CHILDREN’S ENVIRONMENTAL HEALTH
The Problem and the Solution

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CHILDREN TODAY LIVE IN A WORLD OF UNPRECEDENTED ENVIRONMENTAL CHANGE

- Population growth
- Urbanization
- Globalization
- Inequality
- Increasing production of chemicals and pesticides
- Industrialization of low- and middle-income countries
- Climate change
- Pollution
RAPIDLY GROWING GLOBAL POPULATION

Current world population: 7.0 billion. Compares to 1.6 billion in 1900. Projected peak of 9.0 billion in 2050
Today for the first time in human history, over half of the world’s population lives in cities.
GLOBALIZATION

- Transport
- Internet
- Spread of commerce
- Spread of ideas
- Migration of people
- Spread of infectious diseases
- Spread of toxic chemicals
- Movement of heavy industry from developed to developing countries
- Spread of the Western diet
3 billion people worldwide live in poverty - Income less than $2.00 US per day
HEALTH INEQUALITY

Maternal Deaths

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HEALTH INEQUALITY

Distribution of Doctors

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INCREASING PRODUCTION OF CHEMICALS AND PESTICIDES

U.S. chemical production, 1947–2007

Production index (100 = year 2002)
INDUSTRIALIZATION OF LOW- AND MIDDLE-INCOME COUNTRIES

Relocation of dangerous industries and toxic chemical production to less developed countries has the potential to profoundly change patterns of morbidity and mortality, especially among children.

Examples:
– Methyl isocyanate - Bhopal, India
– Asbestos
– Pesticides
– Mercury
– E-waste
Bhopal, India: A Sentinel Event
Bhopal, India
ASBESTOS
ASBESTOS

• 2 million tons of new asbestos are produced and sold each year
• Worldwide asbestos sales are strong – almost all increase is in sales to developing countries
• Producer countries engage in deceptive marketing. They advocate “safe use” [no such thing] and claim that chrysotile asbestos is “safe” [a lie]
• The consequence – a global pandemic of asbestos-related diseases
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 IN INDIA

Consumption is increasing at >10 % per year
Used mainly in construction
ASBESTOS EXPOSURE IN SHIPBREAKING
PESTICIDES
PESTICIDES

- Pesticide use is growing rapidly in Latin America: $3 billion (USD) annual sales
- Acute intoxications of workers and children – most commonly by organophosphates and carbamates
- Children experience both community-based and occupational exposures
- Prenatal exposures can cause neurodevelopmental impairment with loss of intelligence and disruption of behavior
GLYPHOSATE USE BY YEAR AND CROP, USA, 1992-2012

IARC considers Glyphosate a Probable Human Carcinogen
MERCURY

• Artesanal and Small-Scale Gold Mining: Major source of exposure. Accounts for at least 25% of the world’s gold production

• Exposure to metallic mercury through inhalation of vapor and of methylmercury through consumption of contaminated fish

• Health consequences: Prenatal brain damage with loss of intelligence and disruption of behavior. Minamata-like disease in extreme cases
EXTRACTION OF GOLD BY ROASTING AMALGAM

Mercury exposure of entire family
E-WASTE

- **Monitors**: 10%
- **Televisions**: 10%
- **Computers, telephones, fax, printers, etc.**: 15%
- **DVD / VCR players, CD players, radios, Hi-Fi sets, etc.**: 15%
- **Refrigerators**: 20%
- **Washing machines, dryers, air-conditioners, vacuum cleaners, coffee machines, toasters, irons, etc.**: 30%
E-WASTE BURNING IN GHANA
INFORMAL E-WASTE RECYCLING

Wires pulled from electronics

Burned in open piles = Resaleable Copper

Circuit Boards

Treated with acids and cyanide = Pollute local water systems

Dioxins, Furans, Others Pollutants = Copper + Precious Metals
NEUROTOXICANTS IN E-WASTE

Informal e-waste recycling: Chronic mixture exposure

Lead

Mercury

Cadmium

Chromium

PBDEs

PCBs (certain e-waste only)

PCDDs/Fs, PAHs (combustion)

Toxicological mechanisms

Oxidative stress

Interfering calcium signaling

Neurotransmission (glutamatergic, dopaminergic)

Neuroendocrine (e.g., thyroid hormone disruption)

Epigenetic control (gene expression)

Neurodevelopmental processes

Proliferation

Migration

Differentiation

Synaptic formation/trimming/plasticity

Myelination

Neurodevelopmental outcomes

Cognitive function

Attention

Executive functions

Motor function

Behavior

Aimin Chen, Kim N. Dietrich, Xia Huo, Shuk-mei Ho, Environmental Health Perspectives: Developmental Neurotoxicants in E-Waste: An Emerging Health Concern
POLLUTION...

...unwanted, dangerous materials discharged into air, water and onto the earth that directly harm human health and degrade the environment.

The externalized, uncounted by-products of production.
POLLUTION IS A MAJOR CAUSE OF DISEASE AND PREMATURE DEATH
Villagers in northern Nigeria cleaning up lead pollution that killed more than 400 children in one year.
A community in Armenia where half of the children have lead poisoning
POLLUTION IS A HUMAN RIGHTS ISSUE

- 94% of deaths from pollution-related disease occur in low- and middle-income countries
- In countries at all income levels, pollution disproportionately affects the poor and marginalized
- Women, children, the elderly and minorities are the main victims
- Contrast these sad realities with Pope Francis’ social and environmental teaching in *Laudato Si’*
RISE OF NON-COMMUNICABLE DISEASE IN THE WORLD’S CHILDREN

- Over the past century, in parallel with changes in the global environment, patterns of disease in children have changed profoundly
- Infectious diseases have declined in frequency and severity (AIDS and tuberculosis notwithstanding)
- Life expectancy has doubled
- Infant mortality has declined by over 90%
- Non-communicable diseases have become increasingly prevalent

*The Epidemiological Transition*
ASTHMA PREVALENCE, USA, 1982–2009

Source: Centers for Disease Control and Prevention
INCIDENCE AND MORTALITY FROM CHILDHOOD CANCER, USA, 1975-1996
INCREASING INCIDENCE OF TESTICULAR CANCER, USA

*Incidence rate per 100,000*

**Year of diagnosis**

- **White males**
- **All races, males**
- **Black males**

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

INCREASING INCIDENCE OF HYPOSPADIAS/CRYPTORRCHIDISM, USA
NEURODEVELOPMENTAL 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
What is the Evidence that Toxic Chemicals in the Environment Contribute to Chronic Disease in Children?
NEW CHEMICALS ARE INTRODUCED WITH GREAT ENTHUSIASM, BUT LITTLE TESTING
SOME ARE FOUND BELATEDLY TO CAUSE DISASTERS
MOST CHEMICALS HAVE NOT BEEN TESTED FOR TOXICITY

- 120,000 + 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
- HPV chemicals are widespread. Many are detectable in adult blood, breast milk and infant cord blood
CHILDREN ARE EXQUISITELY VULNERABLE TO TOXIC CHEMICALS

- 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
- NOx
- 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

Emerging Links to Endocrine Disrupting Chemicals
EVIDENCE FOR ENVIRONMENTAL CAUSATION OF NEURODEVELOPMENTAL DISORDERS

• Initial recognition of high-dose, acute poisoning, example, Minamata Disease

• Subsequent discovery of widespread subclinical intoxication

• The power of prospective birth cohort epidemiologic studies to establish causation
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?

n=12

- n=201
- n>1000
- n>80,000

- Chemicals known to be toxic to human neurodevelopment
- Chemicals known to be neurotoxic in experiments
- Chemicals known to be neurotoxic in human beings
- Chemical universe
SOCIIETAL IMPACT OF 5-POINT LOSS IN IQ

Average IQ = 100

6 million “mentally retarded”

Average IQ = 95

57% increase

9.4 million “mentally retarded”

2.4 million “gifted”
DISEASE OF TOXIC ENVIRONMENTAL ORIGIN IN CHILDREN IS EXTREMELY COSTLY
# AGGREGATE COSTS OF ENVIRONMENTAL DISEASES, US CHILDREN, 2008

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

*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 SAFETY & TOXICITY

• **Goals:** To test new chemicals before they come to market and prioritize testing of chemicals in current use
• The presumption that chemicals are safe is dangerous and disproven by repeated experience
• European REACH program is a model – based on presumption of danger. Chemicals must be proven safe
• The US has recently enacted chemical reform legislation – the Frank R. Launtenberg Chemical Safety for the 21st Century Act. Stronger than the previous US legislation, but not as strong as REACH.
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

• Major epidemiologic studies – National Children’s Study; ECHO
PATIENT CARE

A national and global network of Pediatric Environmental Health Specialty Units (UPAs en America Latina)

An efficient and cost-effective approach to diagnosing, treating and preventing disease of toxic environmental origin in the world’s children
PREVENTION WORKS

Example: The removal of Lead from Gasoline
LEAD USE IN GASOLINE DECLINED FROM 1976 THROUGH 1980

LEAD IN GASOLINE AND LEAD IN BLOOD
NHANES II, 1976-1980

Blood lead levels (mg/dL)

Year


Blood lead

Gasoline lead

Lead used in gasoline (1000 tons)

110
100
90
80
70
60
50
40
30

17
16
15
14
13
12
11
10
9

ENVIRONMENTAL DISEASE IS PREVENTABLE - DECLINING BLOOD LEAD LEVELS IN THE U.S.
1976–1999

Blood Lead Levels (µg/dL)

Year


0 2 4 6 8 10 12 14 16 18

2.7 2.0
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 a generation of more intelligent children.
• Aggregate benefit over the past 30 years of $3 trillion
CONCLUSION

Two Grand Challenges for the Future
GLOBAL CLIMATE CHANGE
POLLUTION
THE LANCET COMMISSION ON POLLUTION & HEALTH

Launched in summer 2015
THE LANCET COMMISSION ON POLLUTION & HEALTH

Goal. To end neglect of the great and growing global problem of pollution and to focus the world’s attention on the threat of pollution-related disease.

Strategies:
• To inform key decision makers, especially heads of government and international donors as well as civil society about pollution’s great, growing but under-recognized contribution to the global burden of disease;
• To inform key decision makers about pollution-related disease’s great economic costs; and
• To present world leaders with actionable, data-driven strategies for pollution control and disease prevention.

Commission report: Lancet, March/April 2017
THANK YOU