Linking Environmental Toxicants with Learning and Behavioral Problems in Children

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New Morbidities of Childhood

Prevalence

Autism | Conduct Disorder | Learning Disability | ADHD | Asthma | Preterm Birth

Environmental Toxicants

• Most recognized toxicants were discovered only as a result of an environmental disaster

• Increasing evidence linking toxicants with cognitive deficits and behavioral problems at levels previously thought to be innocuous or safe

• Increasing evidence linking toxicants with child and adolescent psychopathology

Linking Low-Level Environmental Toxicants with Learning Abilities

Verb Generation Task by Lifetime Mean Blood Lead Concentration (n=42)

Adapted from Lanphear BP, et al. Public Health Reports 2000;115:521-529
The Ongoing Search for a Threshold of Low-Level Lead Toxicity

Research Supporting Adverse Cognitive Effects at Blood Lead Levels < 10 μg/dL


Prenatal PCB Exposure and IQ Scores in 9-year old Children, Oswego, NY

Differences in IQ Scores among 5-year old Children by Prenatal PAH Exposure


Impact of Reducing IQ by 5 points in US Children

Linking Exposures to Environmental Toxicants with Psychopathology

Lead-associated Behavioral and Emotional Problems in Children by Tooth Lead Concentration

Risk of ADHD by Blood Lead Levels in US Children, 8 to 15 years, NHANES 2001-2004


Prenatal Exposure to Tobacco Smoke and Teacher-Rated Behavioral Problems in Children

## Case Control Studies of ADHD by Prenatal Tobacco Smoke Exposure

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>No. Cases</th>
<th>No. Controls</th>
<th>Age of Children</th>
<th>AOR (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>McIntosh (1995)</td>
<td>130</td>
<td>135</td>
<td>6-13</td>
<td>2.7 (1.1-7.0)</td>
</tr>
<tr>
<td>Milberger (1998)</td>
<td>132</td>
<td>139</td>
<td>6-17</td>
<td>4.4 (2.1-15.5)</td>
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<tr>
<td>Mick (2002)</td>
<td>280</td>
<td>242</td>
<td>6-17</td>
<td>2.1 (1.1-4.1)</td>
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<tr>
<td>Langley (2005)*</td>
<td></td>
<td></td>
<td>6-17</td>
<td>2.4 (1.6-3.5)</td>
</tr>
<tr>
<td>Schmitz (2006)</td>
<td>100</td>
<td>100</td>
<td>6-18</td>
<td>3.4 (1.2-10)</td>
</tr>
</tbody>
</table>

* Pooled analysis

## Risk of ADHD by Prenatal Tobacco Exposure in US Children, 8 to 15 years, NHANES 2001-2004

Joint Effects of Lead and Tobacco Exposure on ADHD in US Children NHANES 2001-2004


Joint Effects of DRD4 7-Repeat and Prenatal Tobacco Exposure with ADHD in Children

“If causes can be removed, then susceptibility ceases to matter. “

Geoffrey Rose, MD

Number of Arrests by Childhood Lead Exposure: The Cincinnati Lead Study

Relationship of Lead Exposure and Murder Rate (/100,000) in the U.S.

![Graph showing relationship between lead exposure and murder rate](image1)


Reduction in Gray Matter by Childhood Lead Exposure

![Brain images](image2)

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, et al. PLoS Medicine 2008).
Reduction in Gray Matter by Childhood Blood Lead Levels and Subject’s Sex

Men (n=83)  
Women (n=74)  

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, Brubaker C, Dietrich KN, et al. PLoS Medicine 2008).

Development of the Brain and Timing of Exposure to Environmental Toxicants

3-6  Rapid Growth in Frontal Circuits: attention, vigilance, alertness
7-15  Growth Spurt in temporal/parietal lobes: languages, mathematics
16-20  Tissue Loss in Frontal Circuits: self-control, planning, regulate behavior

Source: UCLA Lab of Neuroimaging
Developmental Trajectory of Lead Exposure by Gray Matter Deficits

Year 1

Year 2

Year 3

Year 4
Developmental Trajectory of Lead Exposure by Gray Matter Deficits

Year 5

Year 6

Reduction in Gray Matter by Age of Blood Lead Levels and by Sex

% Gray Matter Affected

Age

Men
Men & Women
Women
Lead Reduces Neurite Length in Dopaminergic Neurons after 48 Hr Exposure to Lead Acetate

The lowest concentration of lead acetate used (0.001 μM) caused a significant decrease in neurite length that was exacerbated by incubation in higher concentrations of lead (0.01 and 0.10 μM).

The Impact of Toxicants on Human Health

- Increasing evidence that environmental toxicants are toxic at levels previously thought to be safe or innocuous

- Subtle shifts in cognition, behavior, birth weight or physiologic parameters in children are antecedents of disease and disabling disorders in older children and adults

- The effects of environmental toxicants are systemic

- Disease and disability associated with environmental toxicants is preventable
“Few tragedies can be more extensive than the stunting of life, few injustices deeper than the denial of an opportunity to strive or even to hope, by a limit imposed from without, but falsely identified as lying within.”

Stephen Jay Gould