Considerations in Biomonitoring Pesticides

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Today’s Talk

• Brief refresher on exposure biomarkers

• Recent epidemiologic analyses

• Where do children spend time and what pesticides are used there?

• Considerations for biomonitoring pesticides

Metabolites may be class, but not pesticide-specific, creating uncertainty.

Metabolites in urine may reflect exposure to preformed metabolites, not parent compounds.

However:

- Many studies show clear links between determinants of exposure and metabolite levels in urine.
- Epidemiologic studies show consistent associations with adverse health outcomes.
- Easy to collect, especially for children.
A birth cohort study investigating the health effects of environmental exposures in low income Mexican-American children living in an agricultural community.
Agriculturally Applied Organophosphates
CHAMACOS Cohort Study

Birth 1 yr 3 ½ yr 7 yr 10 ½ yr

Pregnancy (two visits) 6 mo 2 yr 5 yr 9 yr 12 yr
CHAMACOS children’s OP metabolite levels are also higher than US averages (NHANES)
Prenatal DAP metabolite levels associated with:

- Shorter gestation (Eskenazi et al. 2004).
- Abnormal reflexes in newborns (Young et al. 2005).
- Pervasive developmental disorder (CBCL) at 2 years (Eskenazi et al. 2007).
- Poorer neurodevelopment scores through age 7 (Bouchard et al. 2011, Eskenazi et al. 2007).
- Attention deficits at 5 years (Marks et al. 2010).
- Consistency across age points.

➢ New findings
And mothers’ OP metabolite levels were also related to child’s IQ at age 7
Theoretical Framework

Stress $\rightarrow$ Neurodevelopment $\rightarrow$ Prenatal Neurotoxic (OP) Exposure
The children grew up with many adversities...

Housing Density >1.5 per room 49%
Rodents 32%
Food Insecurity ~38%
No blocks or stacking toys (12m) ~51%

Photo by Seth Holmes
Poor Housing Quality
Poor Housing Quality
Effect of OPs is **stronger** in children experiencing early life adversity

Among kids with low family adversity:

Prenatal DAPs $\rightarrow$ 2.5 point decrease in IQ  
(not statistically significant)

Among kids with **high** family adversity:

Prenatal DAPs $\rightarrow$ **8.2 point decrease in IQ**

Stein et al., 2016.
Interaction Between Adversity and DAPs on 7y IQ

Model adjusted for maternal IQ score and language of neurological assessment.

Stein et al., 2016
Pesticides and Asthma

- Acute OP pesticide exposure associated with respiratory distress
- Some occupational studies show association of OP exposure and poorer respiratory outcomes
Postnatal DAPs (AUC) associated with reduced lung function ($FEV_1$) at age 7

Adjusted for:
- Child’s gender
- Child’s age
- Maternal smoking
- ETS
- Season of birth
- PM2.5
- Breastfeeding
- Mold
- Traffic
- Roaches

Prenatal DAPs are not associated with lung function

Raanan et al. Thorax, 2015
Nearby Pesticide Use

Pesticide Use Reporting (PUR) Data:

- Mandatory in California since 1990
- Provides the following:
  - Pesticide active ingredients
  - Pounds applied
  - Application date
  - Location to a square-mile section
  - Crop treated
Methods – Pesticide Use Residential Proximity

PLSS Sections

Pesticide Use Within 1km of Residence

<table>
<thead>
<tr>
<th>Pesticide Use</th>
<th>100kg</th>
<th>300kg</th>
<th>500kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>16kg + 170kg + 8kg</td>
<td>200kg × 8% = 16kg</td>
<td>200kg × 85% = 170kg</td>
<td>100kg × 8% = 8kg</td>
</tr>
<tr>
<td>2kg + 50kg + 6kg</td>
<td>100kg × 2% = 2kg</td>
<td>200kg × 25% = 50kg</td>
<td>300kg × 2% = 6kg</td>
</tr>
</tbody>
</table>

2% of Section

8% of Section

85% of Section

Pesticide Use Reporting (PUR)

1 Mile (1.6 km)

2% of Section

25% of Section

8% of Section
Two Different Exposure Methods: OPs Associated with Decreased IQ at age 7

Adjusted for: child’s age, sex, language of assessment, maternal education, maternal intelligence, household poverty level, maternal depression, maternal country of birth and HOME score.

Adjusted for prenatal DAPs

Bouchard et al., EHP, 2011
Gunier et al., 2016
With increase in OP use within 1 km of mother’s home during pregnancy:

→ 2 point decrease in IQ

• Similar to what we saw with OP metabolites in urine
• PUR and urine both independently associated with IQ.

➢ PUR and urinary metabolites reflect different pathways/timeframe of exposure or pesticides? Strongest individual PUR slope for oxydemeton-methyl.
Where do children spend time and what pesticides are used there? Implications for biomonitoring.

- Agricultural communities
- Homes
- Childcare
Trend of declining insecticide use in California

Has Increased 6-fold in the last decade.

Source: California Department of Pesticide Regulation, 2013
Neonicotinoid Agricultural Pesticide Use in California

Source: California Department of Pesticide Regulation – Pesticide Use Report Data
Home pesticide use

- Dominated by pyrethroids
- Increasing use of neonicotinoids
- Commonly used on pets with many new materials-
  - Imadacloprid
  - Fipronil
  - Selamectin
  - Pyriproxyfen
  - Methoprene
  - Pyriproxyfen
  - Others
Child care in California

- ~45,000 licensed facilities in California (2012)
- ~1 million children in licensed child care facilities
- Some children spend up to 50 hours a week in child care
Pest problems in California child care centers

- 90% reported at least one pest problem
- About half reported using spray pesticides
- About 20% reported monthly or more frequent applications

Bradman et al. 2010
Pesticides frequently detected (>90%) or used in California childcare facilities

Detected in dust:
- Diazinon – ag. use, prior indoor use
- Chlorpyrifos – ag. use, prior indoor use
- Permethrin – indoor use, some ag. use
- Bifenthrin – indoor use
- Dachthal – ag. use

Reported use:
- Pyrethroids
- Bromadiolone
- Fipronil
- Indoxacarb
- Difethialone
- Dinotefuran
- Imidacloprid

Bradman et al. 2012

DPR reporting pesticide use reporting requirements under the Healthy Schools Act will greatly improve school/childcare PUR data starting in 2016.
Considerations for biomonitoring pesticides

• Need for more information on variability
  - Spot versus 24 hour samples
  - Frequency of sampling to meaningfully characterize exposure

• Must evaluate potential for exposure to preformed metabolites in the environment

• Pesticide use does not necessarily equal exposure

  ➢ Prioritize monitoring for pesticides used in environments where children spend time.
Thanks to our funders
Questions/Discussion
END