Introduction to Environmental Determinants of Health: The Special Vulnerabilities of Children

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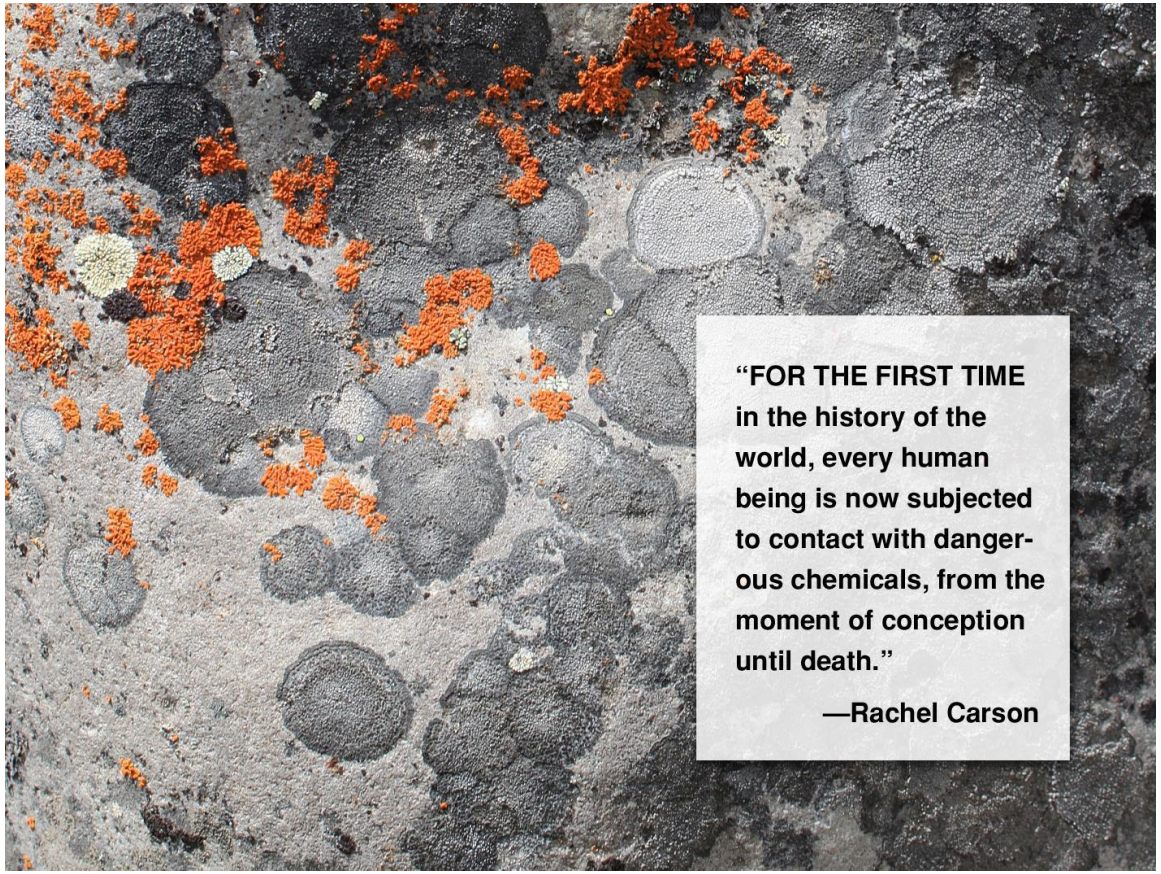
DALHOUSIE UNIVERSITY
Inspiring Minds
Faculty of Medicine

Visioning and Objectives

The environmental health field is a multidimensional and complicated one. There exist many toxins in our environment and these can cause many health outcomes. Foetuses and young children are especially vulnerable to toxins in the environment. Medical practitioners can play roles at many levels- primary care, public health, research and advocacy.

Objectives

- Characterize the biological, chemical and physical hazards affecting human and ecosystem health.
- Evaluate possible links between environmental toxic exposures and the documented rise of common chronic illnesses.
- Describe individual and population-based approaches to prevention, treatment and management that address environmental determinants.


"FOR THE FIRST TIME in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death."
—Rachel Carson

Environmental Toxins

- Most recognized toxins were discovered only as a result of an environmental disaster
- Increasing evidence linking toxins with disease and disability at levels previously thought to be safe
- Need to revise regulations and reduce exposures to environmental chemicals and toxins

The Invisible Epidemic

- In Canada and the United States, medical schools rarely cover the topic of environmental toxins, their health impacts, or how to counsel patients to avoid toxins. Exceptions include tobacco, alcohol and lead exposures for pregnant women.
- Genetic predisposition AND toxic exposures can result in significant health impacts to individuals and have large population health impacts
- Foetuses and young children are particularly vulnerable
- Outcomes can include mental and physiological conditions as well as epigenetic changes that affect subsequent generations

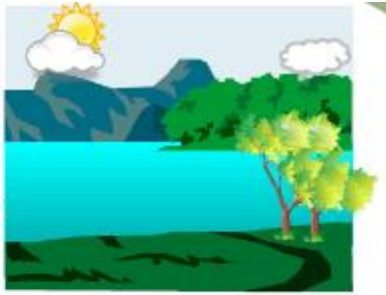
Small Doses Add Up

Dr Bruce Lanphear: “Little Things Matter” video

- https://www.youtube.com/watch?v=E6KoMAbz1Bw

Exposure Pathways

- Occupational Exposures



- Air, soil, water

"Take-home pathway"

- Food/water

- Direct soil contact

Cell Injury → Tissue/Organ Pathology

Changes to:
-Cell Metabolism
-Cell processes
-Gene expression
-Adaptive structural changes

→

Cell Death
-Necrosis
-Apoptosis

Processes:
-Toxicity
-Mutagenicity
-Teratogenicity
-Endocrine Disruption

→

Disease
-Pathophysiological changes
-Inflammation
-Tumorogenesis
-Abnormal development
-Endocrine dysfunction

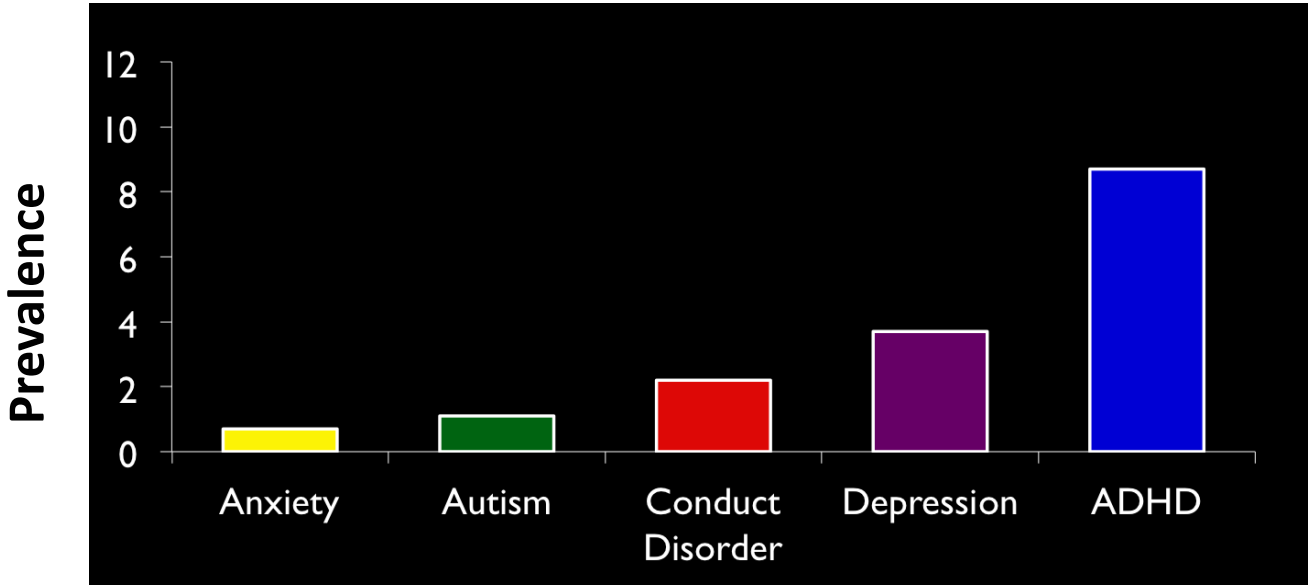
The Impact of Toxins on the Developing Brain

- Environmental toxins are toxic at levels previously thought to be safe or innocuous
- •Subtle shifts in cognition, behavior or physiologic parameters are antecedents of disease and disabling disorders in older children and adults
- •Disease and disability linked with environmental toxins are preventable

Vulnerability of the Developing Brain

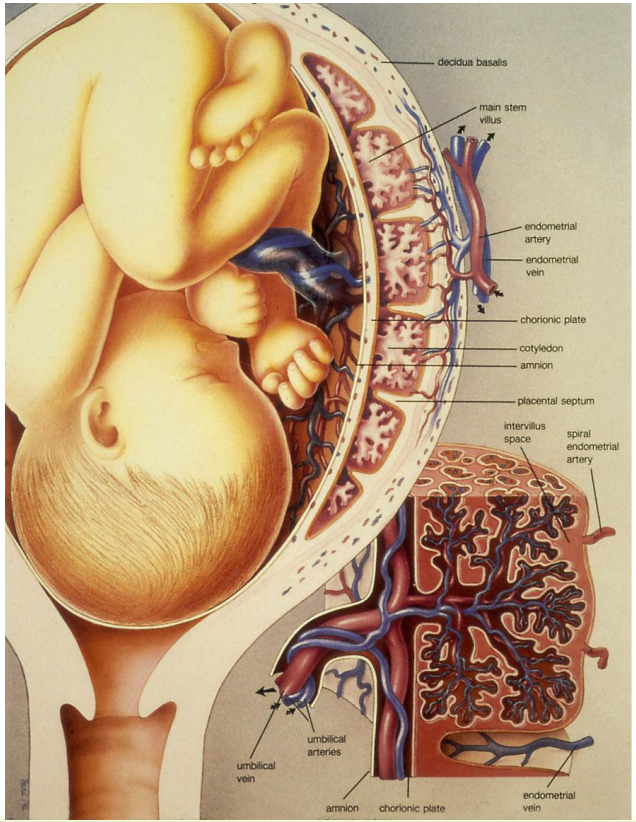
- The blood brain barrier isn't fully formed; it is more permeable to toxins
- Rapidly growing cells are often more vulnerable to toxins than slowly growing cells
- Brain growth occurs over a longer duration than other organs
- The foetus and child may lack enzymes to detoxify contaminants
- Young children often more heavily exposed to contaminants than older children and adults

Brain-based Disorders in Children



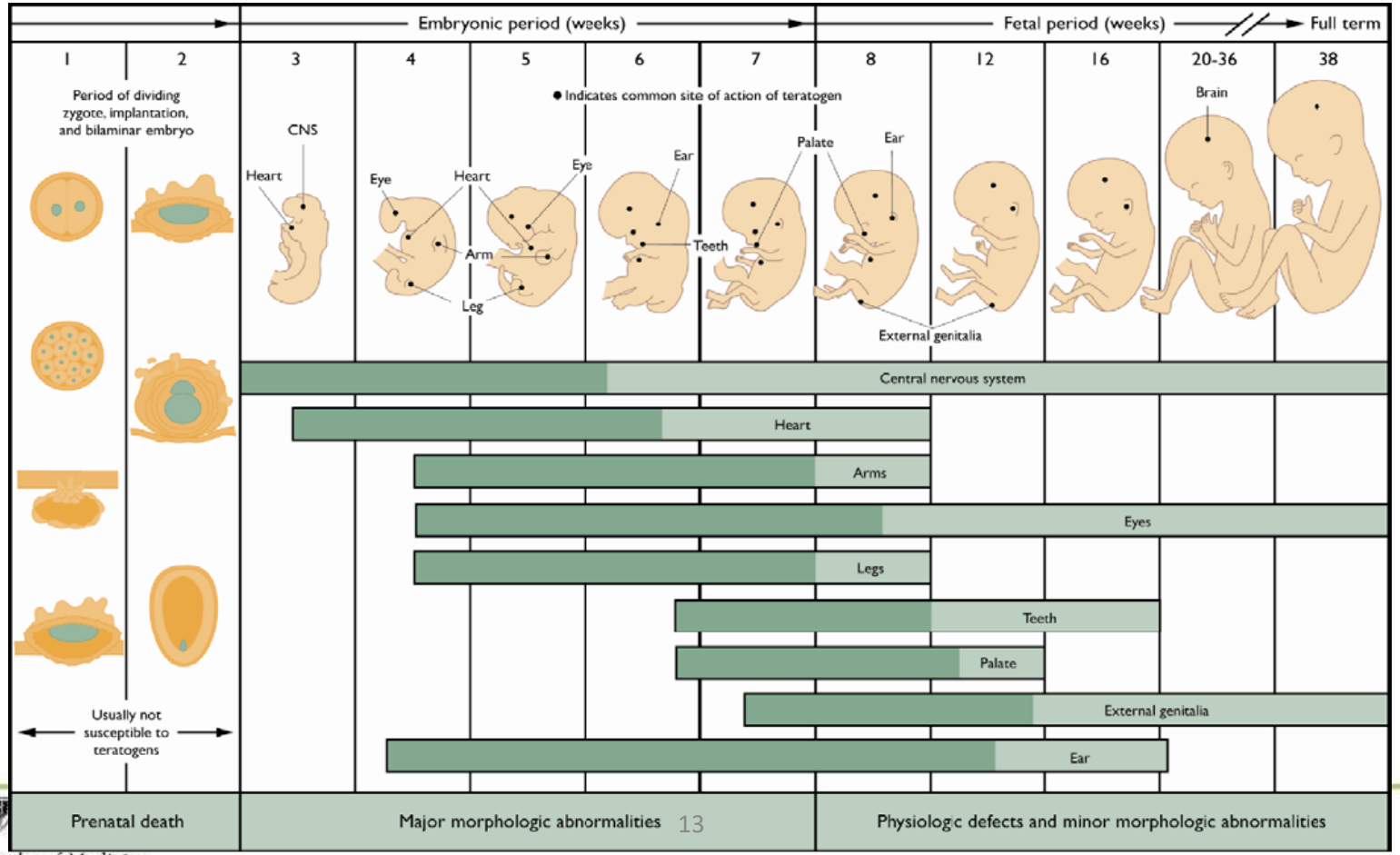
Merikangas KR, He JP, Brody D, et al. Prevalence and treatment of mental disorders among US children in the 2001-2004 NHANES. Pediatrics 2010;125:75-81. Centers for Disease Control and Prevention. Prevalence of autism spectrum disorders, United States, 2008. MMWR Surveill Summ 2012; 61:1-19. Boyle CA, Boulet S, Schieve LA, et al. Trends in the prevalence of developmental disabilities in US children, 1997-2008. Pediatrics 2011;127:1034-1042.

Factors that Impact Brain Development

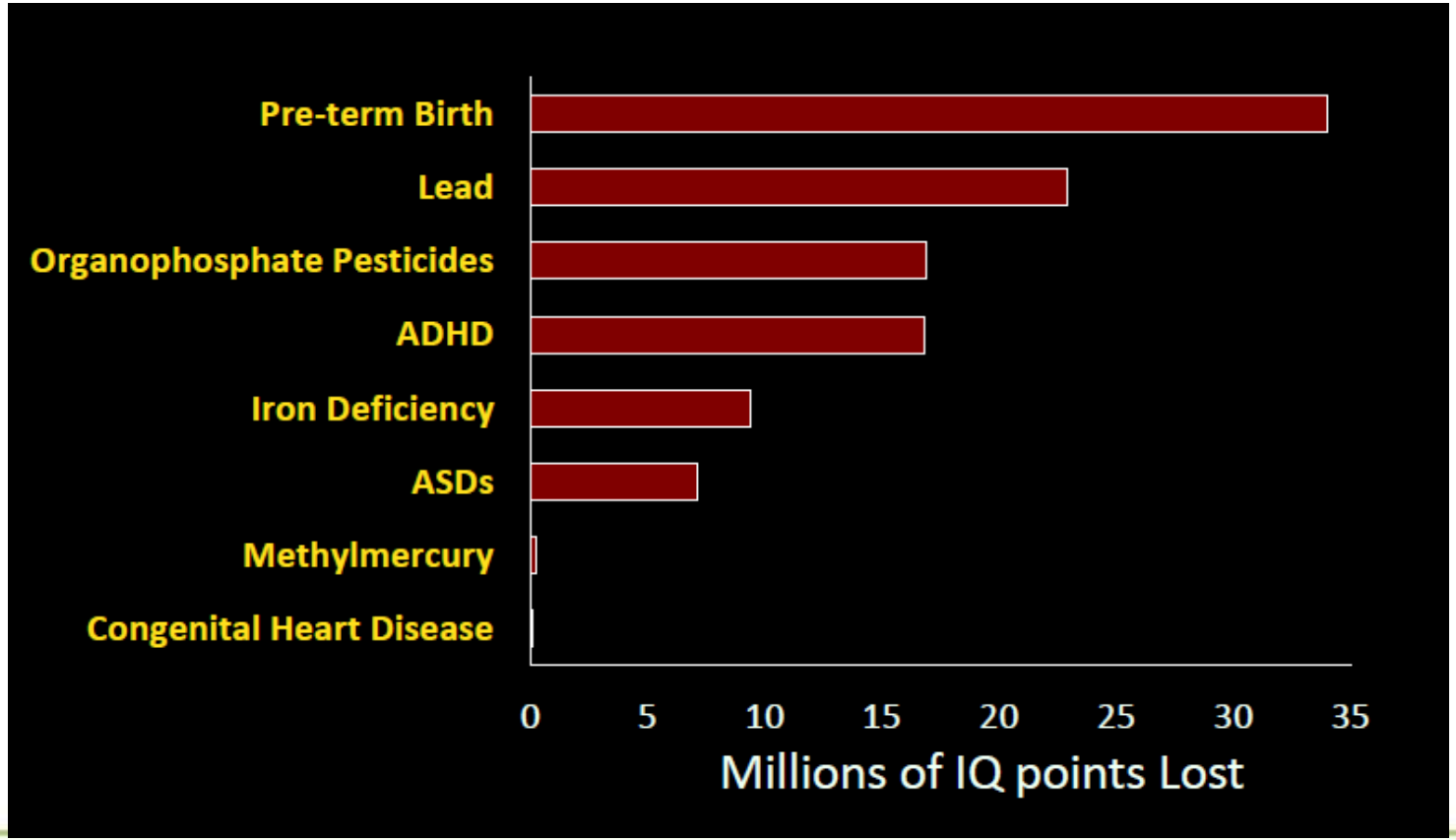


- Sex
- Nutrition
- Preterm Birth
- Social Stressors
- Built Environment
- Maternal Depression
- Genetic Susceptibility
- Preschool Attendance
- Environmental Toxins

Critical Windows of Vulnerability

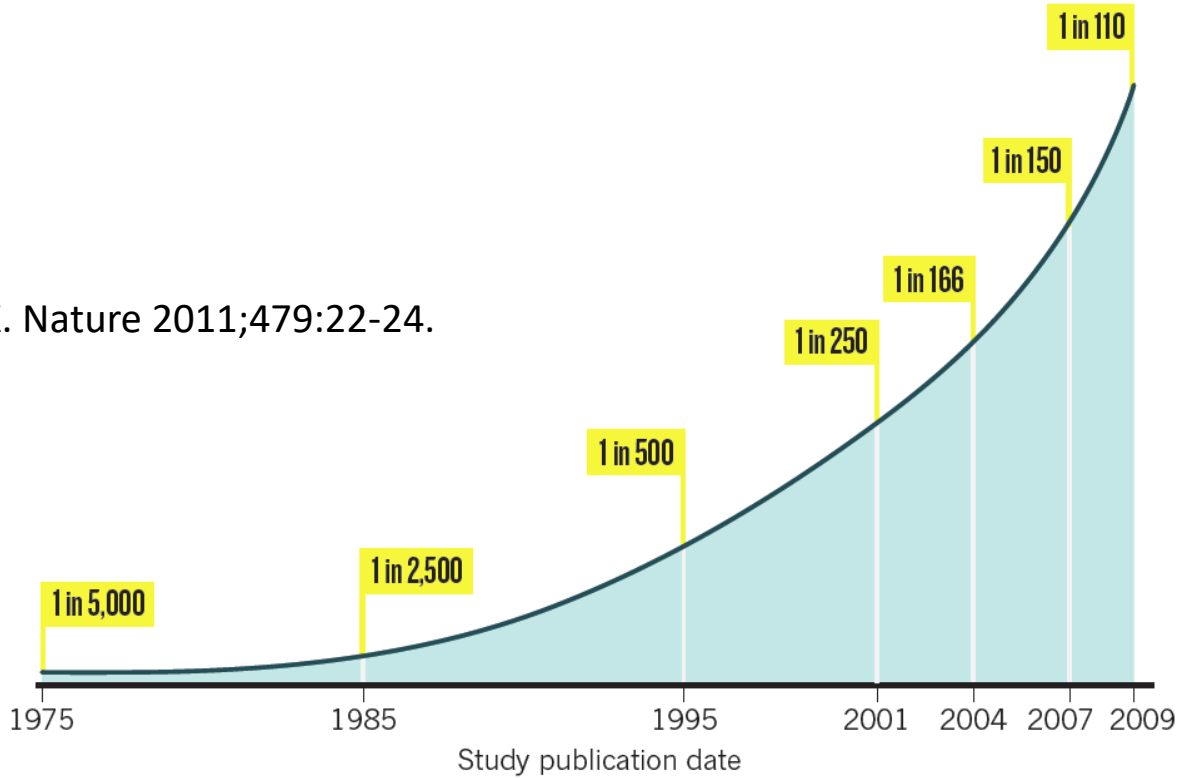


IQ Loss for Various Risk Factors

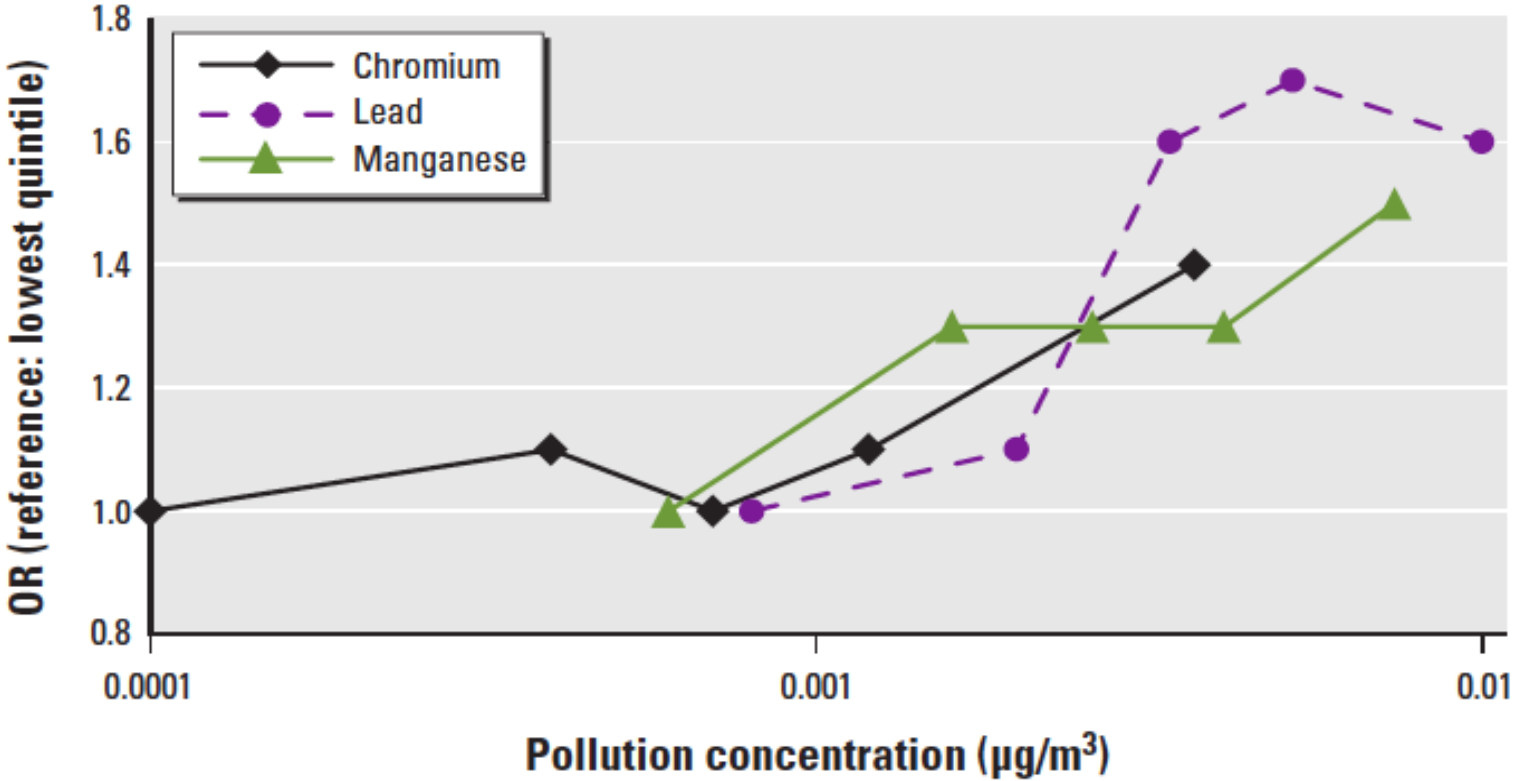


The Rise of Autism

Weintraub K. Nature 2011;479:22-24.

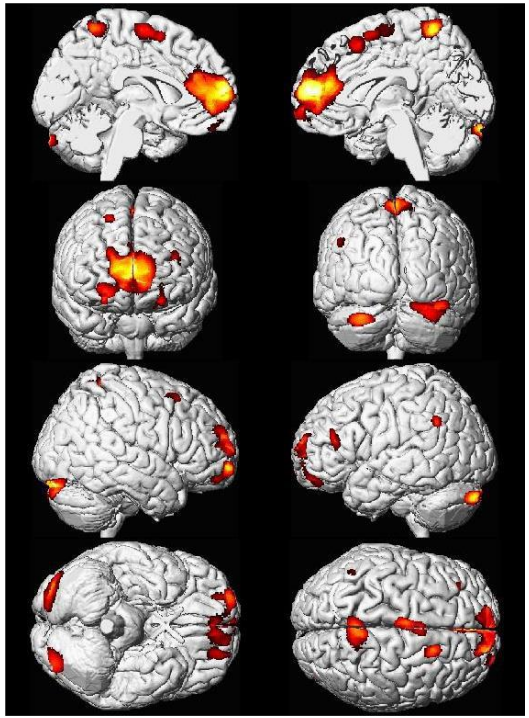


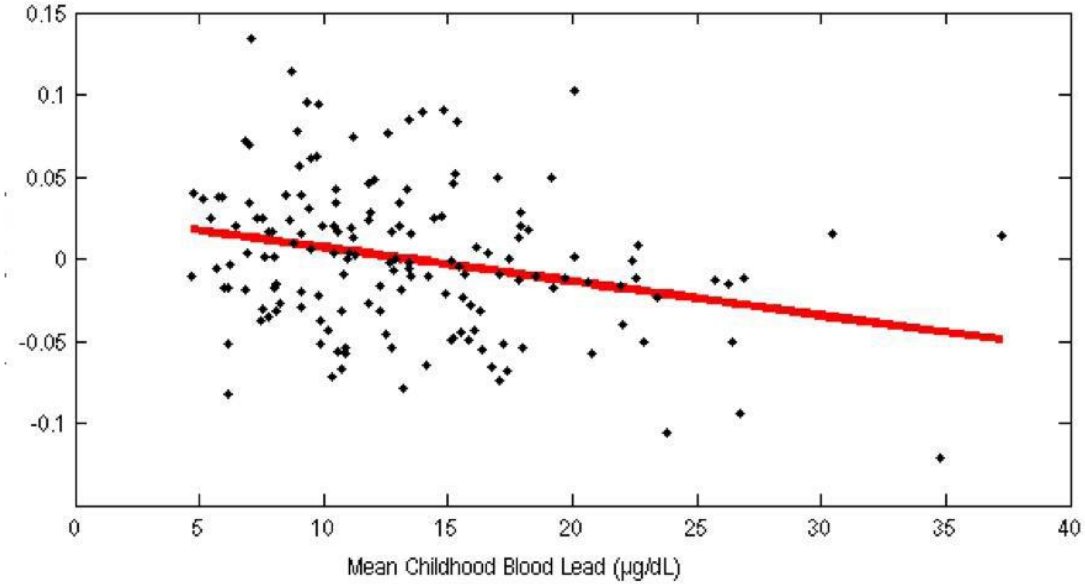
Risk of Autism Spectrum Disorder by Exposures to Airborne Metals



Roberts et al. EHP 2013. Adjusted for maternal age, year of birth, census tract.

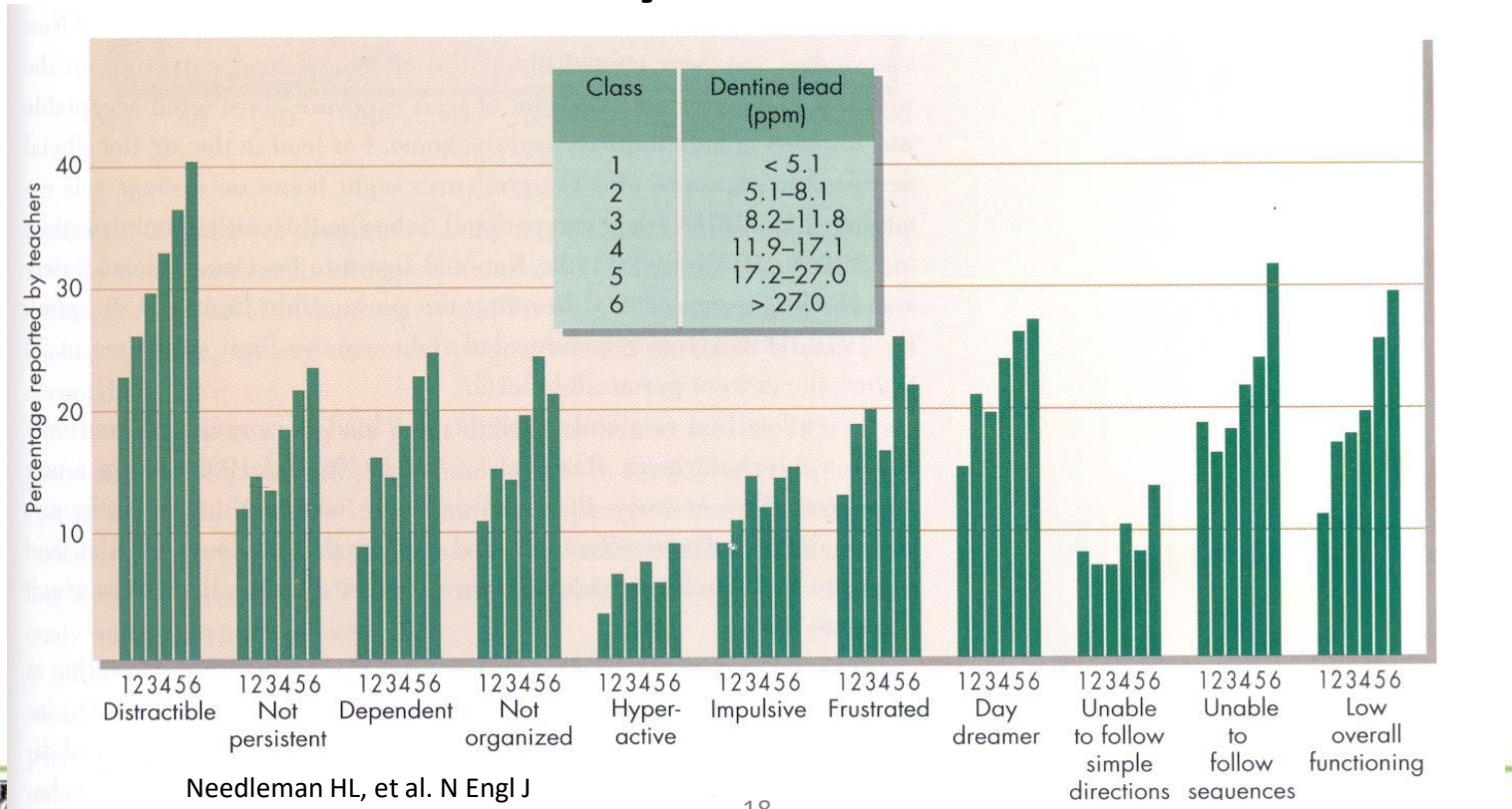
Gray Matter Loss by Childhood Lead Exposure





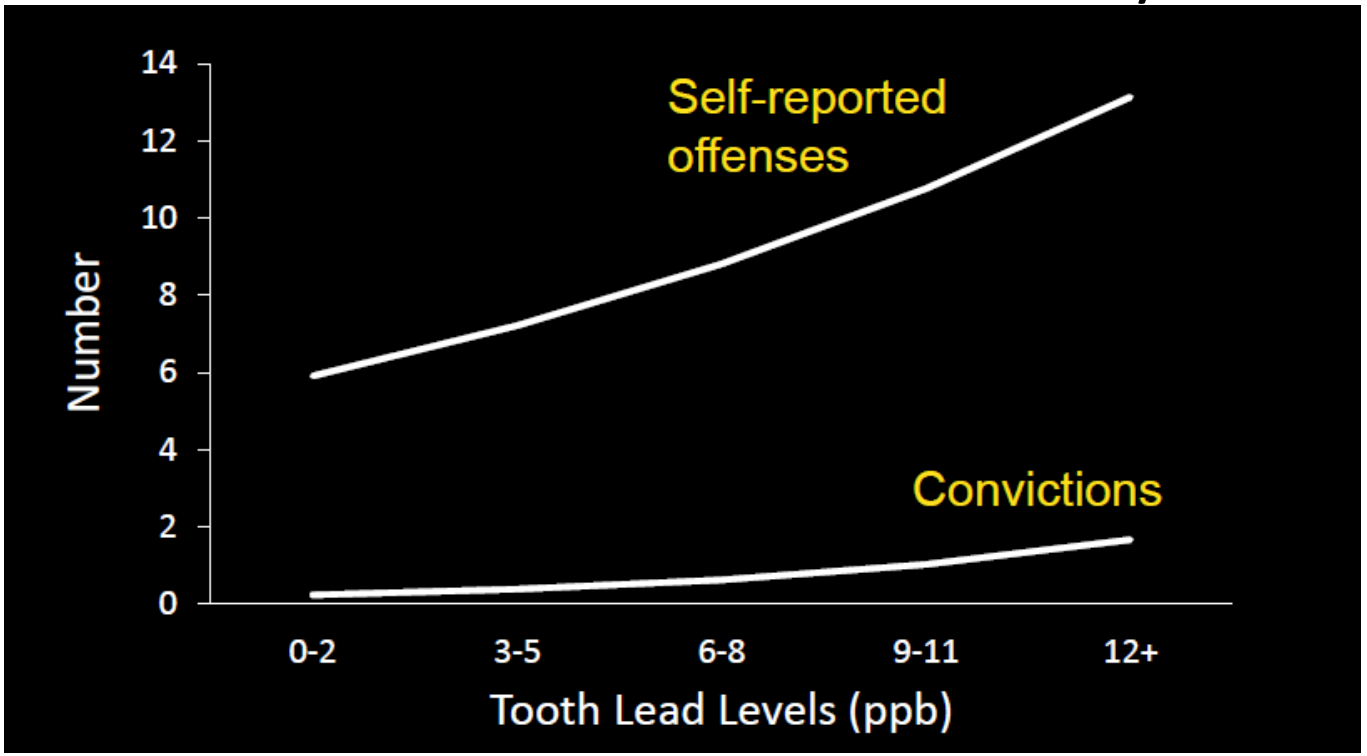
Adjusted for child's age, birth weight. Sex, gestational age, IQ, prenatal tobacco, prenatal alcohol, prenatal marijuana, total intracranial volume, SES and HOME Inventory did not alter results (Cecil K, PLoS Medicine, et al. 2008).

Lead-associated Mental Health Problems in School Children by Tooth Lead Levels



Needleman HL, et al. N Engl J Med 1979;300:689-95.

Tooth Lead Levels and Criminality



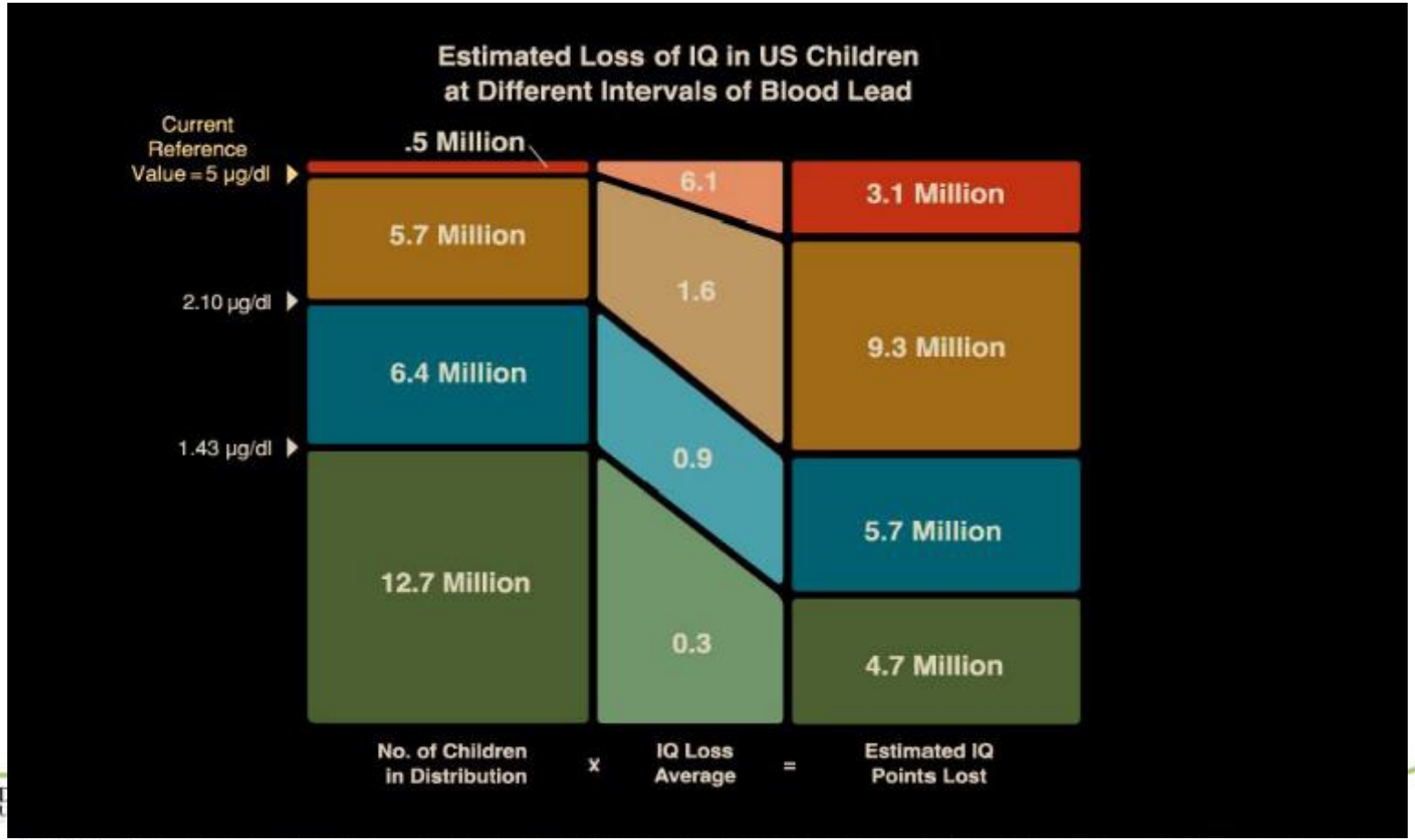
Fergusson D, et al. J Epidemiol Community Health 2008;62:1045-1050. Adjusted for SES, maternal education, ethnicity, family conflict, maltreatment, maternal smoking during pregnancy, parental criminal offending

The Prevention Paradox

The population health burden of disease and disability is greatest as a result of low levels of exposure.

- Many more people are exposed to low levels
- Low level exposures have long-lasting health consequences

The Prevention Paradox



Endocrine Disruptors Causing Adverse Fertility and Development

Bisphenol A (BPA)

-Xenoestrogen

-Exposure: dust, ingestion, plastics, tin can lining

Phthalates

-Anti-androgen

-Exposure: dust, ingestion, food, plastics

Endocrine disruptors cont'd

BPA- Animal studies and human population studies:

High dose developmental toxicity

- Spontaneous abortion
- Birth defects (urogenital, sex differentiation)

Phthalates- Animal studies:

- Urogenital malformations
- Reduced anogenital distance
- infertility

A few human studies (Swan et al. 2005; 2008; Latini et al. 2003):

- reduced anogenital distance, shorter penile length, undescended testis, shorter gestational age at birth

The Silent Epidemic- What can you do?

- Incorporate prevention counselling into patient visits, especially for prospective or new parents
- Increase awareness, provide information to peers
- Ask for this topic to be added to the curriculum, into nursing programs, prenatal clinics
- Support research in this area
- Advocate for policy change to reduce toxins in environment

Advice for Patients: How to Avoid Exposures to Toxins

- Eat fresh, organic and unpackaged foods; avoid canned foods
- Minimize use of pesticides around the home
- Avoid cosmetics, fingernail polish and lotions
- Support bans on smoking in public places and cosmetic pesticides
- Support efforts to update chemical management policies and reduce industrial pollutants

Video for Parents

- http://www.healthyenvironmentforkids.ca/resources/creating-healthy-home-environments-kids-top-5-tips