

CHILDREN'S HEALTH AND THE ENVIRONMENT: The Problem and the Solution

Philip J. Landrigan, M.D., M.Sc., F.A.A.P.
Dean for Global Health
Professor of Preventive Medicine and Pediatrics
Icahn School of Medicine at Mount Sinai
New York, USA

THE ENVIRONMENT IS A POWERFUL DETERMINANT OF HEALTH AND DISEASE, ESPECIALLY FOR CHILDREN

Over the past century, patterns of disease have changed profoundly.

In the same time, the environment has changed remarkably

- Infectious diseases have declined in frequency and severity (AIDS and tuberculosis notwithstanding)
- Life expectancy has doubled
- Infant mortality has declined by over 90%
- Chronic diseases have become increasingly prevalent

The Epidemiological Transition

PATTERNS OF PEDIATRIC DISEASE IN DEVELOPING AND DEVELOPED COUNTRIES

Developing Countries

- Pneumonia
- Dysentery
- Malaria
- AIDS
- Tuberculosis

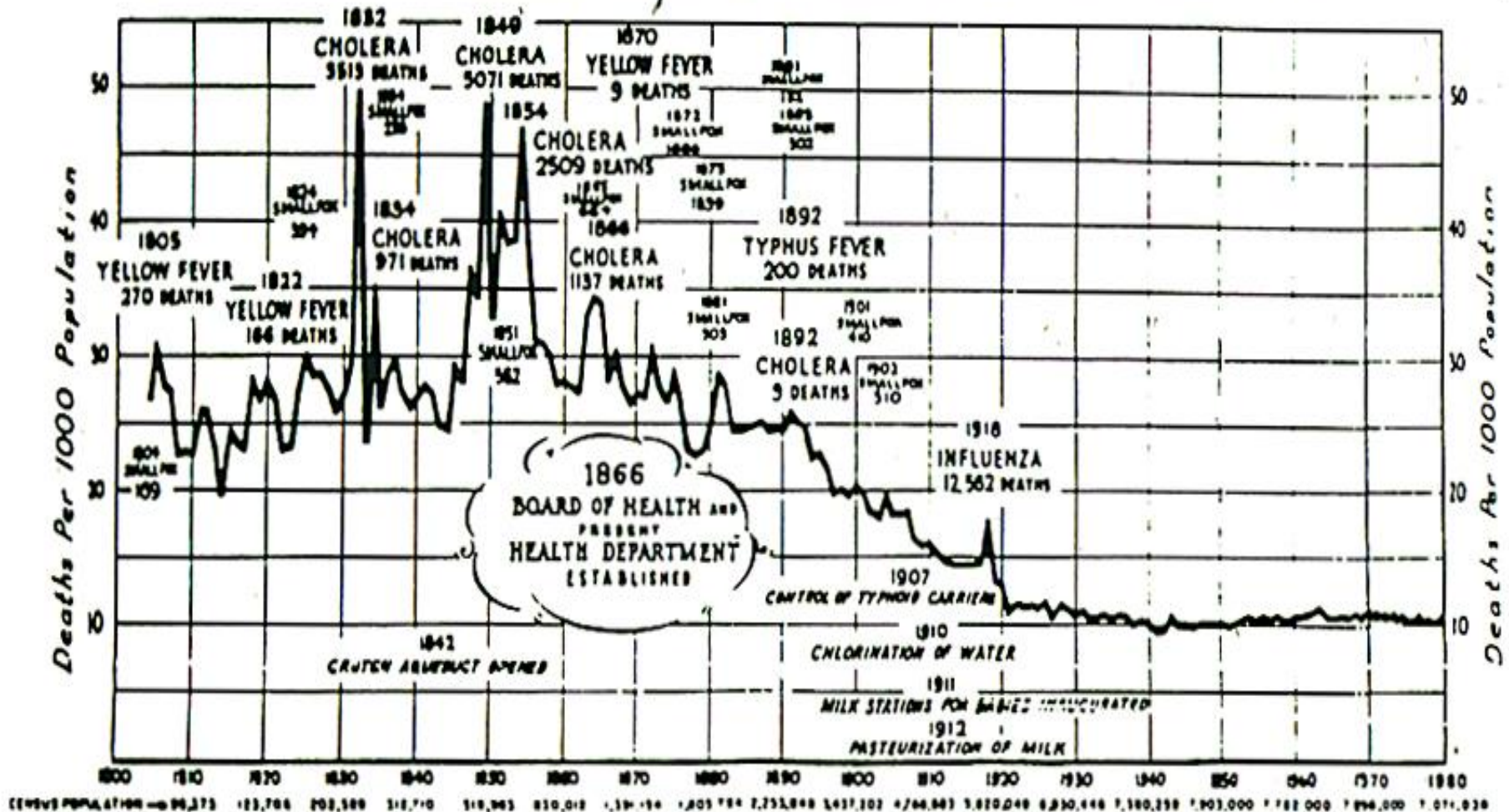
Developed Countries

- Asthma
- Cancer
- Birth defects
- Learning disabilities
- Obesity
- Diabetes

PATTERNS OF DISEASE CHANGE WITH DEVELOPMENT

The CONQUEST OF PESTILENCE in NEW YORK CITY ~

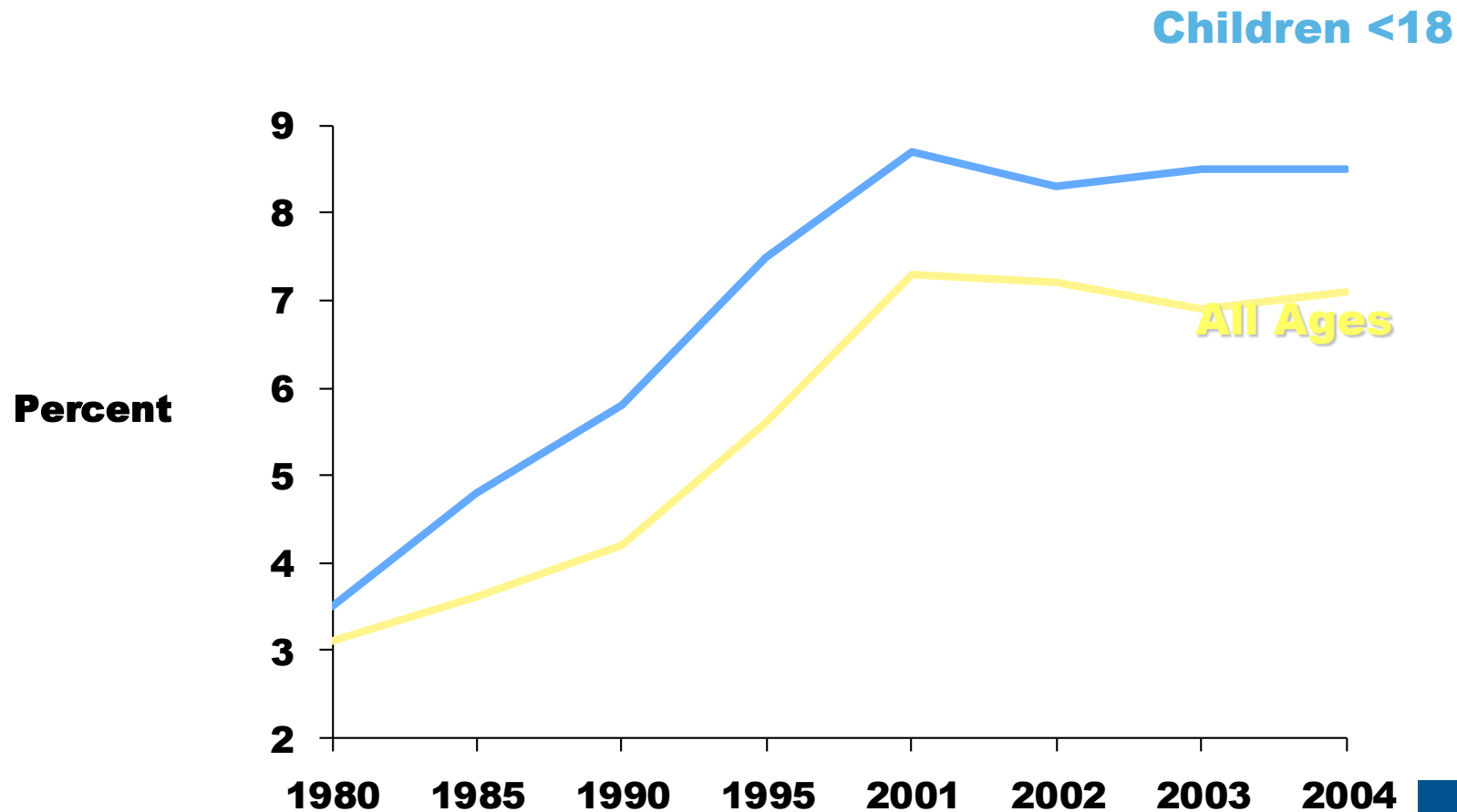
... As Shown by the Death Rate as Recorded in the Official Records of the Department of Health.



Environmental Change is the Driving Force

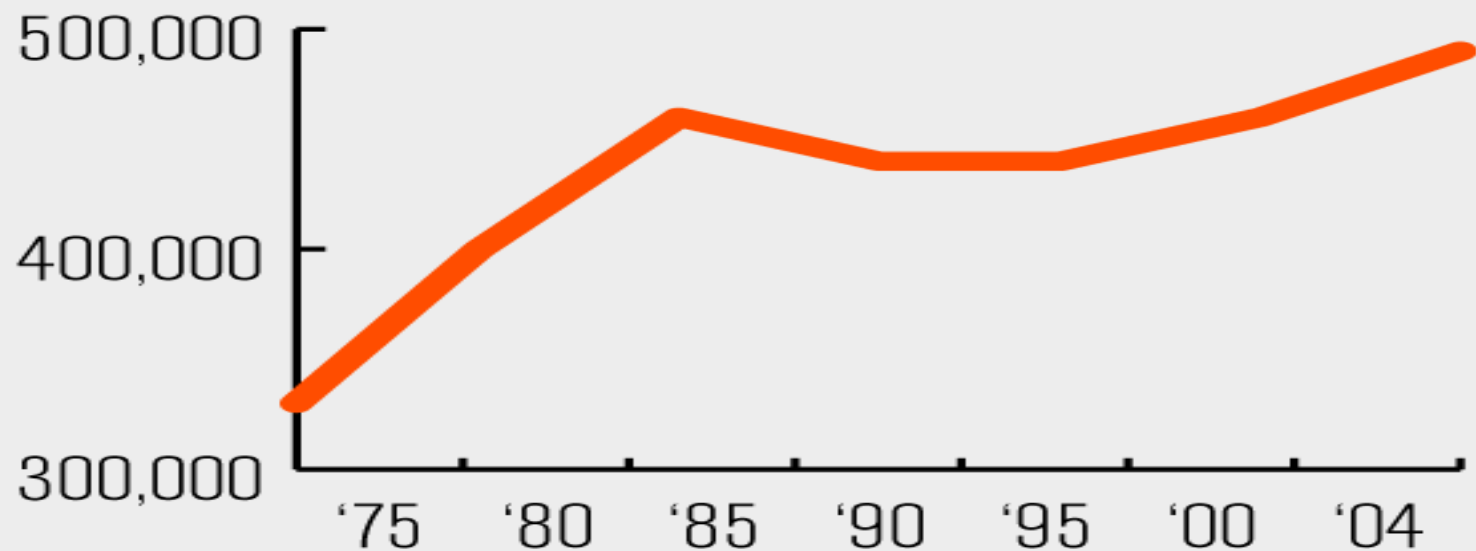
IN THE AFTERMATH OF THE
EPIDEMIOLOGICAL TRANSITION,
CHRONIC DISEASES ARE ON THE RISE

THE INCREASING PREVALENCE OF ASTHMA IN THE US

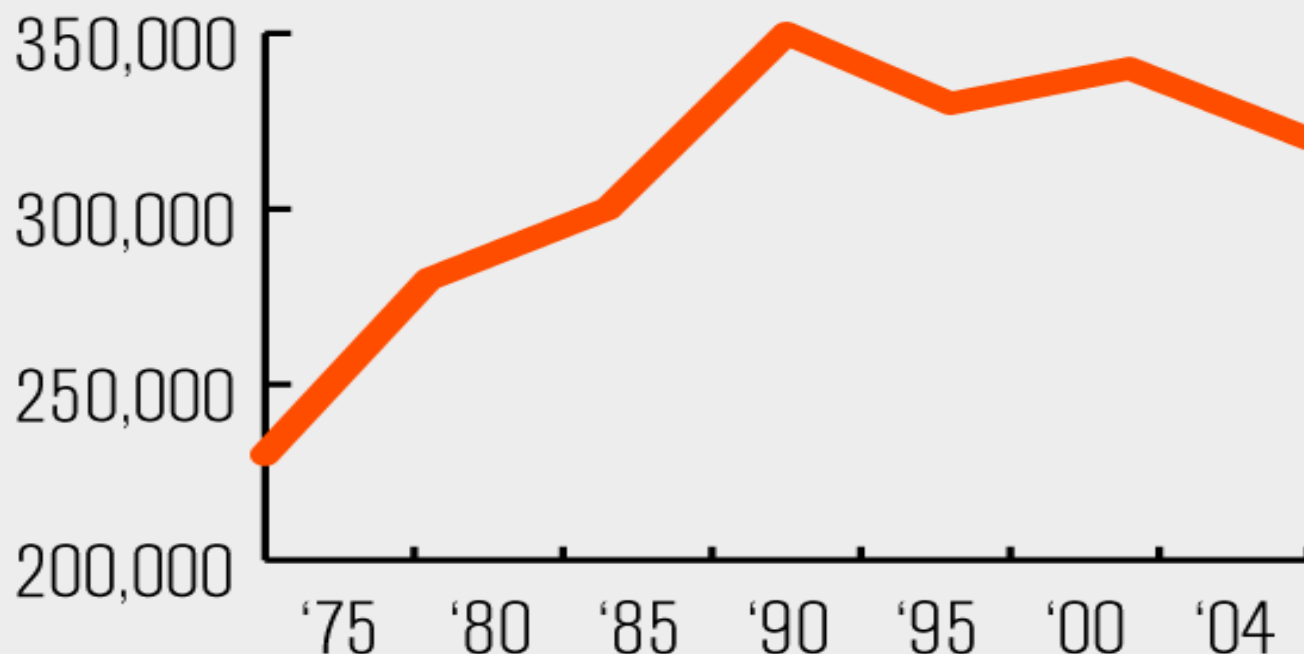


Source: CDC MMWR, October 19, 2007 / 56(SS08);1-14;18-54

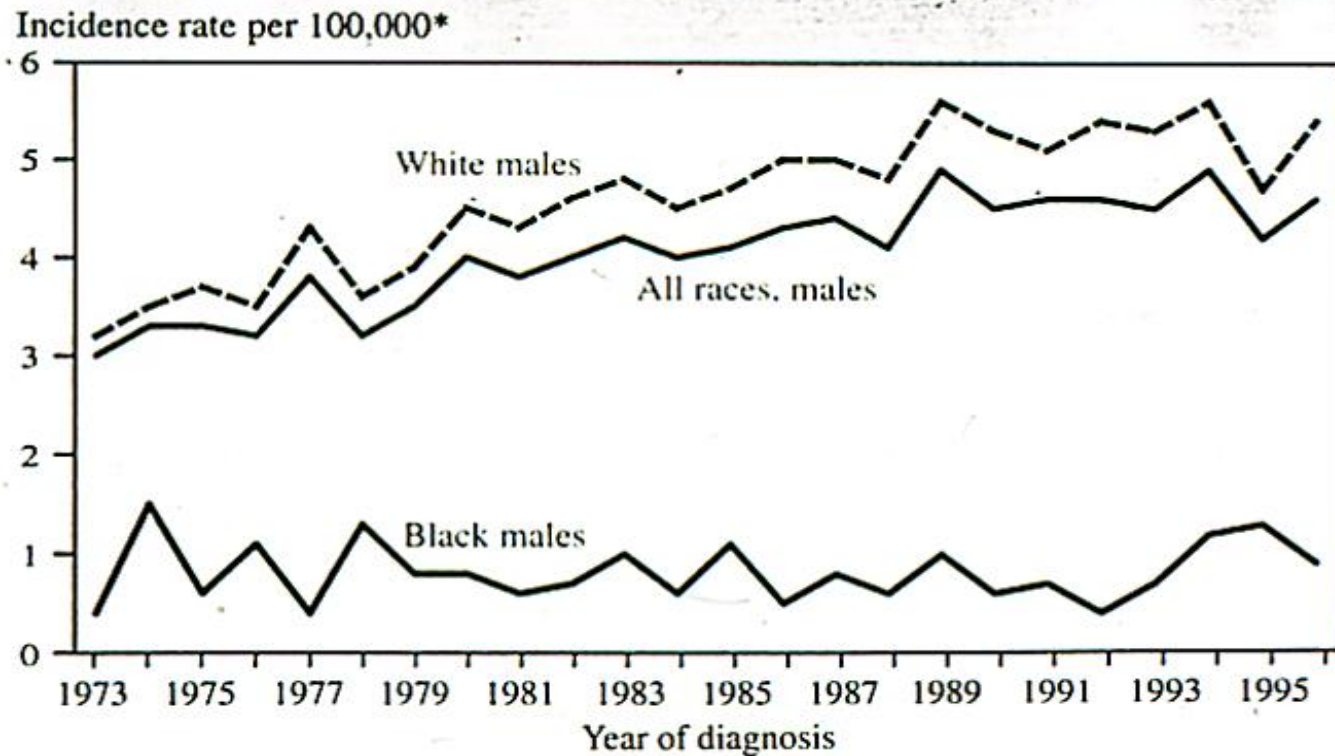
Incidence of Childhood Leukemia 1975-2004



Incidence of Childhood Brain Cancer 1975–2004



INCIDENCE OF TESTICULAR CANCER

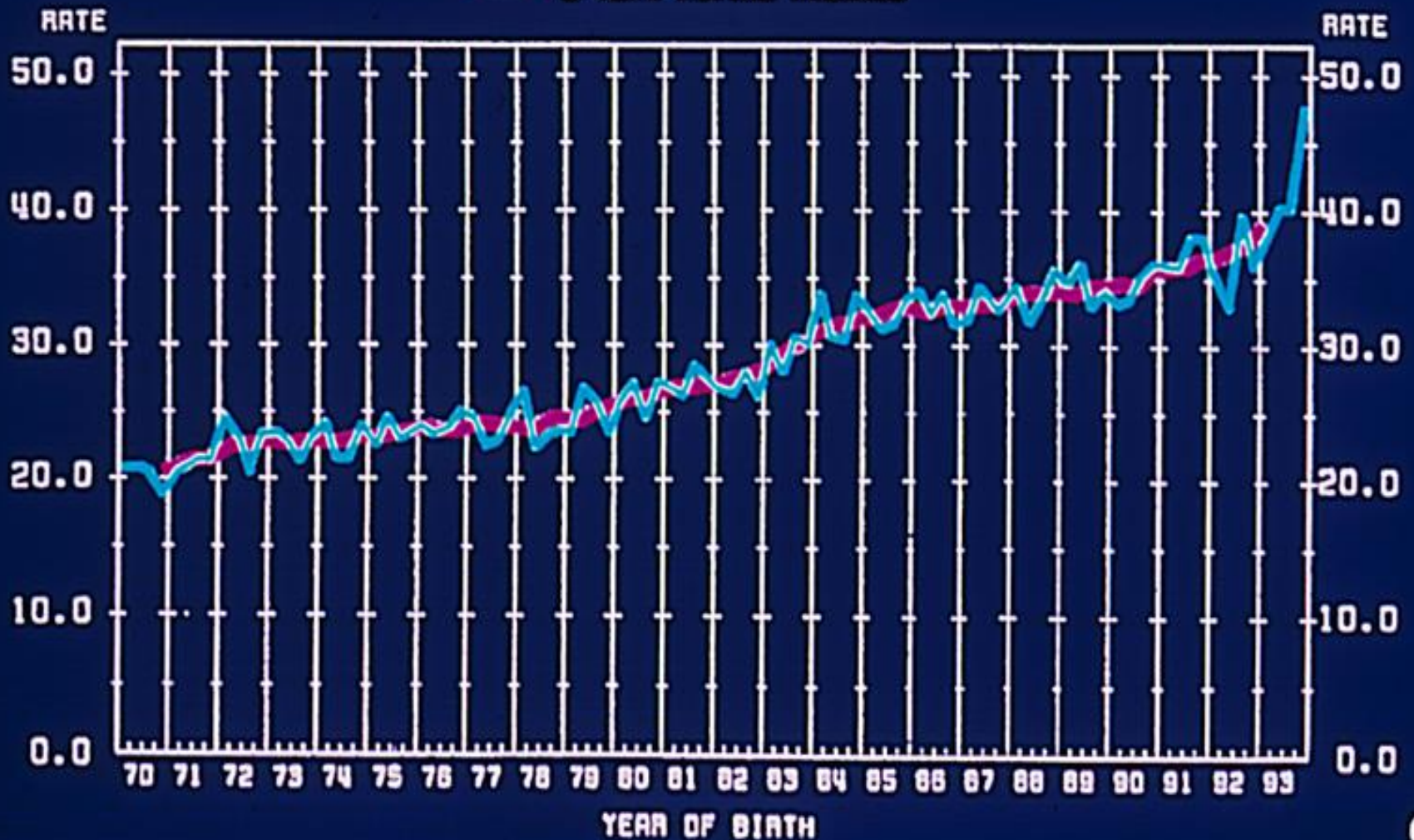


*Age-adjusted to the 1970 U.S. standard population.

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>

HYPOSPADIAS/EPI SPADIAS

Trends in Birth Defects of Male Reproductive Organs, USA – 1970-1993



DEVELOPMENTAL DISABILITIES

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

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

Terrible 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



THE CENTRAL QUESTION IN PEDIATRIC ENVIRONMENTAL HEALTH RESEARCH:

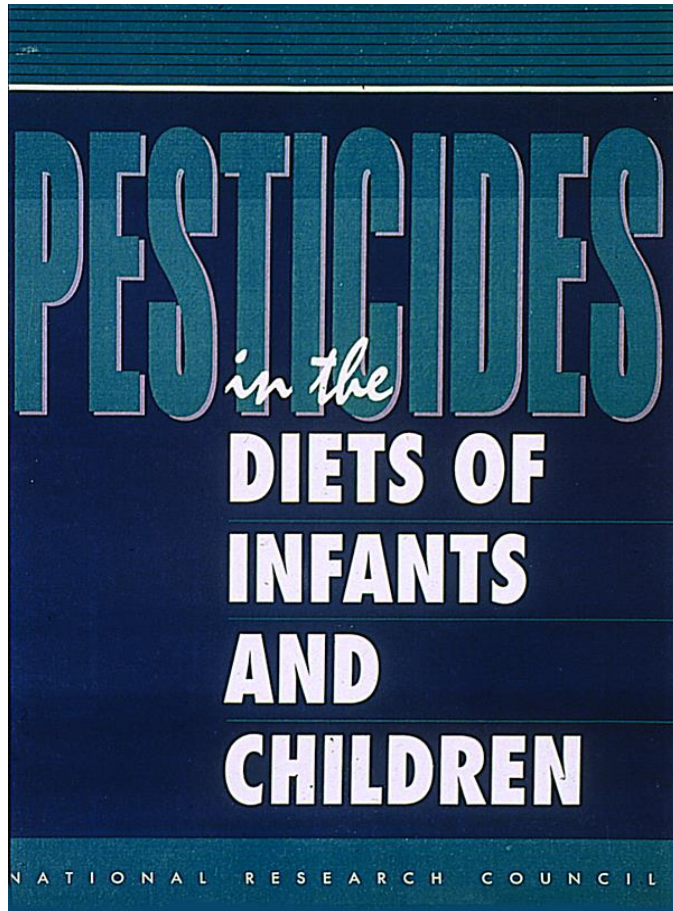
What is the Evidence that
Toxic Chemicals in the Environment
Contribute to
Chronic Disease in Children?



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 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

WHY 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

**EVIDENCE IS INCREASING THAT
TOXIC CHEMICALS IN THE
ENVIRONMENT CONTRIBUTE TO
CAUSATION OF DISEASE IN
CHILDREN**

GROWING EVIDENCE OF LINKS BETWEEN ENVIRONMENT AND DISEASE - ASTHMA

Indoor triggers

- House dust
- Second-hand tobacco smoke
- Mold and mites
- Cockroach droppings
- Animal dander
- Certain pesticides

Outdoor triggers

- Ground-level ozone
- Fine particulates
- NO_x
- Diesel exhaust

Prevention is Achieved Through Reducing Exposures

EVIDENCE FOR ENVIRONMENTAL CAUSATION OF CHILDHOOD CANCER

- Radiation – post Hiroshima and Nagasaki
- DES and adenocarcinoma of vagina
- Solvents, especially benzene
- Pesticide exposure, especially prenatally
- Nitrosamine
- Aspartame
- Protective effects of folic acid and breast feeding

Upward Trend Still Unexplained

EVIDENCE FOR ENVIRONMENTAL CAUSATION OF MALE REPRODUCTIVE DISORDERS

- Falling sperm counts – cause not known
- Rising testicular cancer – cause not known
- Increasing hypospadias – cause not known

Are Endocrine Disrupting Chemicals Responsible? Not known.

EVIDENCE FOR ENVIRONMENTAL CAUSATION OF NEURODEVELOPMENTAL DISORDERS

Sequence of Discovery:

- Initial recognition of high-dose, acute poisoning, example, Minamata Disease
- Subsequent discovery of widespread subclinical intoxication
- The power of prospective birth cohort studies

写真集

水俣

MINAMATA

W. ユージン・スミス
アイリーン M. スミス
中尾ハジメ 訳

三一書房

A CHILD MASSIVELY EXPOSED TO MERCURY – MINAMATA, JAPAN, 1960



No visible damage to the mother

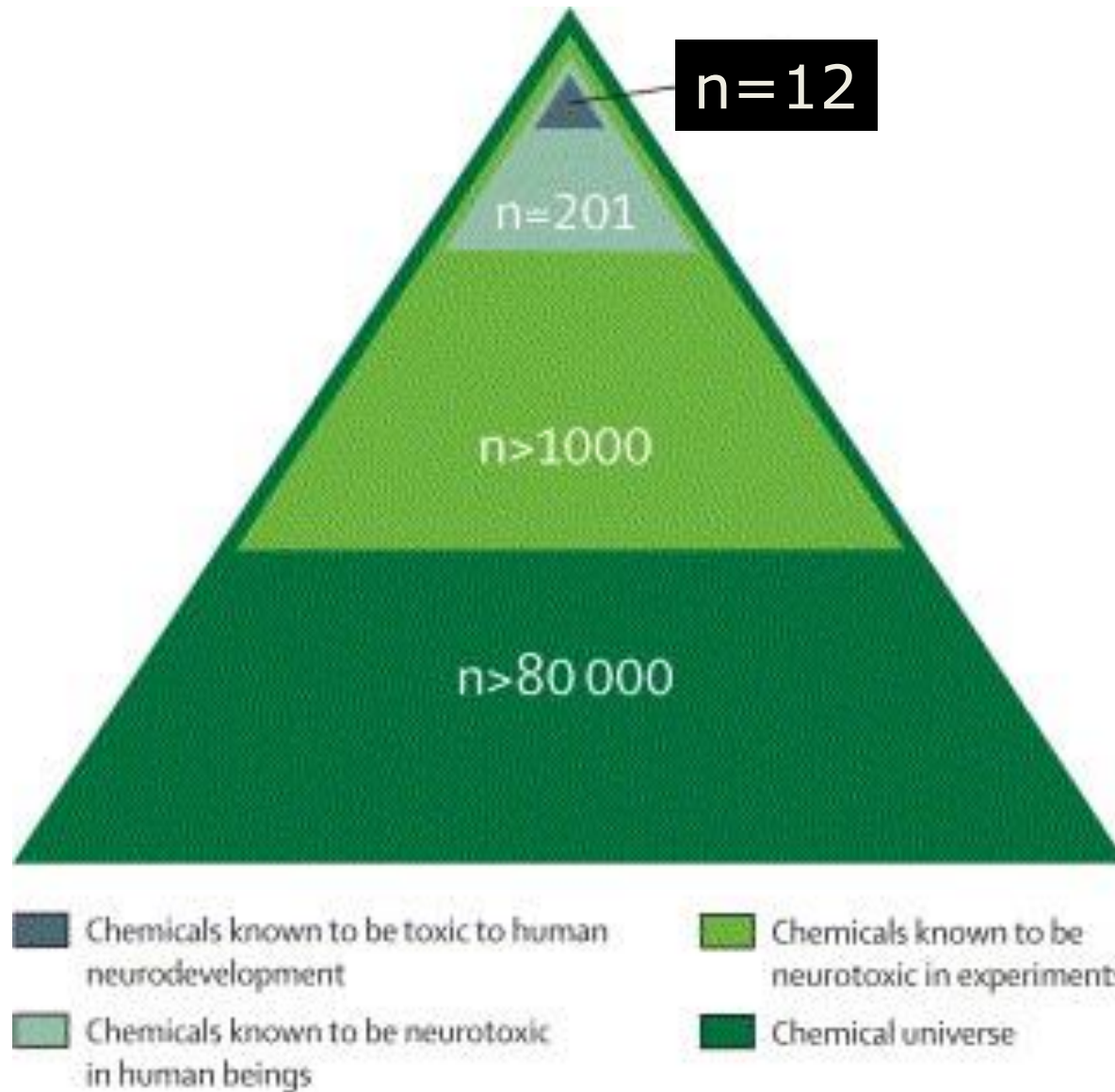
EVIDENCE FOR ENVIRONMENTAL CAUSATION OF NEURODEVELOPMENTAL DISORDERS

- Lead
- Methyl Mercury
- Polychlorinated Biphenyls (PCBs)
- Arsenic
- Manganese
- Organic solvents, e.g., Ethanol and Toluene
- Organophosphate pesticides - Chlorpyrifos
- Organochlorine pesticides
- Phthalates
- Bisphenol A
- PBDEs
- PAH

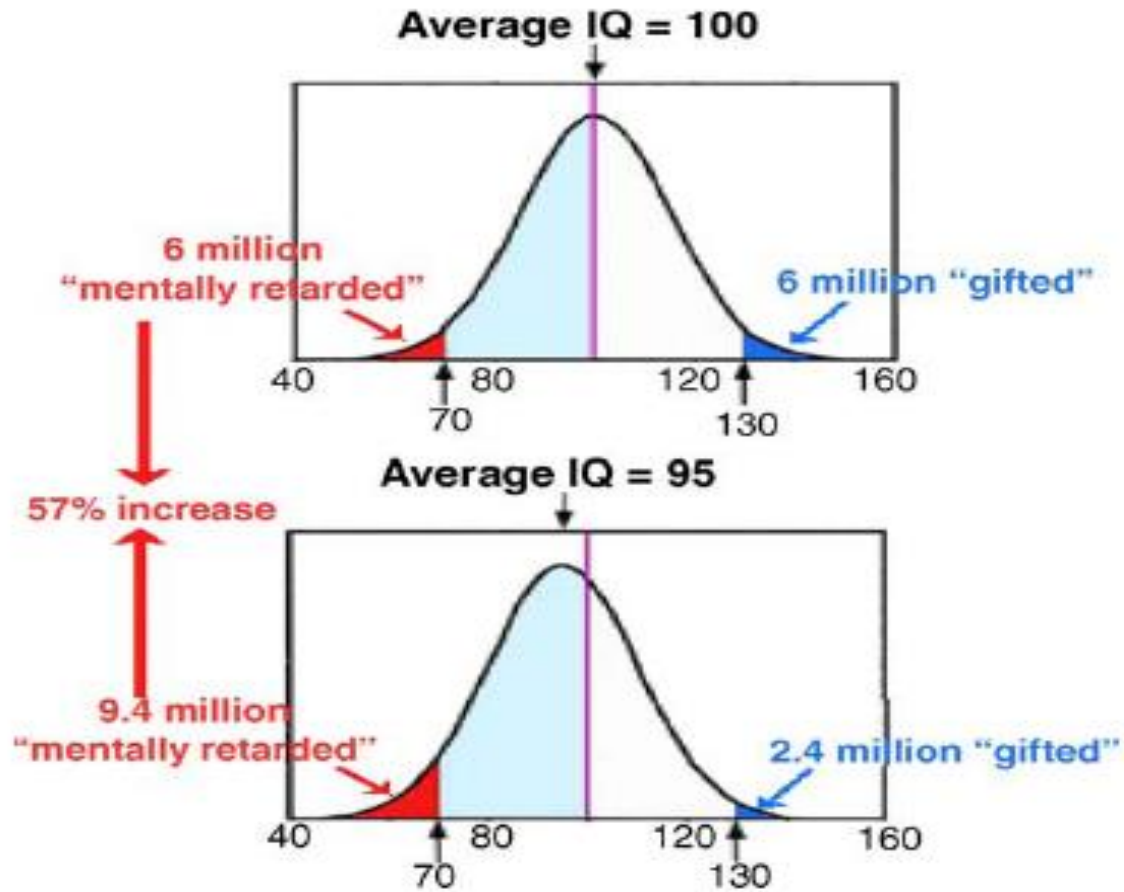
➤ *Another 200 industrial chemicals are known to cause neurotoxicity in adults, but developmental toxicity is untested.*

➤ *An additional 1,000 are neurotoxic in animals.*

ARE THERE ADDITIONAL UNDISCOVERED DEVELOPMENTAL NEUROTOXICANTS?



SOCIETAL IMPACT OF 5-POINT LOSS IN IQ



EVIDENCE IS ACCUMULATING THAT EXPOSURE TO INDUSTRIAL CHEMICALS MAY INCREASE RISK OF DEGENERATIVE BRAIN DISEASE IN LATER LIFE -

Parkinson's Disease and Chemicals

- Twin studies
- MPTP
- Rotenone
- Manganese
- Occupational studies of pesticide applicators
- Can exposures in infancy cause PD? Studies of rodents exposed to the herbicides maneb and paraquat

DEMENTIA FOLLOWING EXPOSURE TO LEAD

- Increased rates of dementia in lead workers
- Decreased cognitive function in older adults with higher lead burdens
- The potentially modulating role of ApoE4 genotype
- Does early exposure to lead have late effects on cognition?

**DISEASE OF TOXIC ENVIRONMENTAL
ORIGIN IN CHILDREN IS EXTREMELY
COSTLY**

AGGREGATE COSTS OF ENVIRONMENTAL DISEASES , US CHILDREN, 2008

	<u>Base-case estimate</u>	<u>Low-end estimate</u>	<u>High-end estimate</u>
Lead poisoning	\$50.9 billion	\$44.8 billion	\$60.6 billion
Methylmercury toxicity	\$5.1 billion	\$3.2 billion	\$8.4 billion
Asthma	\$2.2 billion	\$728.0 million	\$2.5 billion
Intellectual disability	\$5.4 billion	\$2.7 billion	\$10.9 billion
Autism	\$7.9 billion	\$4.0 billion	\$15.8 billion
AD/HD	\$5.0 billion	\$4.4 billion	\$7.4 billion
Childhood cancer	\$95.0 million	\$38.2 million	\$190.8 million
Total	\$76.6 billion	\$59.8 billion	\$105.8 billion

Source: *Trasande et al., 2011*

THE SOLUTION

Progress Against Disease of Environmental Origin in Children Will Require Work in These Areas

- Testing chemicals for toxicity
- Disease tracking
- Research
- Training of health care providers
- Patient care
- Prevention

TESTING CHEMICALS FOR TOXICITY

- Goals: To test new chemicals for toxicity before release to the environment and to prioritize testing of chemicals in current wide use
- Current approach under TSCA is not working – Chemicals are being tested in children, rather than in the laboratory
- European REACH program may be a model
- In the last three Congresses, the late Senator Frank Lautenberg proposed the Safe Chemicals Act. No action to date.

RESEARCH

The Goal: To Increase Knowledge of the Preventable
Environmental Causes of Disease in Children

Steps taken in the USA

- Establishment of a national network of Centers in Children's Environmental Health and Disease Prevention Research:
 - Asthma
 - Neurodevelopmental disorders
 - Autism
 - Lead poisoning
- Prospective epidemiologic studies

PROSPECTIVE EPIDEMIOLOGIC STUDIES OF CHILDREN'S HEALTH

- US National Children's Study
- New York Children's Study
- Intermountain Children's Study
- California Children's Study
- Japan Environment and Children's Study
- Shanghai Children's Cohort Study
- ALSPAC – UK
- MoBA – Norway
- Israel Children's Study

PATIENT CARE

Centers of Excellence in
Children's Environmental Health

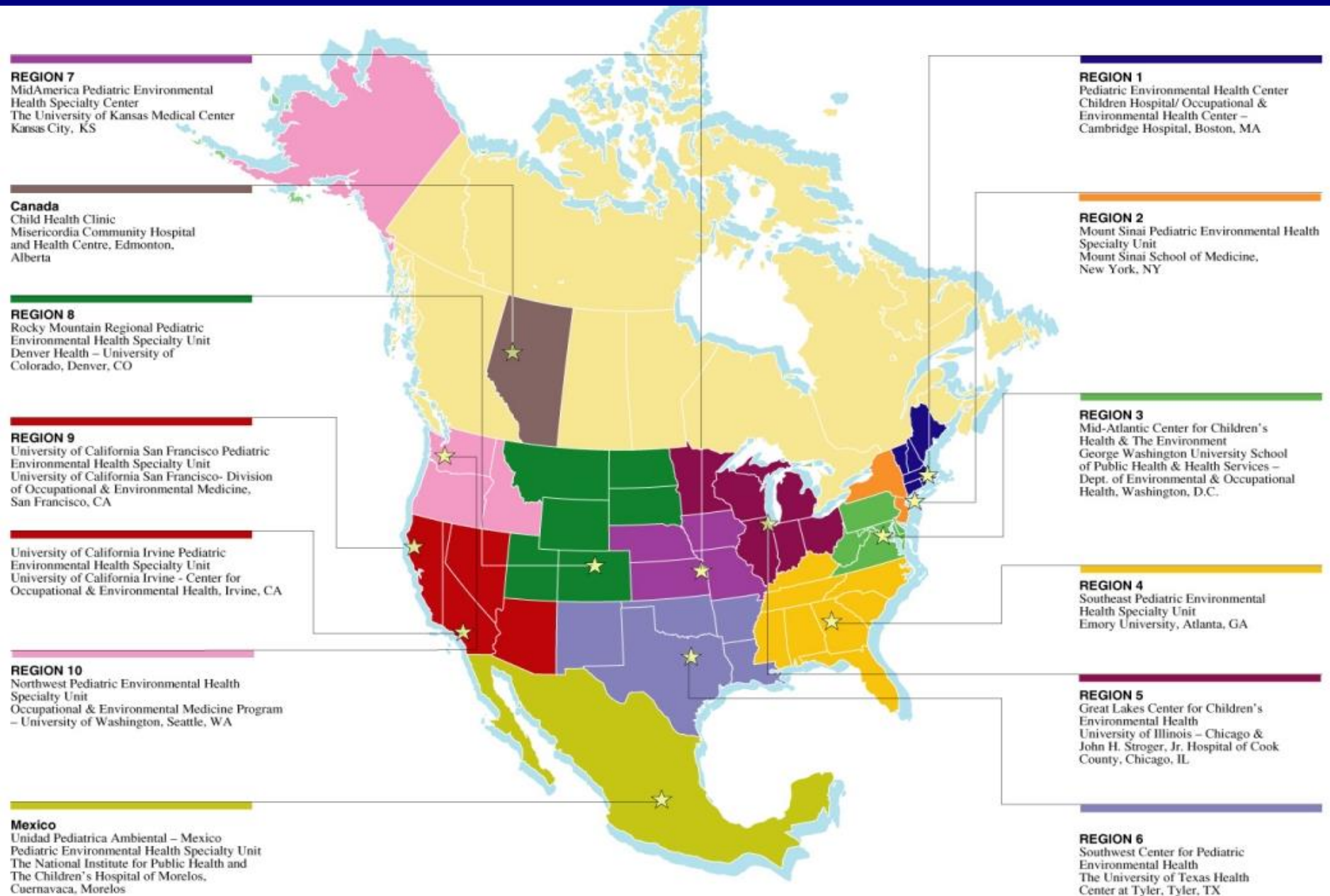
An efficient and
cost-effective approach to
diagnosing, treating and preventing disease
of toxic environmental origin.

WHY ARE CENTERS OF EXCELLENCE NEEDED?

Survey of NYS American Academy of Pediatrics Members

- Pediatricians agreed that:
 - ☐ the role of the environment in children's health is significant (average 4.43 on a 5-point scale)
 - ☐ the magnitude of children's environmentally related-illnesses is increasing (average 3.85 on a 5-point scale).
- ~ 90% reported that they had seen at least one patient affected by environmental exposures in the past year
- While pediatricians were confident about their ability to evaluate lead exposure, they were much less confident about evaluating mercury, pesticide or other environmental exposure.

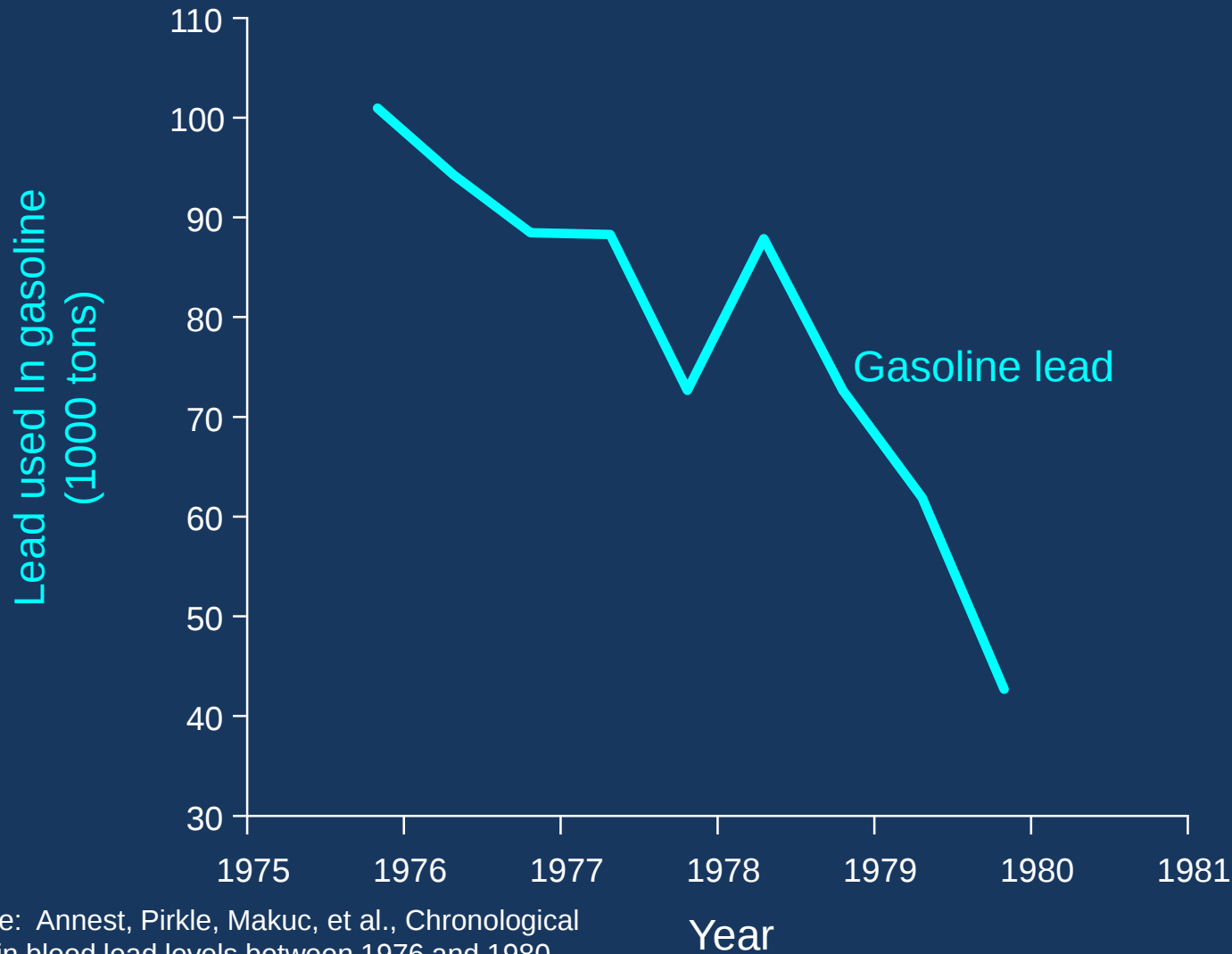
PEHSUs



PREVENTION WORKS

Example: The removal of Lead from Gasoline

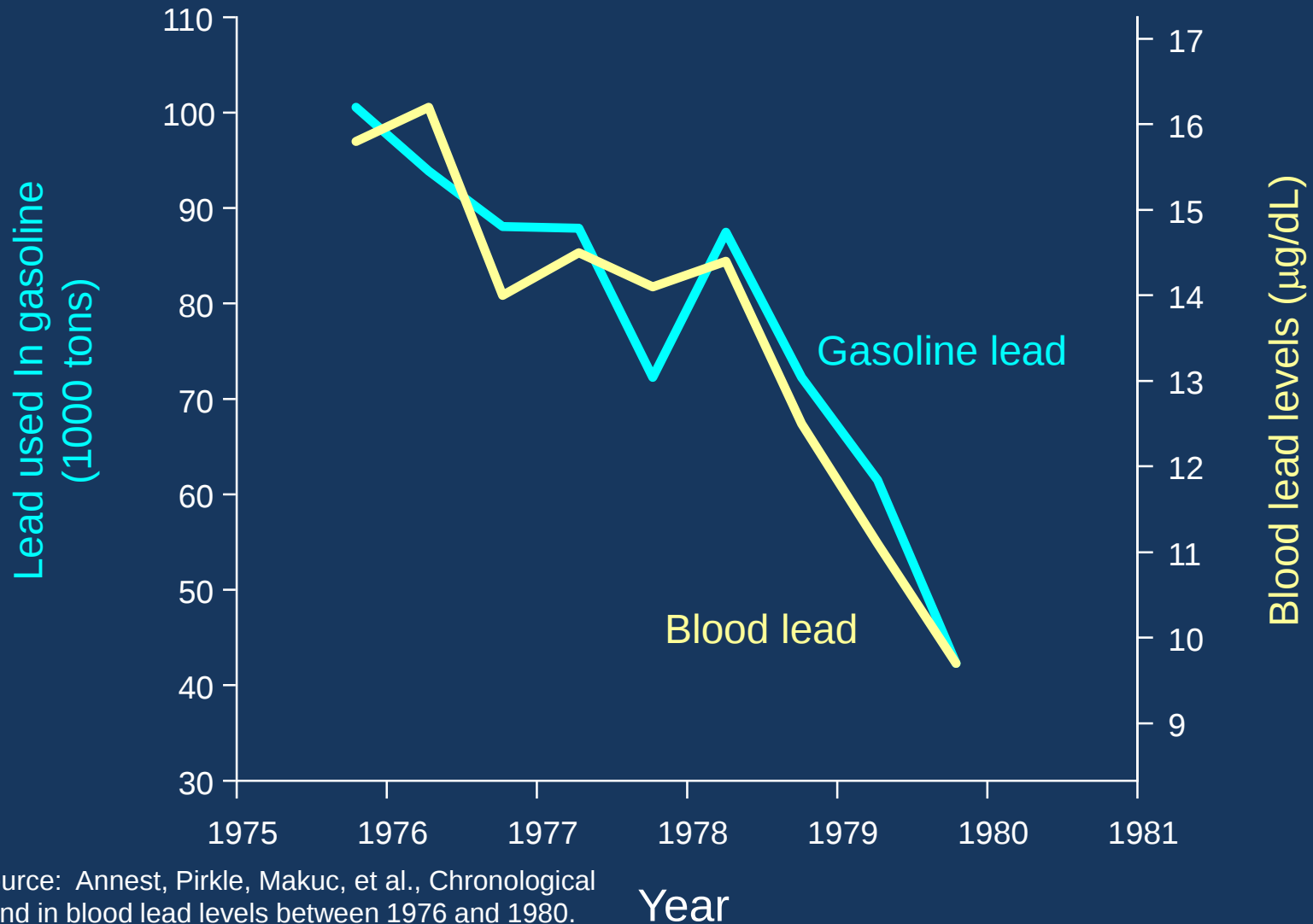
LEAD USE IN GASOLINE DECLINED FROM 1976 THROUGH 1980



Source: Annest, Pirkle, Makuc, et al., Chronological trend in blood lead levels between 1976 and 1980. NEJM 1983; 308;1373-7.

LEAD IN GASOLINE AND LEAD IN BLOOD

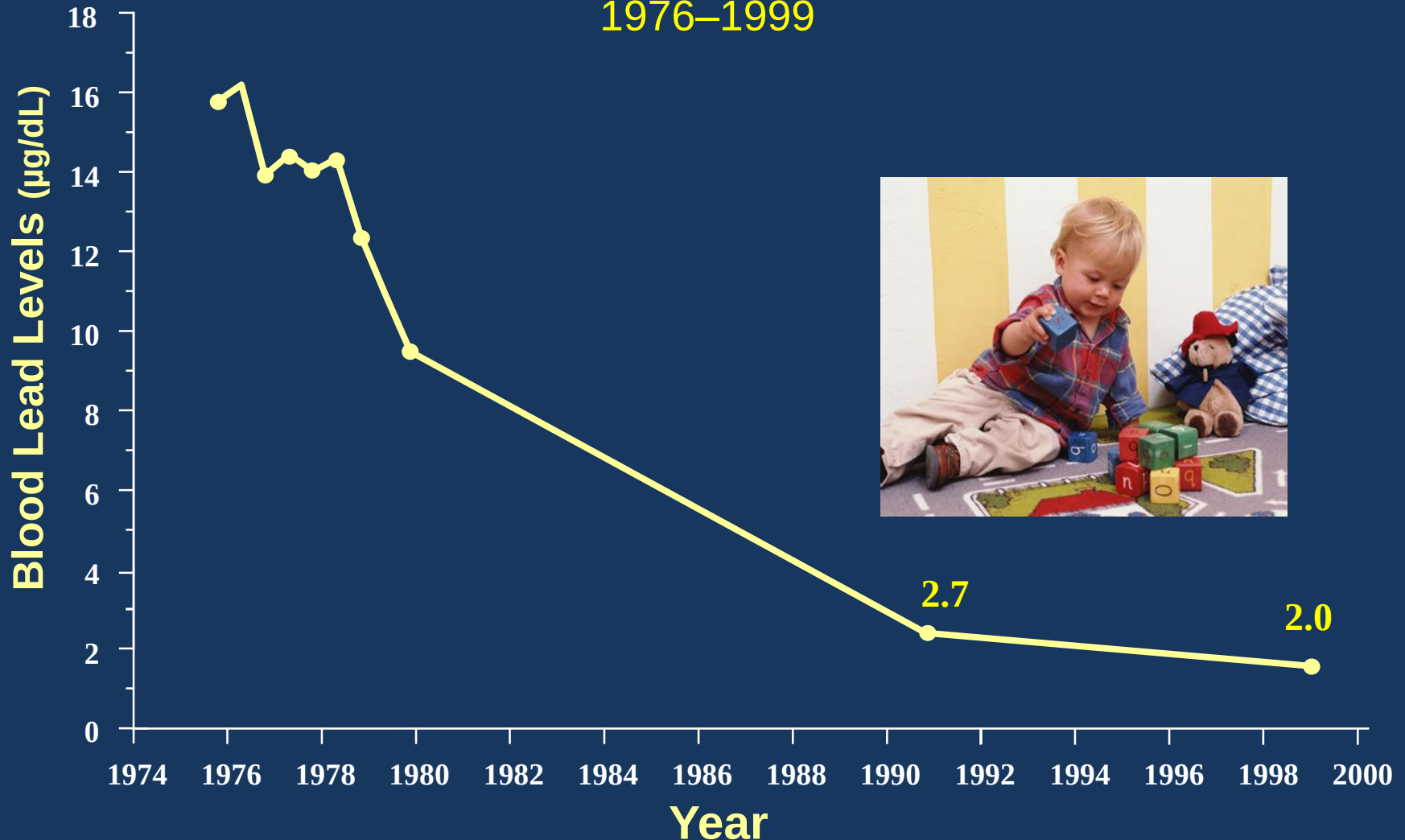
NHANES II, 1976-1980



Source: Annett, Pirkle, Makuc, et al., Chronological trend in blood lead levels between 1976 and 1980. NEJM 1983; 308:1373-7.

ENVIRONMENTAL DISEASE IS PREVENTABLE - DECLINING BLOOD LEAD LEVELS IN THE U.S.

1976–1999



CONSEQUENCES OF REMOVAL OF LEAD FROM GASOLINE

- 95% reduction in blood lead levels in US children
- 95% reduction in incidence of lead poisoning
- 2-5-point gain in population mean IQ
- \$200 billion annual economic benefit to US each year since 1980 through increased economic productivity of more intelligent children

DECLINING LEAD LEVELS AND FALL IN THE MURDER RATE

Is there a Connection?



THE GLOBAL DIMENSION OF CHILDREN'S ENVIRONMENTAL HEALTH

- Toxic pollution affects the health of more than 100 million people, shortening their productive life spans by 12.7 years on average *
- 20% of deaths in the developing world are attributable to environmental factors from pollution+



The export of toxic chemicals and hazardous processes from the industrially developed to the developing nations of the world has the potential to profoundly change patterns of morbidity and mortality, especially in children

Risks to Developing Nations of the Export of Hazardous Technologies and Toxic Chemicals

Five Examples:

- Methyl isocyanate - Bhopal, India
- Lead in petrol
- International trade in asbestos
- Export of banned pesticides
- E-waste

Bhopal, India



Photo - Courtesy : Pablo Bartholomew

Copyright © 1985 All Right Reserved - Pablo Bartholomew / Gamma- Liaison Network

THE GLOBAL USE OF LEAD IN GASOLINE

- Lead was first added to gasoline in 1922
- By the 1970s, almost all gasoline produced worldwide contained lead
- In the USA, peak annual consumption was almost 200,000 tons (mid-1970s)
- A disaster for public health

ASBESTOS



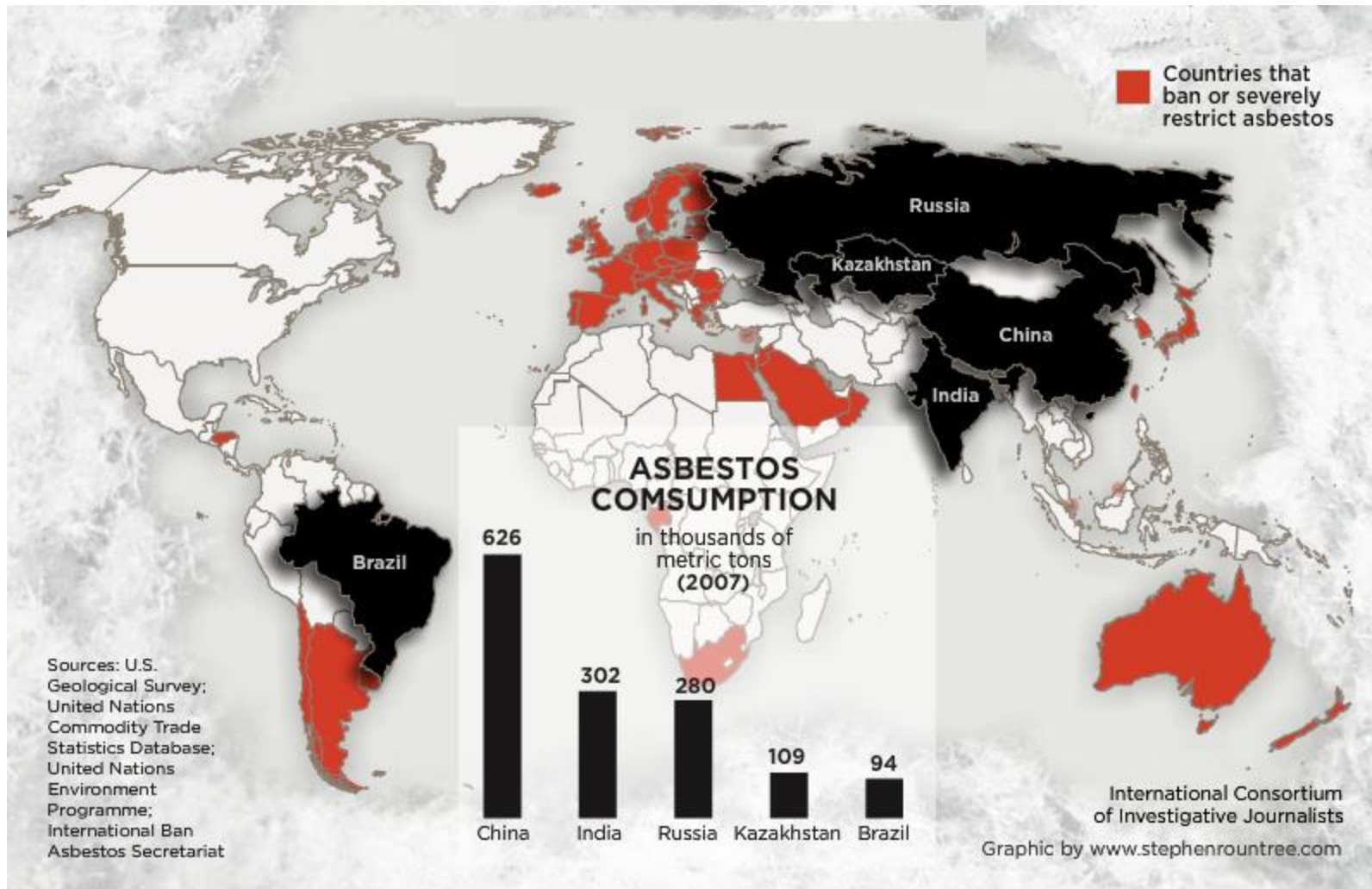
ASBESTOS

- Currently 125 million people encounter asbestos in the workplace
- 100,000 workers die each year from asbestos-related diseases
- Forecast a total of 5 million to 10 million deaths from asbestos-related cancers by 2030
- By 2020, deaths from asbestos-related cancers could exceed 1 million in developing nations

Asbestos is Known to Cause the Following Diseases:

- Lung Cancer
- Malignant Mesothelioma
- Asbestosis
- Other Malignancies
 - Larynx
 - Ovary
 - GI (probably)

Top 5 Asbestos Consumers



Export of Toxic Pesticides

- 2001-2003, the US exported ~ 1.7 billion lbs of pesticide products
 - = 32 tons per hour
- Included were 27 million pounds of pesticides banned in the US
 - 500,000 pounds known or suspected carcinogens
- Endocrine disrupting pesticides were sent overseas at the rate of 100 tons a day

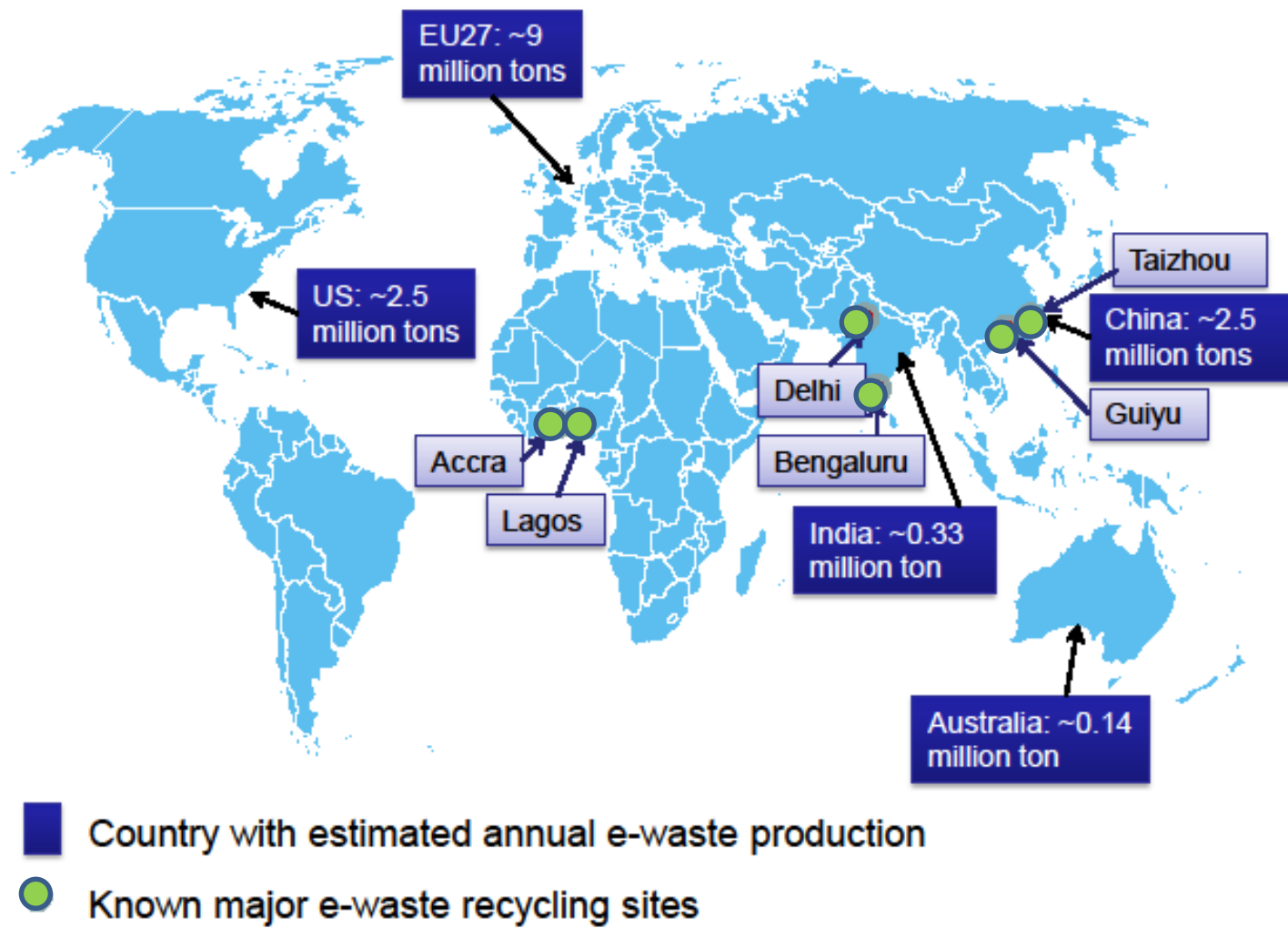


GLOBAL EXPORT OF E-WASTE

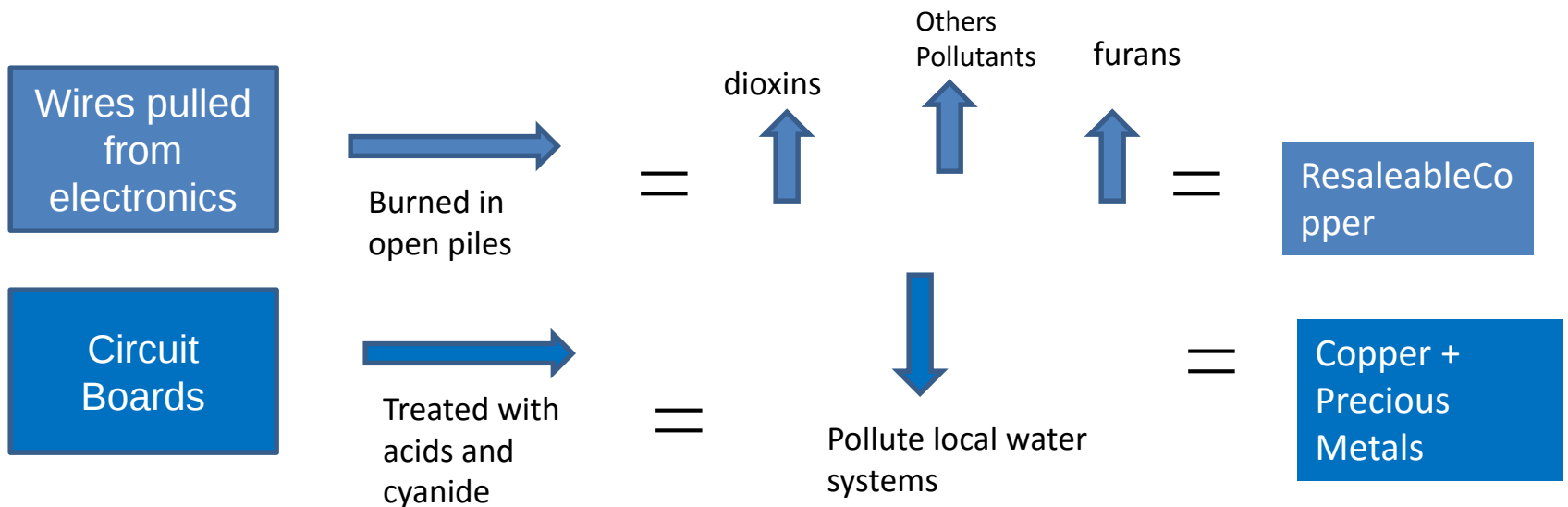
- E-waste is the fastest-growing component of the waste stream worldwide*
- In 20 years, developing nations will be discarding 400-700 million personal computers annually⁺
- Developed nations will be throwing out 200-300 million a year

*Jinglei Yu, Eric Williams, Meiting Ju and Yan Yang: *Environ. Sci. Technol.*, 2010, 44 (9), pp 3232–3233

⁺ National Resource Defense Council



Informal E-Waste Recycling



Thank you!



***Protecting Children against
Environmental Threats to Health***