The contribution of diet to pesticide exposure in pregnant women and children

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A birth cohort study investigating the health effects of environmental exposures in low income Mexican-American children living in an agricultural community.
CHAMACOS mothers’ OP metabolite levels are higher than US averages (NHANES)

Source: www.ucl.ac.uk

Bradman et al. EHP, 2005,
We modeled exposure to the mom’s:

- Air (moving phase)
- Non-moving phases (floor, carpet, walls, dust, surface films)
- Air transport
- Soil tracking
- Reaction
- Cleaning

McKone et al., ES&T, 2007
Estimated maternal chlorpyrifos dose vs. modeled sources

McKone et al., ES&T, 2007
Cumulative Distributions of DAPs in CHAMACOS Mothers and NHANES Women

McKone et al., ES&T, 2007
Determinants of Maternal DAPs

Percentage Change in DAPs

- Fruit Juice
- Burritos
- Chicken
- OP Use <1 km
- Live <60m from Fields

Number of servings per week per 100 lbs
CHAMACOS children's OP metabolite levels are higher than US averages (NHANES)

Bradman et al. EHP, 2005, 2011
## Pesticides in breast milk

<table>
<thead>
<tr>
<th>Type</th>
<th>Pesticide</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall (N=93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organophosphates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorpyrifos*</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>Chlorpyrifos-methyl</td>
<td>56%</td>
<td></td>
</tr>
<tr>
<td>Fonofos</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Phosmet</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Disulfoton</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Diazinon</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Pyrethroids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cis-Permethrin</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>trans-Permethrin</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propoxur</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Bendiocarb</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Atrazine</td>
<td>23%</td>
<td></td>
</tr>
</tbody>
</table>

Weldon et al., JEM, 2011
Median DM metabolite levels by fruit and vegetable consumption

Bradman et al., IJERPH, 2011
Metabolites in 24 hr urine samples collected 3 days apart (n=25 pairs).

Estimated within and between variability (SD)

- Between: 31%
- Within: 69%

Bradman and Kogut et al, 2012, EHP.
Juice appears to be a major source of OP pesticide metabolites

- N=25 children
- Variables: time outside, fruits/vegetables, juice
- $R^2=0.48$

Bradman et al., unpublished
Organic Diet Study – Research Questions

- Does an organic diet reduce pesticide exposure among low-income children?

- Does the estimated impact of an organic diet differ between low-income children living in urban and agricultural communities?
Study Population (N=40)

- Convenience sample:
  20 urban children (Oakland, CA)
  20 farmworker children (Salinas, CA)
- 3-6 year old boys and girls
- Farmworker parent (Salinas, CA)
- Mexican-American/Mexican immigrants
- Low-income (65% < poverty threshold)
- Jun-Sept 2006
# Study Design & Sample Collection

## Conventional Diet (C1)
- Days 1-4: Consent, main questionnaire, home inspection, trained parents on urine sample collection
- Days 5-11: Daily interviews, Food diaries

## Organic Diet
- Days 5-11: Urine Sample (FMV), Daily interviews, Food diaries

## Conventional Diet (C2)
- Days 12-16: Delivery of organic food

**Day 1:** Consent, main questionnaire, home inspection, trained parents on urine sample collection

**Days 2-16:**
- Urine Sample (FMV)
- Daily interviews
- Food diaries

**Day 4:**
- Delivery of organic food
Exposure Assessment

- Measured 23 metabolites reflecting potential exposure to pesticides used indoors and/or in agriculture. Analysis done by CDC.
Washout days excluded from analyses

Day 1: Consent, main questionnaire, home inspection

Days 2-16: Urine Sample (FMV)

Washout Days (excluded from analyses)
Other exclusions and statistical analyses

• Parent-reported that child did not follow diet protocol

• Reported pesticide use during the study period (only those relevant samples for relevant metabolites)

• Adjusted linear–mixed effects models to estimate the effect of diet on urine metabolite concentrations (% change); interaction term (loc x diet; p<0.20)

• C1 and C2 were combined; no significant difference in metabolite levels between these phases
Non-specific OPs, pyrethroids, and two herbicides were commonly detected

Specific Metabolites

**OP Pesticides:**
- Coumaphos (CMH)
- Diazinon (IMPY)
- Isazophos (CIT)
- Malathion (MDA)
- Pirimiphos-methyl (DPY)

**Pyrethroids:**
- Cyfluthrin (4FP)
- Deltamethrin (DBCA)

**Herbicides:**
- 2,4-D
- 2,4,5-T
- Acetochlor
- Alachlor
- Atrazine
- Metolachlor

Non-specific Metabolites

**OP Pesticides**
(DAPS: DMP, DMTP, DMDTP, DEP, DETP, DETP, DEDTP)

**Pyrethroids**
- 3-PBA
- CDCA
- cis-DCCA
- trans-DCCA

**Total DEs, DMs, DAPS**

2,4-D, MET

3-PBA
Total DMs/DAPs: Significant decrease in levels during the organic diet for ALL children

Bradman and Quiros et al 2015
Total DMs/DAPs: Estimated effect of the organic diet did NOT differ by location

Bradman and Quiros et al 2015
Salinas (Ag) vs. Oakland (Urban)

*Living near agriculture also important*

Bradman and Quiros et al 2015
Results for DM/Total DAP metabolites similar to other studies

In Seattle children

Lu 2006

In Australian adults

Oates 2014

Fig. 3. ΣDAP, ΣMP and ΣEP (creatinine corrected). Mild outliers are marked with a circle (O) and extreme outliers are marked with an asterisk (*) on the boxplot.
Total DEs: Decrease in levels during the organic phase (~1.2%) albeit non-significant for all children.

Bradman and Quiros et al. 2015
**3-PBA**: Borderline significant decrease (~13%); observed differences by location

Bradman and Quiros et al 2015
2,4-D: Significant decrease (~25%) during the diet phase; no differences by location

Adjusted GM (nmol/L)

Bradman and Quiros et al 2015
**MET:** Decrease (~6%) during the diet phase albeit non-significant; no differences by location

\[ \text{Adjusted GM (nmol/L)} = \frac{0.50}{0.25} = \frac{0.20}{0.15} = \frac{0.15}{0.10} \]

\[ p_{\text{int}} = 0.50 \]

Bradman and Quiros et al 2015
Organic diet study: Summary of results

- Organic diet was associated with:
  - Significant decrease for total DMs, DAPs, 2,4-D
  - Borderline significant decrease for 3-PBA

- Results for OP metabolites similar to prior studies
Potential sources of DAPs in urine

Attributing urinary DAPs solely to parent OP compounds may lead to overestimation of exposure to parent OPs and exposure misclassification.
Conclusions

• Diet is a source of pesticide exposure.

• Typical commons sense recommendations if concerned about pesticide exposure:
  • Thoroughly wash all produce under running water
  • Consider organic produce

• Eat a variety of fruits and vegetables!

Bradman and Quiros et al 2015
For Discussion

• Diet seems to be a key factor influencing pesticide metabolite levels.
• The metabolite levels we have measured in mothers and child have been consistently associated with health outcomes in the children.
• Dietary exposure important for health outcomes?
For Discussion

- We have seen differences in associations of these biomarkers and health outcomes among different cohorts in pooled analyses. Perhaps reflect differences in exposure to preformed metabolites versus parent compounds?

- We are seeing that nearby agricultural pesticide use is associated with several key developmental outcomes independent of urinary biomarkers. Perhaps the urinary metabolites are driven by diet (shorter term) and the ag use information is a better measure of longer term environmental exposure.
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Thank YOU!!!

www.cerch.org