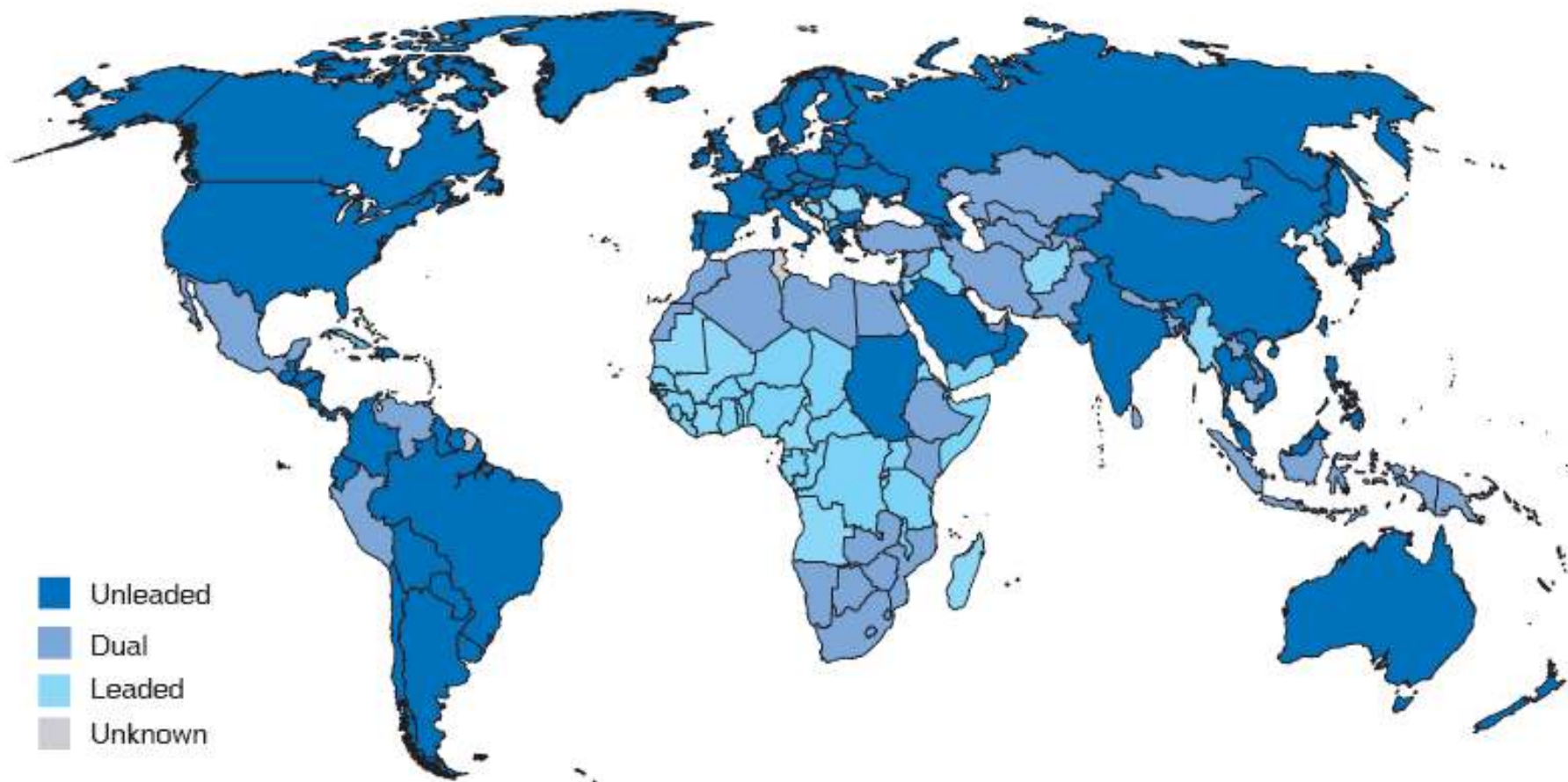
- At end of 20<sup>th</sup> century developed countries phased out leaded gasoline
- But few developing countries had done so
- Concrete targets were set for complete elimination

## Success in campaign to phase out leaded gasoline

- Began in 2002
- 120+ members (doctors, parents, scientists, government, industries, international organizations)
- Clearing house in Nairobi; 12 staff



## Leaded Petrol Phase-Out: Global Status

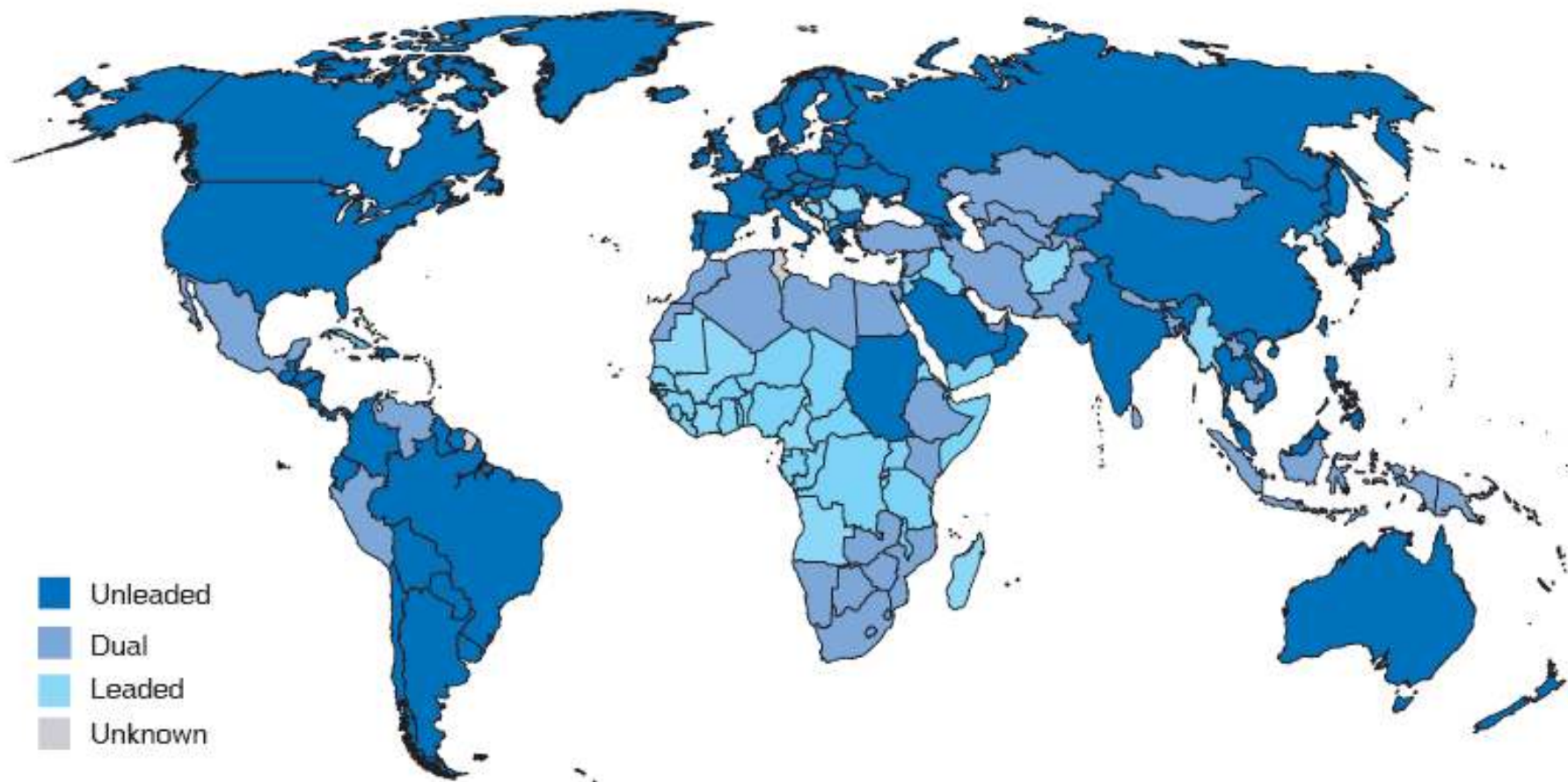


- Unleaded
- Dual
- Leaded
- Unknown

Status as of End 2002



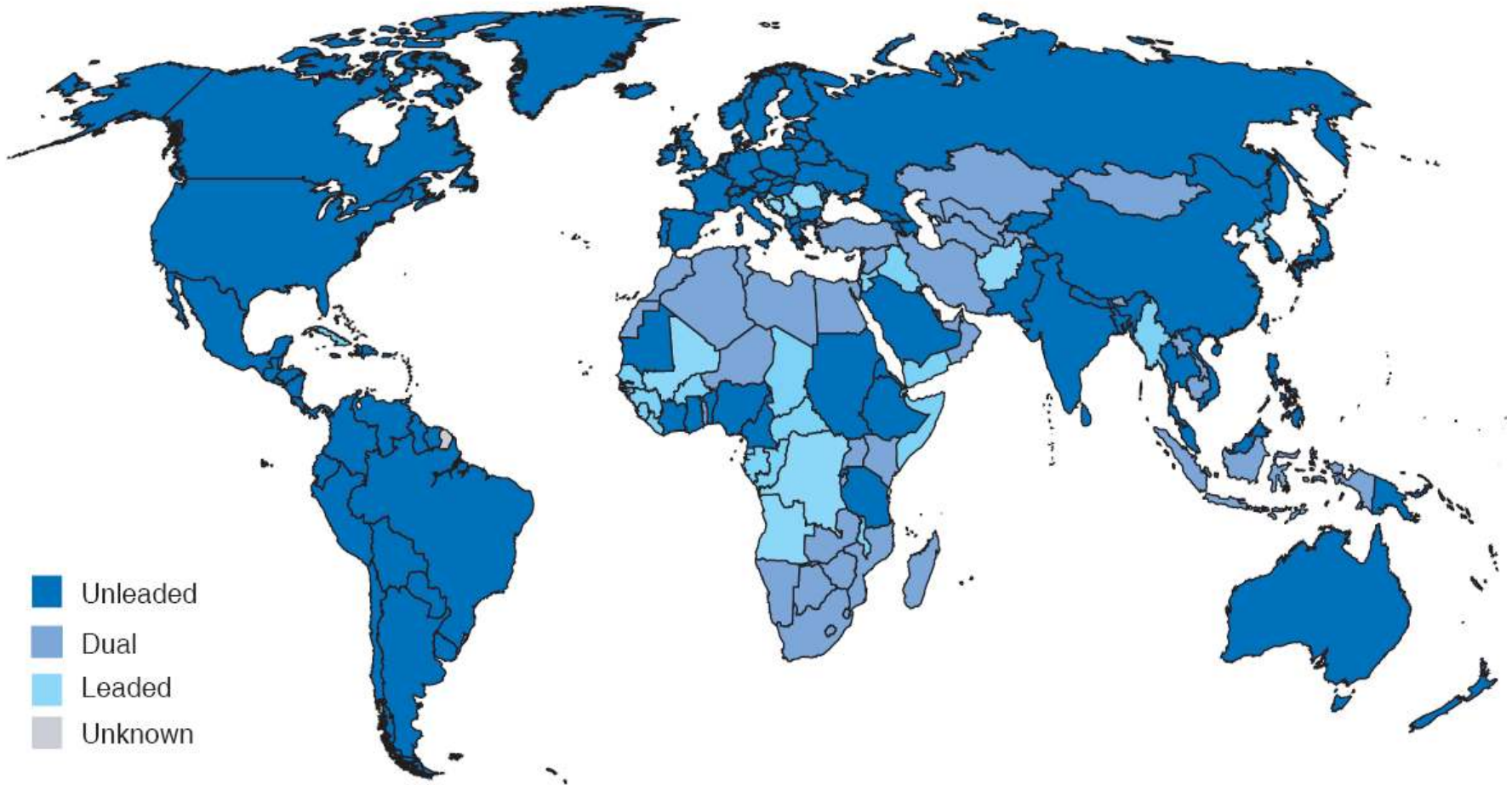
## Leaded Petrol Phase-Out: Global Status



Status as of End 2002



## Leaded Petrol Phase-Out: Global Status

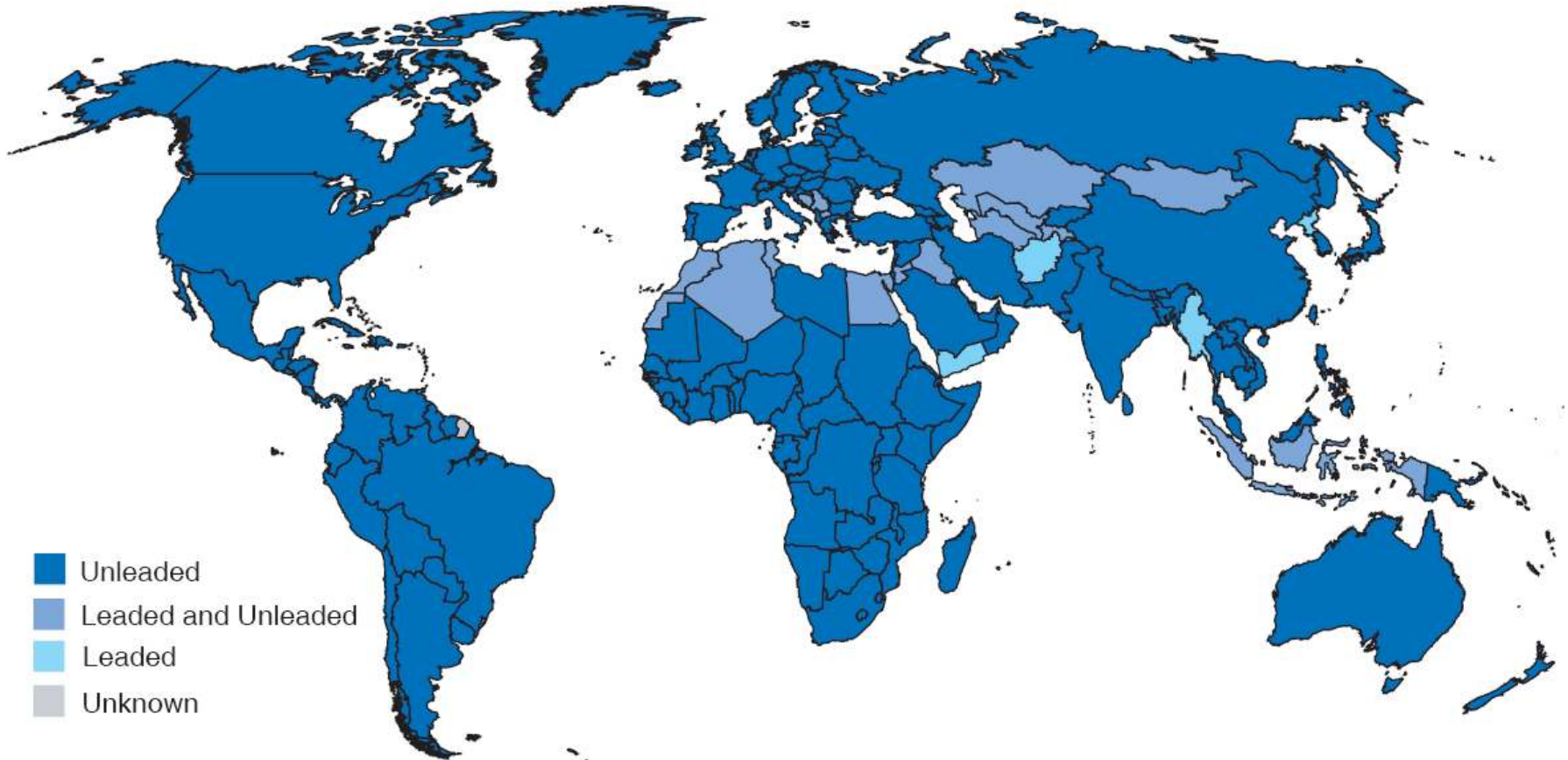


- Unleaded
- Dual
- Leaded
- Unknown

Status as of 2005



## Leaded Petrol Phase-Out: Global Status

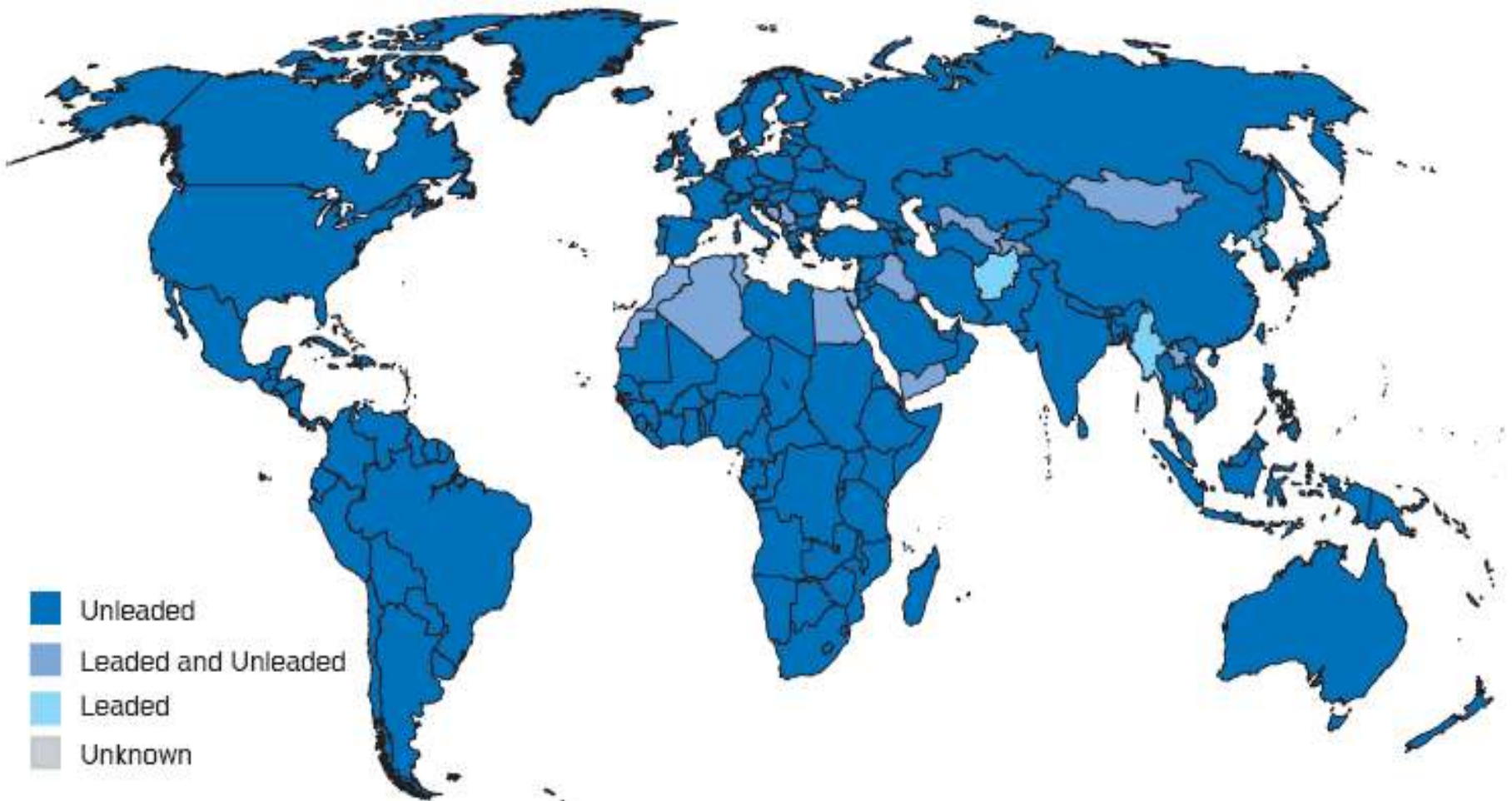


- Unleaded
- Leaded and Unleaded
- Leaded
- Unknown

Status as of 1 January 2006



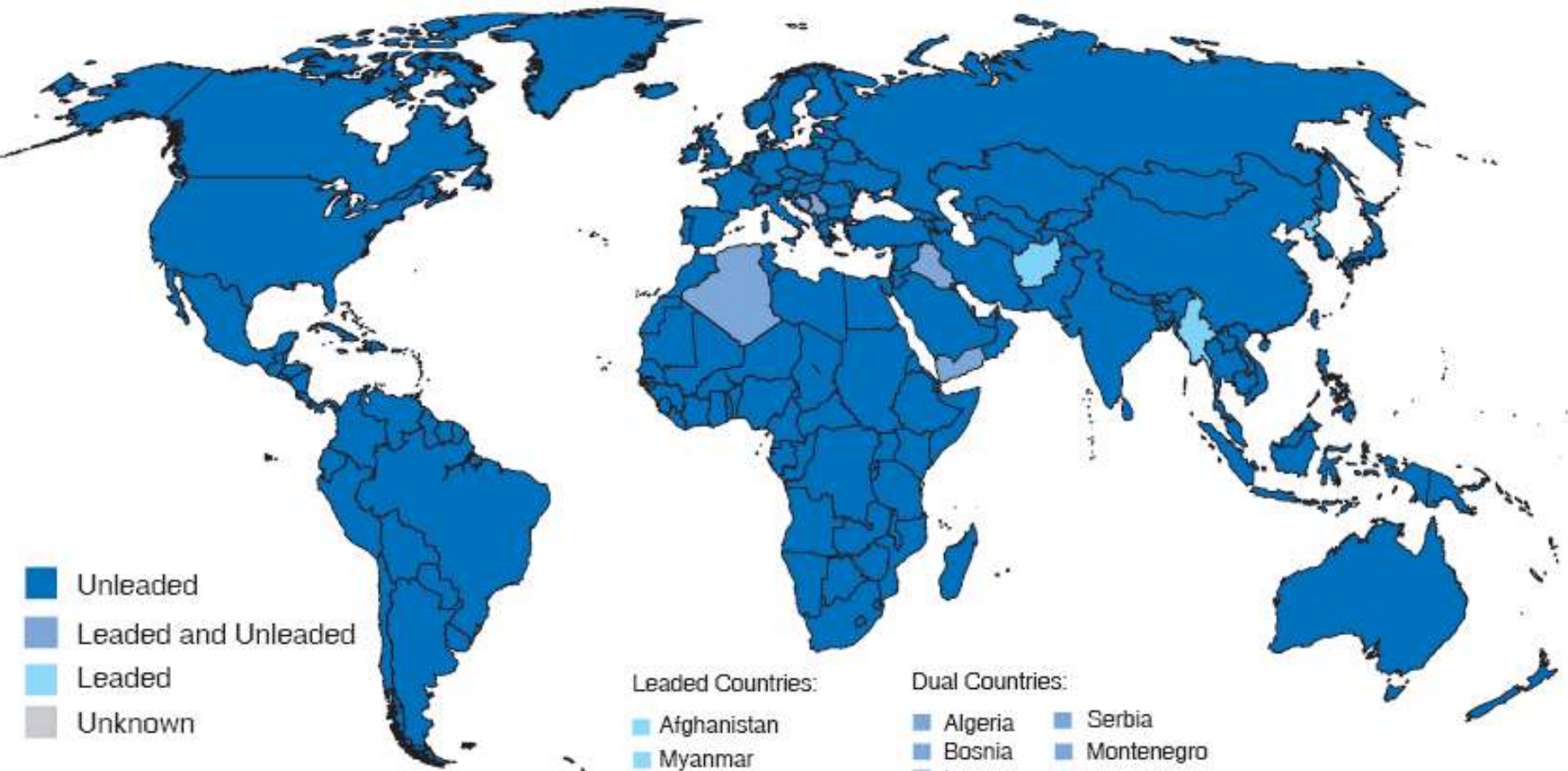
# Leaded petrol phase-out: Global status January 2008



- Unleaded
- Leaded and Unleaded
- Leaded
- Unknown



# Leaded Petrol Phase-out: Global Status October 2010



- Unleaded
- Leaded and Unleaded
- Leaded
- Unknown

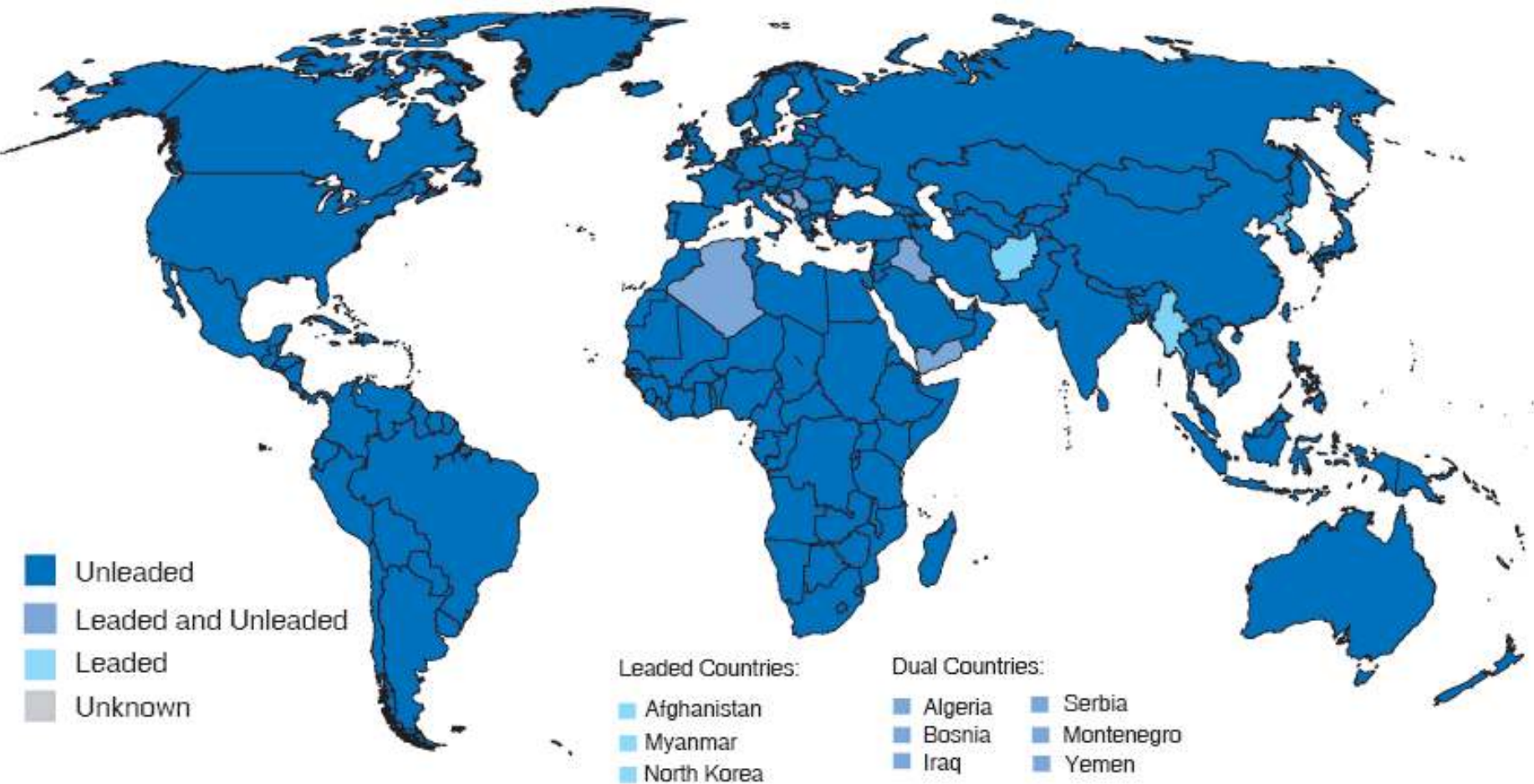
### Leaded Countries:

- Afghanistan
- Myanmar
- North Korea

### Dual Countries:

- Algeria
- Bosnia
- Iraq
- Serbia
- Montenegro
- Yemen

## Leaded Petrol Phase-out: Global Status October 2010



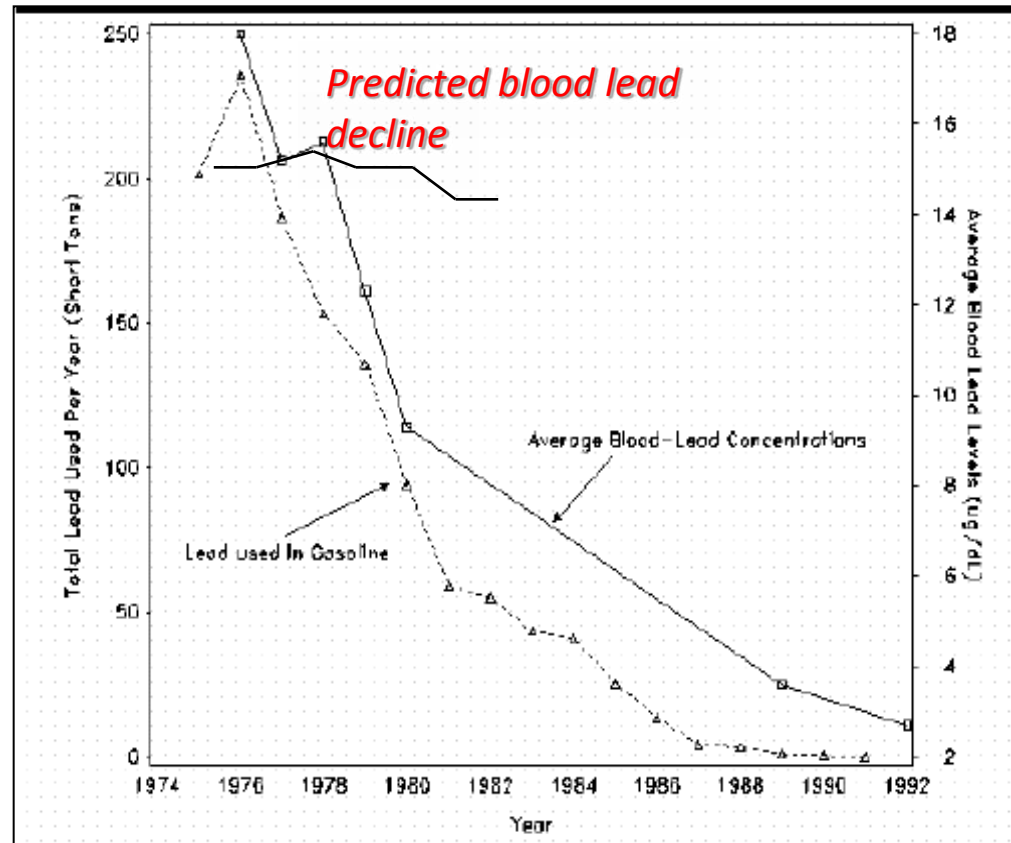


## Leaded Petrol Phase-out: Global Status January 2011



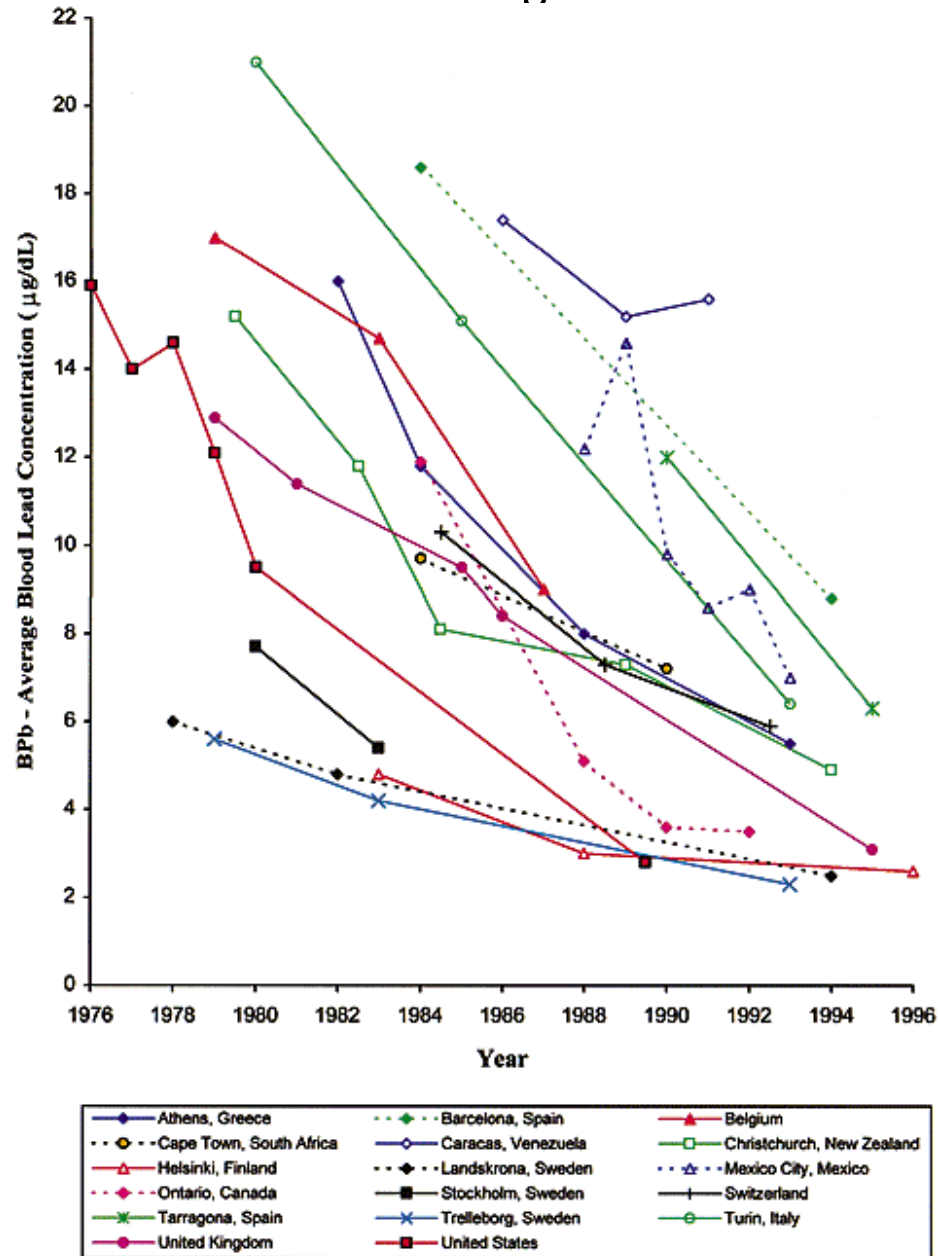
# LEADED GASOLINE & CHILDREN'S BLOOD LEAD LEVELS - U.S.

- ❖ Lead removed from gasoline
- ❖ Blood lead levels in children fell in parallel lead in air
  - Much more than models predicted
- ❖ New understanding of important sources of lead exposure in children



USEPA, Great Lakes Binational Toxics Strategy

Multiple countries around the world have phased lead out of gasoline and shown similar reductions in average blood lead concentrations



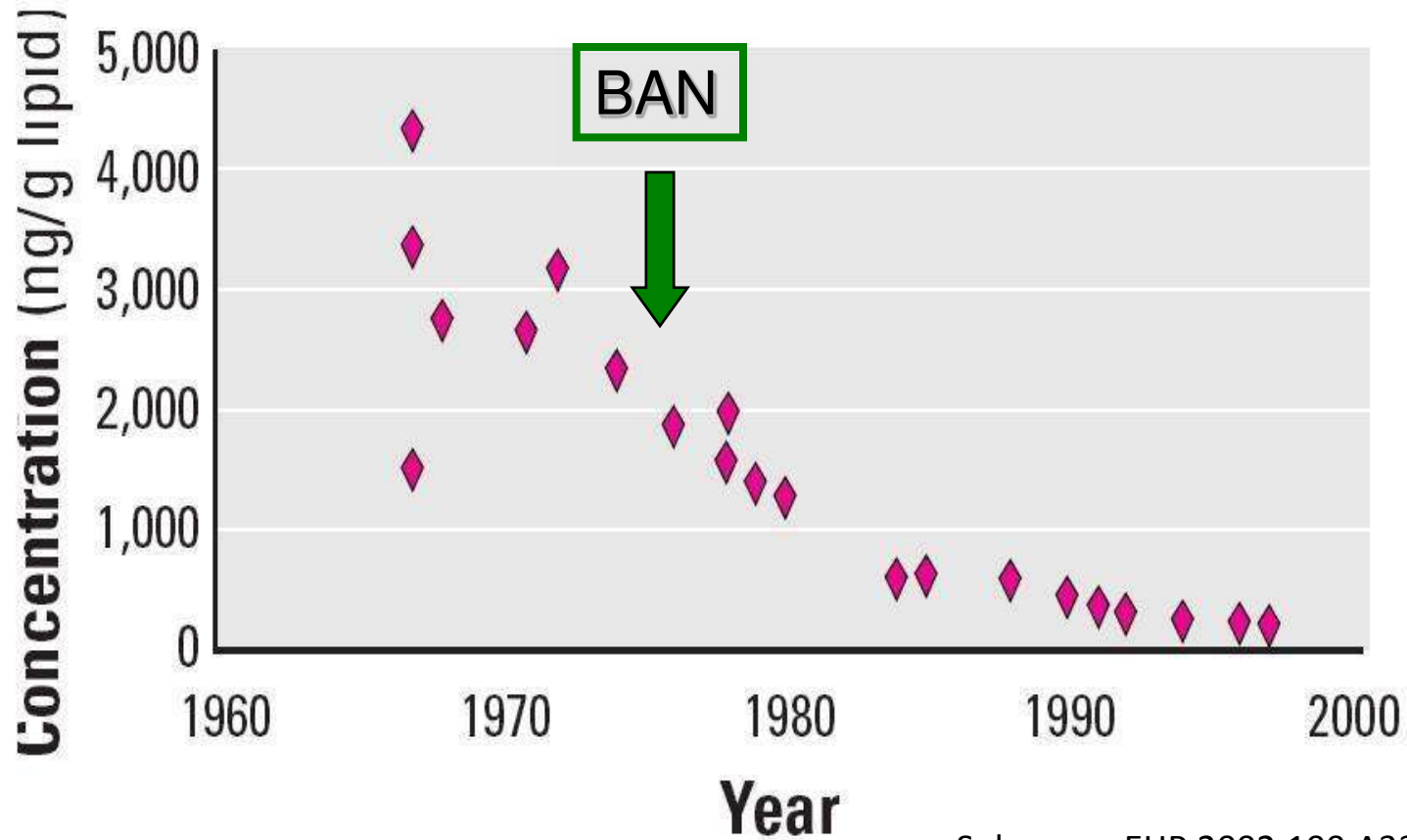
Reason for Hope:

Environment –  
the invisible issue –  
becoming more visible.

# Another alternative



## Less DDT in Breast Milk after Sweden's ban



# Policy changes make a positive impact

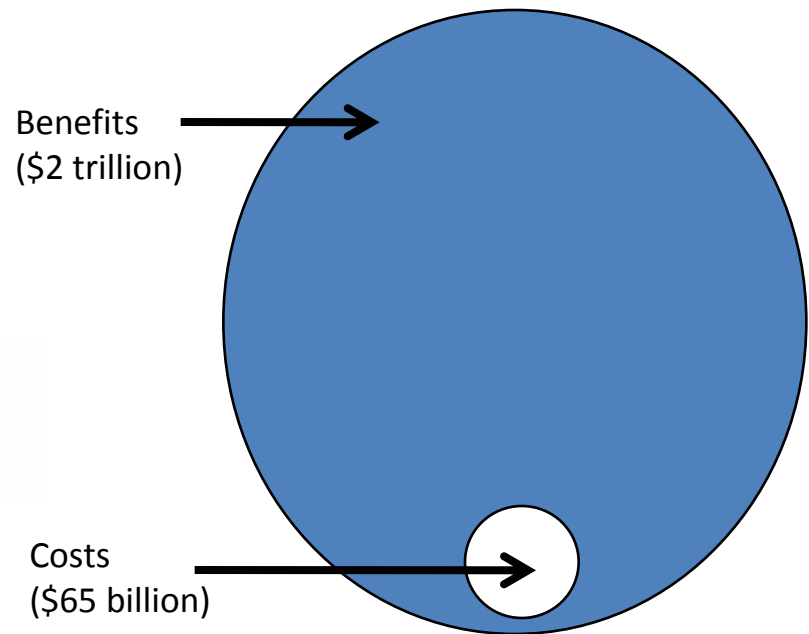
## Benefits of the Clear Air Act Amendments of 1990

- Benefits will reach approximately \$2 trillion in 2020
- Over 230,000 early deaths prevented

Clean Air Act Amendments benefits exceed costs by a factor of more than 30 to one

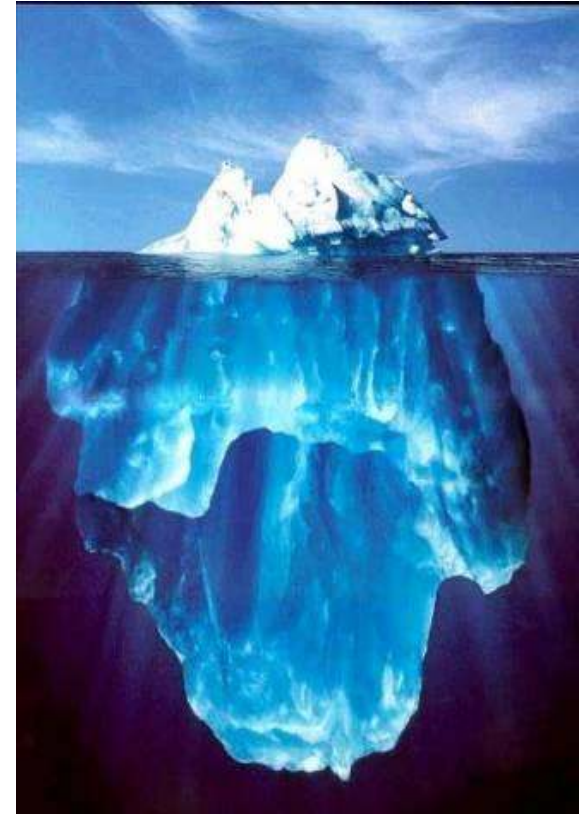
# Policy changes make a positive impact

- Direct benefits of 1990 CAA Amendments and associated program significantly exceeded their direct costs
- Economic welfare and quality of life for Americans were improved by the passage of the amendments



# There is reason for hope to reduce the environmental determinants of health

- More children with illnesses caused by environmental contamination will be recognized as such
- Advocacy can prevent or reduce illness in others in the community



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THANK YOU

