Our Environment, Our Health, Our Future

Children’s

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Targeting Environment and Neuro-Developmental Risks (TENDR)
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National Institutes of Health • U.S. Department of Health and Human Services
The National Institute of Environmental Health Sciences

• One of the 27 NIH Institutes and Centers

• Wide variety of programs supporting our mission of environmental health:
  – Intramural laboratories
  – Extramural funding programs
  – Disease prevention
  – Clinical research program
  – National Toxicology Program
  – Public Health Focus
NIEHS Strategic Plan

Mission
The mission of the National Institute of Environmental Health Sciences is to discover how the environment affects people in order to promote healthier lives.

Vision
The vision of the National Institute of Environmental Health Sciences is to provide global leadership for innovative research that improves public health by preventing disease and disability.
Should We Be Concerned?

Increase in Diabetes (1980-2010)

Increase in Autism Prevalence

Prevalence per 1,000 Children

Surveillance Year

Increase in Asthma

Increase in ADHD

Data from CDC / National Center for Health Statistics
Why Environmental Health Matters

• 13 million deaths could be *prevented* per year by improving our environment

• Environmental factors influence 85 out of the 102 non-communicable diseases in WHO report

• Environmental factors account for at least 2/3 of cancer cases in the United States

• You can’t change your genes, but you *can* change your environment

“ENVIRONMENT” Includes:

- Industrial chemicals
- Agricultural chemicals
- Physical agents (heat, radiation)
- By-products of combustion and industrial processes (dioxin)
- Infectious agents
- Microbiome (gut flora)
- Foods and nutrients
- Prescription drugs
- Lifestyle choices and substance abuse
- Social and economic factors
Diseases with a Known or Suspected Environmental Component Include:

- Cancers
- Birth defects (cleft palate, cardiac malformations)
- Reproductive dysfunction (infertility)
- Lung dysfunction (asthma, asbestosis)
- Neurodegenerative diseases (Parkinson’s)
- Neurodevelopmental disorders (autism)
- Cardiovascular disease (air pollution, dioxins)
- Endocrine disorders (diabetes)
Conceptual Shift for Environmental Health Sciences

OLD… chemicals act by overwhelming the body’s defenses by brute force at very high doses

NEW… chemicals can act like hormones and drugs to disrupt the control of development and function at very low doses to which the average person is exposed

NEW… susceptibility to disease persists long after exposure (epigenetics)
Ubiquitous Exposure

- Chemicals are widely dispersed in our environment
- Chemicals are often dispersed at biologically effective levels, exposure to humans is common
- Exposures do not occur singly
- One exposure can alter body’s response to other exposures
- Combinations must be studied
- “Exposome” is the totality of exposures for a person
Consideration of vulnerable populations

• Pregnant women
  – How do the complex series of immunological changes during pregnancy affect susceptibility to pollutant exposure and effects?

• In utero exposure of fetus to pollutants
  – Potential organizational effects from pollutants could lead to permanent changes

• Exposure of child during sensitive developmental windows
  – Susceptibility changes over time and could lead to different health outcomes from a single exposure
Windows of Susceptibility

- Development is sensitive time for exposure
  - Rapid Growth
  - Active and extensive cell differentiation
  - Increased metabolic rate
  - Developing immune system
  - Opportunities for initiation of lesions and promotion of altered cells
  - Development is a highly integrated process
  - Programming (epigenetic marks set)

- *In utero*, infants, childhood, adolescence, pregnancy, old age
Developmental Origins of Health and Disease

Stress
Environmental chemicals
Nutritional imbalance
Drugs

Development (in utero and early-life)

Hormone regulation
Metabolic Pathways
Cellular Differentiation/Stress

Epigenetic regulation:
DNA methylation
Histone modifications
Non coding RNAs

Long term effects on gene expression
Increased disease risk across lifespan

Barouki et al, Environ Health 2012
NIEHS research is focused on understanding the interaction of our genetic susceptibilities and our environmental exposures.
Child Health Extramural Research Studies, FY14
Children’s Research on Air Pollution and the Immune System

• Living within 75m of a major roadway associated with increased risk of asthma

• Genetic variations in immune response to air pollutants may increase susceptibility

• Children in a high-pollution environment showed impaired function of regulatory T cells compared to children in low-pollution setting

• Ambient air pollution may worsen asthma via an immune mechanism

• The pollution may mediate epigenetic changes in regulatory T cells (Nadeau, Journal of Allergy and Clinical Immunology, 2010)
The air we breathe...indoors

• 3 billion people exposed

• Over 4 million people die prematurely from cooking with solid fuels.

• More than 50% of premature deaths among children under 5 are due to pneumonia caused by particulate matter (soot) inhaled from household air pollution.

• 3.8 million premature deaths annually from non-communicable diseases

Indoor Air Quality associated with multiple adverse health outcomes

- Decreased Neurodevelopmental Performance Associated with Woodsmoke exposure. (Dix-Cooper et al. 2012)

- Indoor biomass fuel exposure is associated with increased risk of LBW (49%), respiratory illness (39%) and infant mortality (21%) (Tielsch et al. 2009)

- Asthma associated with open-fire cooking in Venezuela (Kraai et al. 2013)

- Household Air Pollution is a major avoidable risk factor for Cardiorespiratory Disease (Mortimer et al. 2012)

- Decreased Lung Function Associated with Carbon Monoxide Exposure in Household Air Pollution (Pope et al. 2014)
Studies on the Growing Brain

• Childhood Autism Risks from Genetics and the Environment (CHARGE)

• Markers of Autism Risk in Babies: Learning Early Signs (MARBLES)

• Early Autism Risk Longitudinal Investigation (EARLI)

• Environmental Epidemiology of Autism Research Network (EEARN)
ADHD and Pesticide Exposure Associated with lower IQ and increased ADHD, Autism

• In animal models, researchers are investigating pesticide exposure as a possible risk factor for ADHD

• In humans, researchers found that higher maternal urinary levels of organophosphate metabolites were associated with ADHD, decreased IQ, and behavioral issues in children

UC Berkeley; Marks et al., 2010; Eskenazi et al., 2013
Heavy Metal Exposure in Children

Real-world Exposures to Metals Often Consist of Low Doses

- Very low levels of Arsenic exposure (5-10ug/L) in drinking water are associated with lower IQ scores in 3-5 grade children. Wasserman et al., Environ Health (2014)

- Children exposed to Mercury show decreased visuospatial processing and memory. Grandjean et al., Neurotoxicol Teratol (2014)

- Exposure to Manganese is associated with poorer memory and attention in children, even at low levels commonly encountered in North America. Oulhote et al., EHP (2014)

- Very low levels of lead exposure (below 10 μg/dL) are associated with lower IQ scores in children ages 3 and 5 years old. Canfield et al., NEJM (2003)
Economic Costs of Autism Spectrum Disorders

• $17,000 more per year to care for a child with ASD compared to a child without ASD. For a child with more severe ASD, costs per year increase to over $21,000.

• Estimated that total societal costs of caring for children with ASD were over $9 billion in 2011.

• In addition to medical costs, intensive behavioral interventions for children with ASD can cost $40,000 to $60,000 per child per year.

Data: http://www.cdc.gov/ncbddd/autism/data.html
EU environmentally attributable costs of childhood lead exposure, methylmercury exposure, developmental disabilities, asthma and cancer

• $70.9 billion in 2008 (range: $58.9-$90.6 billion).

• These costs amounted to ~0.480% of the gross domestic product of the EU.

Health Effects of Arsenic in Drinking Water

• Cancer – Lung, larynx, liver, kidney, bladder, skin
• Respiratory Effects – Bronchiectasis, COPD, Emphysema, Chronic Lung Infections
• Vascular and Cardiovascular Disease
• Reproductive and Developmental Problems
• Neurological Problems and Reduced Cognitive Function in Children
• Type 2 Diabetes
• Endocrine Disruptor – ER, PR, AR, GR, MR, RAR, TR, PPAR
In Utero and Childhood Arsenic Exposure and Cancer
(Cancer diagnosis age >25yrs)

Lung cancer

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Bladder cancer

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<td>7.7 (4.1-14.7)</td>
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Environmental Chemicals can contribute to Obesity

Prevalence of obesity*, ages 20+, age standardized
Both sexes, 2008

[Map showing prevalence of obesity worldwide, with color codes indicating different percentage ranges.]

WHO 2011
Environmental Chemicals Exposures and Metabolic Disease

- Nicotine likely acts as a developmental *obesogen* in humans
- BPA affects insulin release and cellular signaling in pancreatic β cells
- There is a positive association between diabetes and certain organochlorine POPs
- Exposure to multiple classes of pesticides may affect risk factors for diabetes and obesity, although data gaps remain
NIEHS Core Centers (P30): Building Collaborations

- **Purpose to provide infrastructure and core facilities to EHS research** - *annual RFA; new sliding scale funding*

- **Working Group on Emerging Environmental Health Issues** - *Provides guidance, gauges interest*

- **COEC Webinars** - *Topics of Community Concern*

- **NIEHS Core Center Meetings** - *Facilitates Collaboration, NIH Updates, Working Group Activities*
Vulnerable Populations

Environmental Health Disparities and Environmental Justice Meeting
July 29-31, 2013

Communication Research in Environmental Health Sciences: Environmental Health Literacy
September 22-24, 2014
8:00 a.m. – 5:00 p.m.
NIEHS Building 101, Rodbell Auditorium

Individuals with disabilities who need accommodation to participate in this event should contact David Kinnamont at 919-541-3254 or david.kinnamont@nih.gov. TTY users should contact the Federal TTY Relay Service at 800-877-8339. Requests should be made at least 5 business days in advance of the event.

Any individual seeking access to the NIEHS campus to attend this seminar will need to be prepared to show a photo ID, e.g., driver's license, or company, government, or university ID, and to provide pertinent information about the seminar, e.g., title of seminar, speaker name, or host of the seminar.

Co-sponsored by

United States Environmental Protection Agency
National Institute on Minority Health and Health Disparities
CDC
OMH

National Institutes of Health • U.S. Department of Health and Human Services
Partnerships for Environmental Public Health: Networking to Advance New Approaches

Communication Research to:

• Validate and evaluate existing efforts
• Provide evidence for reach & effectiveness
• Help target & form messages
• Understand uptake of information
Citizen Science and Community Engagement

- Research to Action: Assessing and Addressing Community Exposures to Environmental Contaminants
- Children’s Centers & National Children’s Study
- Environmental Health Sciences Core Centers
- Superfund Research Program
- Deepwater Horizon Research Core
- Worker Education & Training Program
- Disaster Research Response Program
- Climate Change and Human Health
- Global Alliance for Clean Cookstoves
- Sisters Study
- Biomarkers of Oxidative Stress Study (BOSS)
Better Tools for Research

• In 2014, researchers at Oregon State University developed a silicone bracelet that monitors a wide range of environmental exposures.

• Scientists at University of Cincinnati developing personal ultrafine particle counter.

• Field test indicated highest exposures at bus stop when worn by a child.
Barium Distributions in Teeth Reveal Early-life Dietary Transitions (Arora)

- Method for measuring early-life changes in diet based on chemical signatures of barium in teeth.
- Objective retrospective biomarker provides a major advance to studies on children's health to understand the health consequences of early-life diet, including breastfeeding, and chemical exposures.

(Austin et al., Nature, 2013)
Transforming Environmental Health Protection

National Toxicology Program Efforts

• Better coordination of testing across the Federal government
• Increase understanding of “exposome”
• Develop alternative methods of assessment
• Integrate results from new “data rich” techniques with traditional toxicology data
• Toxicity for the 21st Century or “Tox21”
  – MOU between NTP, NCATS, EPA and FDA
  – High throughput, robotic testing of toxic compounds in cell and molecular assays
  – Using knowledge of biological response to identify toxicity pathways
  – Prioritization for further testing
Improvements in Evaluating Environmental Health Questions: Systematic Review

- Address the breadth of relevant data
  - Wide range of human study designs (e.g., clinical, observational)
  - Animal studies
  - Mechanistic studies (in vitro and other relevant data)
- Approach to reach hazard identification conclusions
- Procedure to integrate evidence streams
Conclusions on Confidence in Body of Evidence

- Similar factors may apply to traditional and non-traditional toxicology data
Redistribution of the FY15 Funding for the National Children’s Study - NIEHS

- **Tox21** – Enhance understanding of in-utero and post natal development
  - Development and deployment of development program; NCATS and NTP ($8M towards assays in Tox21)

- **Supplements** – Leverage existing Resources
  - Expansion of Extant Children’s Health Research – NIEHS ($5M)

- **CHEAR** – Tools to measure environmental exposures in children’s health research
  - Building a resource for exposure assessment for studies of children’s health for studies supported across NIH; NIEHS ($48M)
Redistribution of the FY15 Funding for the National Children’s Study - NIH

- **PRISMS** – Development and deployment of personal sensors in studies of children’s health; NIBIB and other ICs ($28M)

- **PROMIS** – Validation of Pediatric Patient Reported Outcomes in Chronic Diseases Consortium (U19); NIAMS ($12M)

- **Human Placenta Project** - Developing Paradigm Shifting Innovations in Human in-vivo Placental Assessments in Response to Environmental Influences; NICHD and NIBIB ($39M)
Communicating the Need for Environmental Health

"We are not faced with two separate crises, one environmental and the other social, but rather one complex crisis which is both social and environmental."

"What kind of world do we want to leave to those who come after us, to children who are now growing up? The question not only concerns the environment in isolation; the issue cannot be approached piecemeal."
Prevention is the Key

- Genetic and environmental factors individually contribute and interact with each other to increase risk.

- The impact of exposures can vary based on timing of the exposure within critical windows.

- Identifying the hazards associated with chemicals to which humans are exposed is critical.

- Environmental factors are more readily identified and modified than genetic factors and therefore present a tremendous opportunity to prevent non-communicable disease.

You can’t change your Genes,… but you **CAN** change your Environment!!!
Thank You!