PRENATAL CARBON MONOXIDE EXPOSURE FROM RURAL GUATEMALANS’ HOUSEHOLD WOODSMOKE AND CHILD COGNITIVE PERFORMANCE AT AGE 6.5 YEARS

COEH- Llewellyn Student Project Award Recipients (2009-10)

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MS in Environmental Health Sciences, GHE, UC Berkeley, 2010
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OUTLINE:

• Background
• Research Question
• Methods
• Preliminary Results
• Considerations

Images: http://www.psych.ubc.ca/~schallerlab/index_files/image001.jpg
http://www.tuftsroundtable.org/breakthrough/1249-snow-forecast-this-weekend
*2.7% of the Global Burden of Disease is avoidable by reducing indoor smoke exposure from solid fuels
Carbon Monoxide is the Primary Component of Wood Smoke

Symptoms of Acute CO Exposure

• Dizziness, headache, loss of judgment, nausea
• Convulsions, coma and death

Cognitive domains affected by CO include:

• memory
• executive function
• information processing speed
• attention and concentration
• visuomotor skills
• visual spatial planning
• visual tracking
• abstract thinking abilities

Ref: Lit review of CO poisoning case reports

Does chronic, elevated CO exposure during the 3rd trimester impair children’s cognitive development?

My Research Question:

CO MEASURED WITH 48-HR MEAN (PPM) PERSONAL PASSIVE DIFFUSION TUBES

COGNITIVE PERFORMANCE MEASURED AT 6.5 YEARS WITH NEUROPSYCHOLOGICAL BATTERY
Study Methods:

- Extensive literature review
- Guatemalan child neurologist, UCB & field station research team consultations
- Surveyed potential testing facilities
  - Selected eligible participants (n=117)
  - Trained the trainer and Child Examiners
- Deployed Maternal Questionnaire
  - Collected Covariates for Data Analysis
  - Created data management system
- Preliminary scale selections made
- Translations & back translations x 2
- Pilot tested children (n=9)
  - Interview schedule creation
- Child Interviews (n=27+)
  - Performed QAQC (video review ratings)
Selecting Eligible Participants

- (n=509 mother-child pairs from RESPIRE study)
  Randomly recruited door-to-door from 21 communities

- (n=117 Eligible)
  Living in 21 communities

- Eligible means I had:
  - CO-ppm 3rd trimester
  - Birthweight
  - Infant diarrhea data
  - Vitality data

- (n=27 Convenience Sample)
  Living in 4 communities

- Convenience means:
  - Driving distance
  - n>8 in eligible pool
  - Some in community used plancha
Study Participants:

- RESPIRE (n=27) 6-7-year-olds in 2nd month of kindergarten (mean age=6.6 years)

- Mam-speaking from 4 rural communities spread over the highlands of Comitancillo, Guatemala

- Live far from major roads & 41% of homes have a smoker

- 63% have electricity

San Marcos, Guatemala
Testing Conditions
Child Interview included:

- Anthropometry (height, weight, waist circumference, child exhaled breath CO-ppm)
- Cognitive domains (*series of 14 brief tests*):
Bender-Gestalt II Drawing
Test phases:

1. Copy
2. Immediate
3. Longterm Recall

- Tests visual motor integration, working and long term memory
- Receive rating from 1 to 4 for accuracy
Child Examiners:

Micaela

Domitila
**Child Performance:**

I. Copy phase

Scored 3 points / 4

N. Long term memory recall

Scored 2 points / 4
Preliminary Results:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (SD) (11F, 16M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenatal 48-hr CO 3rd trimester (ppm)</td>
<td>4.2 (3.4)</td>
</tr>
<tr>
<td>Current weight (kg)</td>
<td>17.8 (1.7)</td>
</tr>
<tr>
<td>Current height (cm)</td>
<td>104.4 (4.6)</td>
</tr>
<tr>
<td>Height-for age (mean percentile)</td>
<td>1.3% (3.3)</td>
</tr>
<tr>
<td>Chuj use day before (Y)</td>
<td>13 (48%)</td>
</tr>
<tr>
<td>Child Exhaled breath CO (ppm) at interview</td>
<td>2.2 (0.8)</td>
</tr>
<tr>
<td>Knows numbers</td>
<td>8 (30%)</td>
</tr>
<tr>
<td>Knows letters *</td>
<td>4 (15%)</td>
</tr>
</tbody>
</table>

- Prenatal 48-hr CO not correlated with exhaled CO at child interview
- Child exhaled breath CO-ppm levels at interview NOT high enough to contribute to any acute symptoms
3rd Trimester Variation in 48-hr CO-ppm between Mothers
Drawing test Raw Scores tend to decline with Prenatal CO Group (no adj)
(WITHOUT COVARIATES)
Copy Test Global Scores improved with lower Prenatal logCO-ppm

B-coef = (-.045)

p-value < 0.10
Preliminary Results (may change!):

- Prenatal logCO significantly associated with Copy Test scores ($B$-coef=$-0.063$; $p<0.05$) when model adj. for:
  - age, sex, mother education, height-for-age percentile, crowding, breastfeed, garbage disposal on land, birth weight

- Height percentile and birth weight contribute most to overall variance
Considerations:

• Allow one week to refresh training, not a few days
• Have child neuropsychologist on site
• Kindergarten so adjust drawing scores using controlled motor tests (Connect the dots and Finger tapping test)
• Hire a data manager
Covariates Collected:

**Neurotoxic Pesticides & As**
- ~75% of children’s parents farm someone else’s land
- Children help with seeding
- As < 5ppb; standard = 10ppb

**Dietary Intake**
- Meat, dairy, caffeine, drugs (mom and kid)

**Home Environment**
- Parent interaction, books and reading in the house, radio and media use
Further Data Analyses to Come

What other cognitive domains are affected?

Is Child interview Exhaled breath CO-ppm associated with performance?

What is the lowest CO exposure level that cognitive effects are seen?
Thank-you Suzanne Llewellyn & COEH, UC Berkeley and Guatemalan Research Team, and all the CRECER participants!!

Child Examiners: Domitila Velasquez Ambrosio and Micaela Isidro Marroquín
Field Project Manager: Carolina Romero

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Andrew Slocombe, MS EHS GHE-to-be
Nick Lam, MS EHS

Arsenic testing supplies and support:
David Dauphine

For her Clinic and dinners in San Lorenzo:
Erika Barrios
“We drive into the future using only our rear view mirror.”


References:
Siddiqui, 2008
Pope 2010
WHO GBDD, 2004
discounted age-weighted
Refs: Alehan, 2007; Beltran-Parrazal, 2010; Lopez, 2009; Carratù, 2008; Benagiano, 2007; Benagiano, 2005; Vaccari, 2001; Carratù, 2000)
## Preliminary Results:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Low CO (2F, 4M)</th>
<th>Med CO (4F, 6M)</th>
<th>High CO (5F, 6M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenatal 48-hr CO 3(^{rd}) trimester (ppm)</td>
<td>&lt;1.7</td>
<td>1.9 – 3.0</td>
<td>4.2 – 12.5</td>
</tr>
<tr>
<td>Spring water = main source</td>
<td>50</td>
<td>50</td>
<td>18</td>
</tr>
<tr>
<td>Mother completed primary school (vs non)</td>
<td>83</td>
<td>70</td>
<td>73</td>
</tr>
<tr>
<td>Mean child age (years)</td>
<td>6.5 (0.2)</td>
<td>6.6 (0.2)</td>
<td>6.7 (0.3)</td>
</tr>
<tr>
<td>Disposed of garbage on own land (% Y)</td>
<td>33</td>
<td>60</td>
<td>82</td>
</tr>
<tr>
<td>Mean mother age (years)</td>
<td>26 (7.7)</td>
<td>26 (4.5)</td>
<td>28 (5.9)</td>
</tr>
<tr>
<td>Crowding (# people per space)</td>
<td>6.0</td>
<td>5.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Breastfed (% Y)</td>
<td>50</td>
<td>70</td>
<td>64</td>
</tr>
<tr>
<td>Knows numbers (% Y)</td>
<td>50</td>
<td>70</td>
<td>82</td>
</tr>
<tr>
<td>Knows ABCs</td>
<td>0</td>
<td>10</td>
<td>27</td>
</tr>
</tbody>
</table>