The Relationship Between Prenatal PAH Exposure and Child Neurocognitive and Behavioral Development

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Research Overview

Mission: Prevention of childhood disease and neurodevelopmental impairment through early identification of environmental risk factors
Study Populations: NYC, Poland, and China

• Young, healthy pregnant women recruited during pregnancy (total ~ 2000 mothers and 2000 babies enrolled)

• Active smokers excluded; passive smokers included

• Subject to varying levels of environmental exposures
NYC Cohort

- >700 African-American and Latina mother-child pairs

- Exposures being studied: PAH, PM, ETS, pesticides, phthalates, BPA

- Prenatal personal air monitoring; maternal urine and blood, cord blood and placenta, child blood and urine
Why Polycyclic Aromatic Hydrocarbons?

- Widespread urban air pollutants generated by fossil fuel burning and other combustion sources
- Carcinogenic, immunotoxic, neurotoxic, mutagenic, and endocrine disruptors
- Experimental animal data show:
  - exposure impairs memory and increases depression-like responses
  - pre- or perinatal exposure affects brain development, impairs learning, and affects emotional behavior
- CCCEH data indicate that prenatal exposure in humans affects early child development
Measurement of Prenatal PAH Exposure in the NYC and Krakow Cohorts

- Area Exposure
  - Area monitor (and GIS)
- Personal Exposure
  - Backpack PAH
- Internal Dose
  - Urinary metabolite (e.g., 1-OH)
- Biologically effective dose
  - Adducts
CCCEH Cohort: Widespread Exposure to PAH in Air

- 100% of pregnant mothers exposed to PAH (mean 3.7 ng/m³; range 0.36 -36.47 ng/m³)

- PAH/aromatic-DNA adducts detected in 100% cord white blood cells

- PAH urinary metabolites detected in 100% pregnant mothers

[Perera et al. 2003; 2004]
Previously Reported Associations between Prenatal PAH and Adverse Health Outcomes (NYC)

- Reduction in birth weight and head circumference
- Developmental delay* (MDI) at age 3 and reduced IQ at 5
- Childhood asthma
- Chromosomal aberrations
- Obesity
- Epigenetic Alterations

[Perera et al. 2009; Edwards et al. 2011]
PAH and Neurodevelopment: IQ at Age 5 in NYC

Differences in full-scale, verbal, and performance IQ scores associated with high levels of prenatal PAH exposure (N = 249)

Results [age 5, 7]

<table>
<thead>
<tr>
<th>Exposure assessment</th>
<th>Anxious /Depressed</th>
<th>Attention Problems</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Poisson</td>
<td>Logistic Dichotomized T-scores</td>
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<tr>
<td></td>
<td>β 95% CI p-value</td>
<td>OR 95% CI p-value</td>
</tr>
<tr>
<td>Cord 32P adducts, age 5, (n=96)</td>
<td>0.34 (0.04, 0.64)  0.026*</td>
<td>8.14 (1.21, 54.94)  0.031*</td>
</tr>
<tr>
<td>Cord 32P adducts, age 7, (n=205)</td>
<td>-0.03 (-0.22, 0.16)  0.773</td>
<td>1.42 (0.45, 4.46)  0.544</td>
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<tr>
<th>DSM-Oriented Anxiety Problems</th>
<th>Logistic Model</th>
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<tbody>
<tr>
<td></td>
<td>OR 95% CI p-value</td>
</tr>
<tr>
<td>Cord 32P adducts, age 5 (n=96)</td>
<td>8.30 (1.13, 60.71)  0.037*</td>
</tr>
<tr>
<td>Cord 32P adducts, age 7, (n=205)</td>
<td>1.26 (0.42, 3.82)  0.683</td>
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- Adjusting for prenatal ETS, sex, gestational age, maternal IQ, home environment, maternal education, ethnicity, prenatal demoralization, and age at assessment

Conclusion

• Adducts tell only part of the story. It is likely that PAH are also operating through mechanisms in addition to direct genotoxicity (epigenetic).

• This research provides evidence that prenatal exposure to environmental PAH at levels encountered in the air of New York City can adversely affect child cognition and behavior.

• Results underscore the need for reduction of ambient PAH exposure.
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