COLUMBIA CENTER FOR CHILDREN'S ENVIRONMENTAL HEALTH

MAILMAN SCHOOL OF PUBLIC HEALTH
Columbia University

Effects of Prenatal Exposure to Fossil Fuel Combustion Pollutants, Pesticides, and Endocrine Disruptors

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January 20, 2010

About the Center

- Founded in 1998
- Mission
  - Improve the health and development of children by identifying environmental toxicants and co-factors that increase their risk of disease
- Work with partner organizations, policymakers, and advocates to share research findings
- www.ccceh.org

The Need for Prevention

- High rates of low birth weight, developmental delay and asthma, obesity and metabolic disease in children in NYC and elsewhere
- Rates of developmental disorders, asthma, certain childhood cancers and obesity have been increasing in the U.S. and worldwide
- Common environmental exposures are known or suspected of contributing, along with adverse social conditions, genes, and nutrition
- We are all exposed; but there are significant ethnic disparities in exposure and in disease

The Developing Fetus, Infant and Child are Highly Susceptible

- Differential exposure
- Greater absorption and retention of toxics
- Decreased efficiency in detoxification/repair
- Higher rate of cell proliferation
- Vulnerability to physical and psychosocial stress
- Time for cancer and other chronic diseases to develop

Parallel Cohort Studies of *In Utero* Exposures

NEW YORK CITY, USA (1998-present)

N. Manhattan/S. Bronx Cohort
725 mothers & newborns and 50+ siblings

World Trade Center Cohort
329 mothers & newborns

KRAKOW, POLAND (2000-present)
550 mothers & newborns

CHONGQING, CHINA (2001-present)
450 mothers & newborns

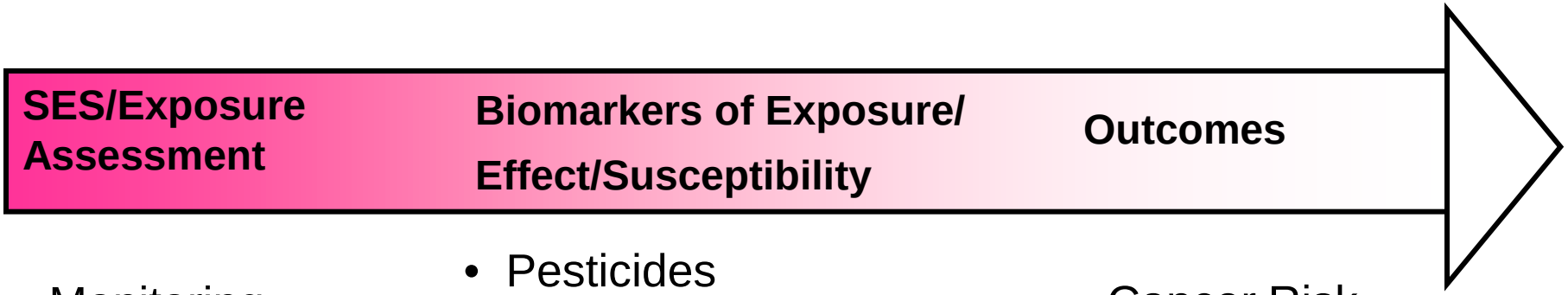
Asthma

Growth & Development

Cancer Risk

Adult Diseases

Pregnancy Through Childhood: Repeat Measures on Women and Children

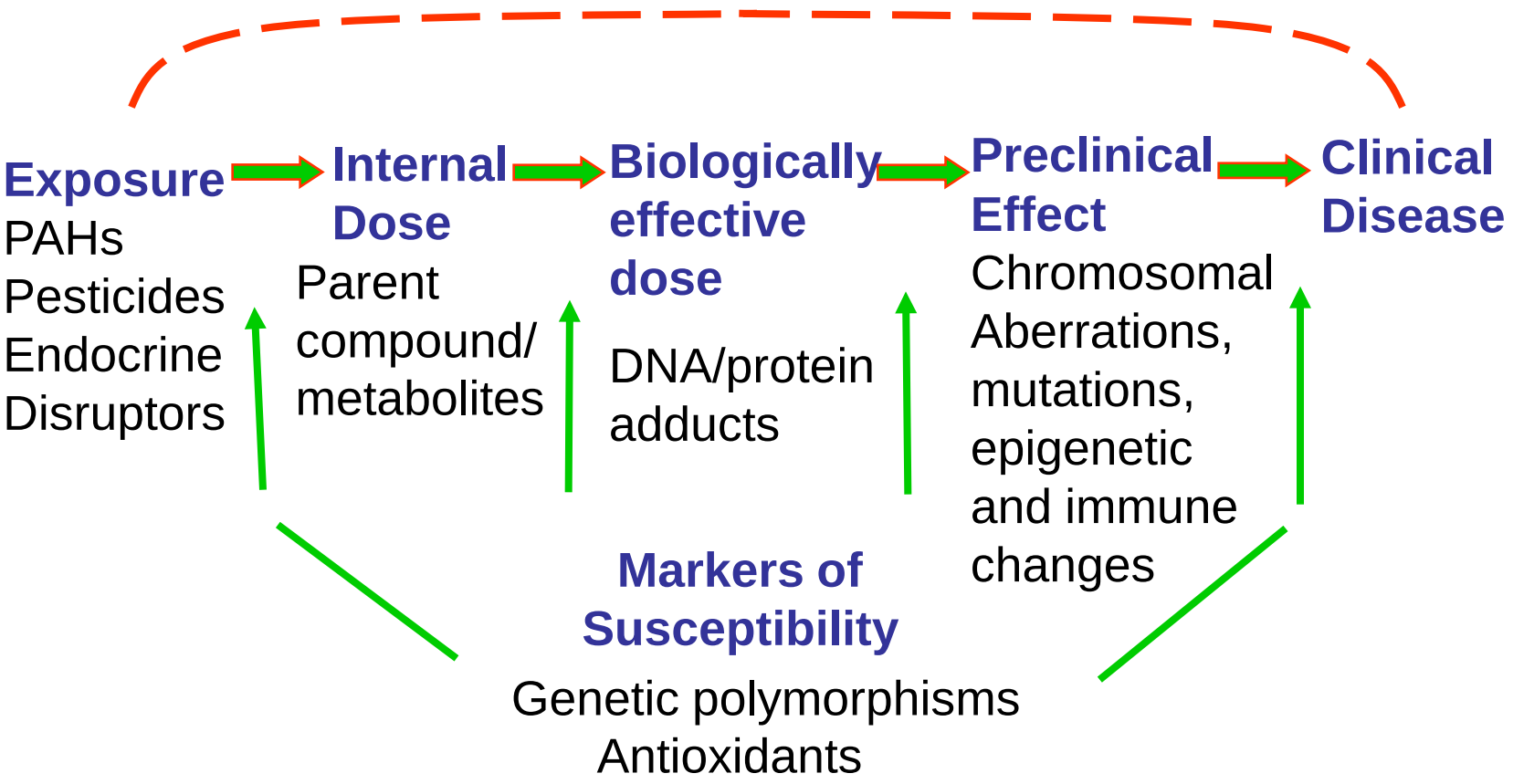


- Monitoring
- Questionnaire
- SES, Stressors
- GIS

- Pesticides
- Cotinine
- Lead, mercury
- PAH-DNA Adducts
- Phthalates
- Bisphenol A
- Chromosomal Aberrations
- Immune Changes
- DNA methylation
- Gene Expression
- Genetic Polymorphisms
- Antioxidants

- Cancer Risk (chromosomal abnormalities, epigenetic changes)
- Growth & Neurobehavioral Development
- Asthma

Molecular Epidemiology



[Perera and Weinstein, J Chron Dis,1982, NAS 1987]

Prenatal Exposures affect Health Over the Life Course

- Toxic “environmental” exposures (e.g., pollutants, nutritional deficits, social stressors) during fetal development can have adverse effects: in childhood, over the life course, transgenerationally
- Disproportionate exposures in poor/disadvantaged communities can contribute to disparities in disease over the life course
- Early intervention can have a big payoff over the full life course

Environmental Exposure: Air Pollution

- Polycyclic aromatic hydrocarbons (PAHs)
- Fine particulates
- Sulfur and nitrogen oxides
- Mercury and other metals
- Benzene
- Environmental tobacco smoke (ETS)

Coal-burning and chemical pollutants

Diesel-gasoline emissions

ETS

Prenatal PAH Exposures Increase Risk of Adverse Health Outcomes

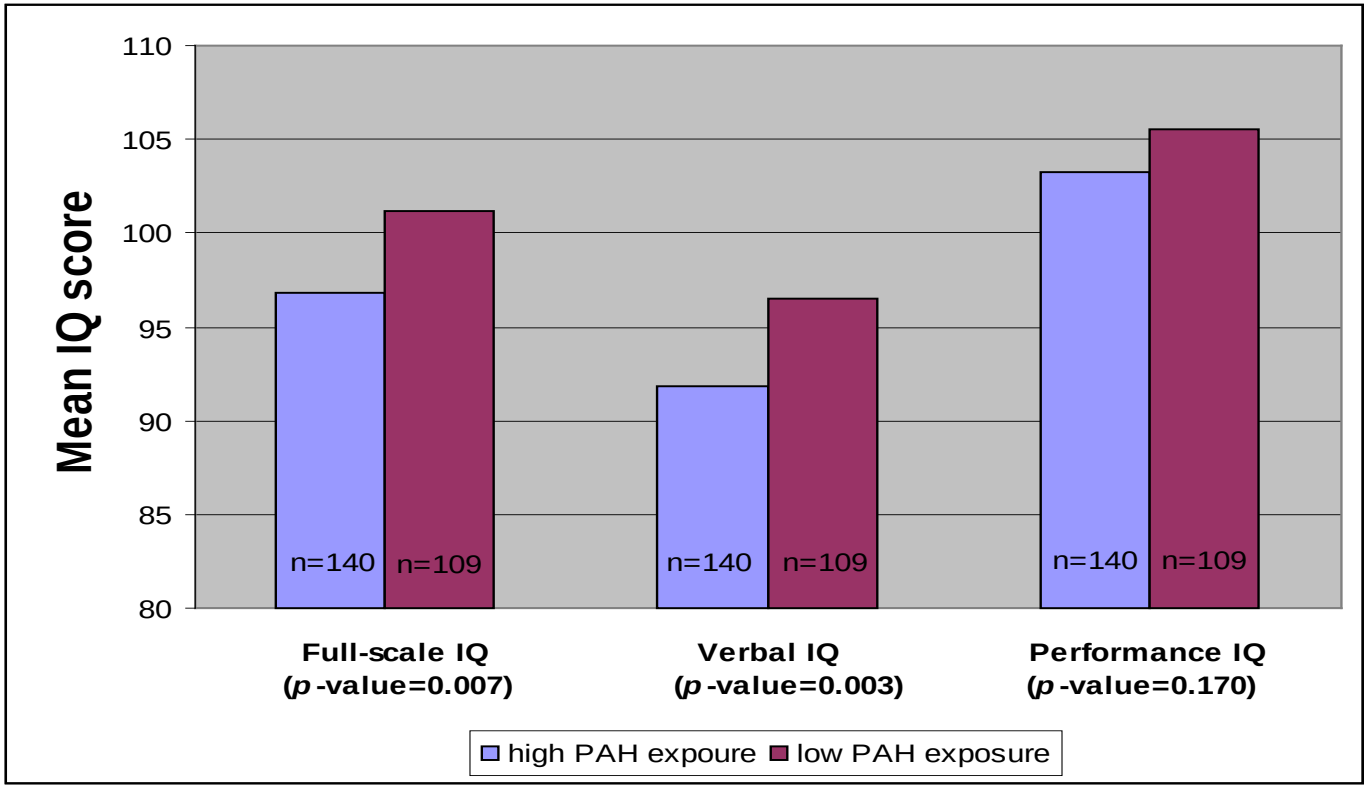
- Fetal and Neurobehavioral Development
  - Development delays at age 3
  - Attentional/behavioral problems through age 7
  - Reduction in birth weight and head circumference
  - Reduced IQ scores at age 5

- Childhood Asthma
  - Increased respiratory symptoms (ETS)
  - Elevated asthma-related immune markers (IgE)
  - Epigenetic alterations in cord blood linked to parental report of asthma by age 5

- Cancer Risk: Chromosomal Aberrations
  - Associated with higher frequency of stable aberrations

Adverse Effects of Prenatal PAHs on Children's IQ

Differences in Full-Scale, Verbal IQ and Performance IQ associated with high prenatal PAH exposure



(*n* = 249). Mean IQ levels are adjusted for ETS exposure during pregnancy, gender of child, ethnicity, mother's intelligence (TONI), mother's education, and the quality of the home caretaking environment (HOME).

New Research Focus: Endocrine Disruptors

- Phthalates
  - Added to plastics to increase flexibility, transparency, durability and longevity
  - Linked experimentally to certain cancers, developmental and reproductive effects
  - In our cohort, a risk factor for shortened gestation

- Bisphenol A
  - Used in hard plastics and in production of polycarbonate and epoxy resins
  - Prenatal exposure known carcinogen and developmental toxicant in animals
  - In our cohort, > 90% of pregnant mothers had detectable levels of BPA

- Ongoing CCCEH research
  - Effects of these endocrine disruptors on neurodevelopment, obesity & metabolic disorders

Polybrominated Diphenyl Ethers (PBDEs)

- PBDEs
  - Endocrine-disrupting chemicals
  - Widely used flame-retardant compounds that are applied to a broad array of textiles and consumer products (mattresses, upholstery, building materials, electronic equipment)
  - Human exposure may occur through dietary ingestion or through inhalation of dust containing PBDEs

- Prenatal exposure to PBDEs is associated with adverse neurodevelopmental effects
  - Children with higher concentrations of PBDEs in their umbilical cord blood at birth scored lower on tests of mental and physical development between the ages of one and six.

- The study is part of a broader project examining the effects of chemicals released by the World Trade Center's destruction on pregnant women and their children.

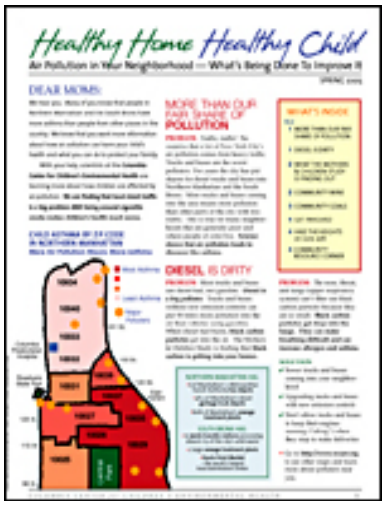
[Herbstman et al, EHP, published online on Jan. 4, 2010]

Disease Investigation through Specialized Clinically-Oriented Ventures in Environmental Research (DISCOVER)

- Interdisciplinary effort to understand role of environmental factors affecting human disease
  - Mechanistic and clinical research

- Four inter-linked projects with the following goals:
  - To understand when and how PAHs and diesel exhaust particles (DEP) increase risk for childhood asthma and airway inflammation
  - Translate research findings for asthma prevention, clinical treatment, physician education, and policymakers

Translating Science to Interventions at Multiple Levels

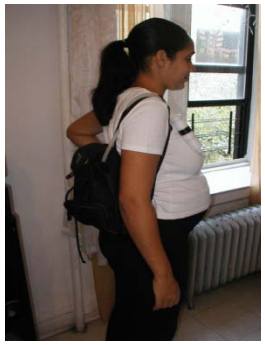


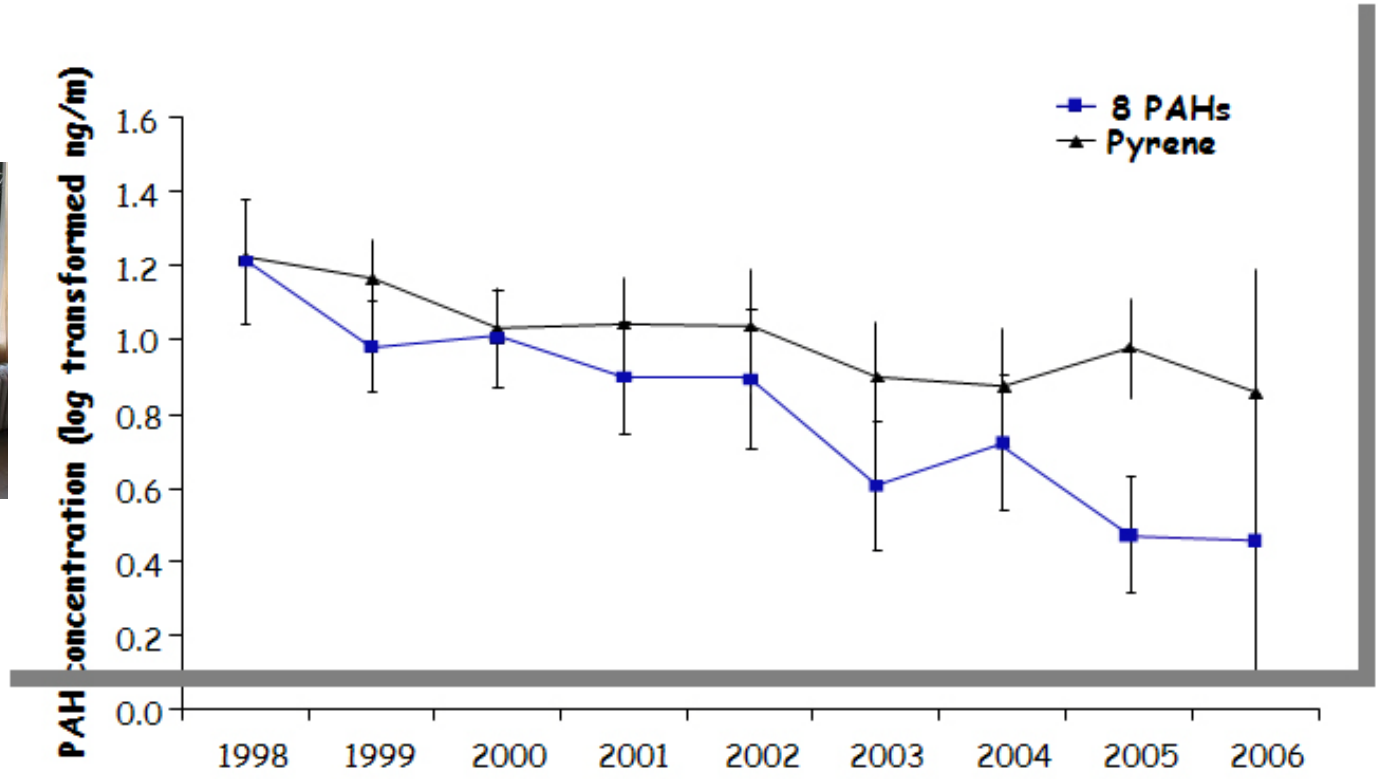
- Education and outreach in the community
  - Healthy Home Healthy Child campaign
  - Materials disseminated via partner organizations, physician offices, and training workshops
  - Translating Science to Policy – Protecting Children's Environmental Health conference on March 30, 2009
- Provide CCCEH research findings to inform policies at local, state and federal levels
  - Clean air policies in NYC
  - Cleaner buses, idling reduction, and low sulfur fuel
  - EPA's ban of residential use of toxic pesticides including chlorpyrifos and diazinon
  - The City cited research to pass Local Law 37 (Pesticide Use by NYC Agencies) which encourages NYC to promote the reduction of pesticide use by City agencies
  - Dr. Miller has communicated recent findings on air pollution and asthma to City Government

Translating Science to Interventions at Multiple Levels (cont.)

- Testing interventions and measuring efficacy
  - Integrated Pest Management (IPM) intervention in public housing with NYCHA and DOHMH
- Providing data on health costs and benefits of policy interventions
  - CCCEH estimated cost of needed Early Intervention services associated with prenatal ETS exposure: $50 - $99 million per year in NYC
  - CCCEH monitoring in cohort shows PAH exposures have been reduced
  - IPM study showed a significant reduction in use of spray pesticides as a result of the NYCHA/DOHMH intervention

Good News: Personal exposure to PAHs in the NYC cohort declined from 1998 to 2006





Data (n=733) displayed as natural log-transformed averaged each year. One error bar = 95% CI; ∑8PAH $p < 0.0001$; pyrene $p = 0.0001$, ANOVA

[Narvaez, Miller et al., 2008]

Good News: Pesticides

- EPA's ban of residential use of toxic pesticides including chlorpyrifos
  - Chlorpyrifos levels declined in maternal and umbilical cord blood samples and prenatal air samples in our cohort after the ban of chlorpyrifos
- Integrated pest management intervention in public housing with Department of Health and Mental Hygiene and NYC Housing Authority
  - Showed changes in personal pesticide use, reducing use of aerosol pesticides

Summary

- Prenatal environmental exposures are associated with reduced fetal growth, developmental impairment, asthma and risk of cancer
- By nature, these exposures are preventable
- Early interventions have direct benefits
- Benefits will accrue over the life-course
- Identification of risks from early life environmental exposures is key to prevention of disease and impairment

Colleagues who made this work possible

CCCEH Key Investigators: H. Andrews, H. Choi, K. Donohue, S. Edwards, D. Evans, R. Garfinkel, I. Goldstein, J. Herbstman, L. Hoepner, K. Lane, M. Williams, P. Kinney, S.A. Lederman, R., S. Mehta, Miller, M. Orjuela, M. Patel, M. Perzanowski, V. Rauh, A. Rundle, B. Sheares, P. Shepard (WEACT), D. Tang, R. Whyatt, S. Wang
CCEHC Research Workers and Staff:, F. Arias, M. Borjas, D. Diaz, L. Cruz, D. Holmes, L. Hua, F. Hua, X. Jing, K. Lane, J. Li, H. Lu, B. Plaza, L. Qu, S. Mehta, J. Ramirez, A. Reyes, M. Reyes, A. Schneider, J. Yu, L. Qu, J. Yu, A. Siebert.
CUMC Genetics Lab: D. Warburton, C. Cujar, T. Tubo, X. Liu
NCI: S. Chanock
University of Cincinnati: S. M. Ho, W. Tang
CDC: D. Barr, T. Bernert, D. A. Calafat, L. Needham, R. Schleicher, A. Sjodin
NIEHS: D. Bell, G. Pittman
DOHMH: D. Kass, M. Hernandez, W. McKelvey
NYCHA: B. Clarke
Institute for Cancer Res., London: A. Ford, M. Greaves, D. Phillips
Univ. of Krakow: W. Jedrychowski
Children's Hospital of Chongqing Medical University: T-Y Li

This research has been made possible by joint funding from:

- The National Institute of Environmental Health Sciences (NIEHS)
- U.S. Environmental Protection Agency (EPA)
- National Cancer Institute (NCI)
- Individuals & Private Foundations

Special thanks to the women and children participating in the studies