Secondhand Smoke Exposure and Neuromotor Performance in Appalachian Children

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Secondhand Smoke Exposure in Children

- **Worldwide**
  - 40% of children
  - 35% of women
  - 33% of men

- **In the U.S**
  - 53.6% (~19 million) children aged 3-11 years

- **In Appalachian communities**
  - 12.1% vs. 8% nationally
  - 16.1 in urban vs. 10.2 rural

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Strong Evidence of SHS and Adverse Neurobehavior in Children

• Neurobehavioral outcomes
  – Learning disabilities
  – ADD/ADHD
  – Conduct disorders
  – Cognitive and academic achievement deficits

• Prevalence in Appalachian children
  – 21% vs. 13% nationally

• “Motor overflow” in children with ADHD

Primary Research Question?

• Does SHS negatively impact neuromotor performance in children?
Marietta Community Actively Researching Exposure Study (CARES)
Study Cohort
7-9 years
N = 407

Marietta, OH/Parkersburg, WV
n = 327

Cambridge, OH
n = 80

Home Environmental Sampling
- Composite Home Dust
- Soil
- Drinking Water

Ambient Air Sampling
- PM$_{2.5}$ 6 days/week
- 4 weeks/season

Personal Air Sampling
N = 40

Neuropsychological Assessment
- Child IQ (WISC-IV)
- BASC-2
- CVLT-C
- Standardized Achievement Test

Neuromotor Assessment
- Grooved Pegboard
- Fingertapping
- Postural Balance n=55

Biological Measures
- Whole Blood: Pb, Mn, Cd, Hg
- Serum: Cotinine, Ferritin, transferrin, TIBC
- Hair: Mn
- Tooth: Mn (prenatal and postnatal)
- Toe Nails

Neuropsychological Assessment
- Child IQ
- BASC-2
- CVLT-C
- Standardized Achievement Test

Neuromotor Assessment
- Grooved Pegboard
- Fingertapping
- Postural Balance n=36
Neuromotor Function Tests

• Halsted Finger Tapping Task
  – Simple motor speed

• Purdue Grooved Pegboard Test
  – Manual dexterity

• Bruininks-Oseretsky Test of Motor Proficiency – 2 (BOT-2)
  – Fine manual control, manual coordination, body coordination, and strength
# Characteristics of Study Cohort

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Reported Smoking in Household</th>
<th>N=40</th>
<th>No Reported Smoking in Household</th>
<th>N=40</th>
<th>P -value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>8.24 (0.85)</td>
<td></td>
<td>8.41 (0.91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (n, %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>22 (55%)</td>
<td></td>
<td>29 (72.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>18 (45%)</td>
<td></td>
<td>11 (27.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race (n, %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>33 (82.5%)</td>
<td></td>
<td>37 (92.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent IQ</td>
<td>94.28 (14.96)</td>
<td></td>
<td>103.85 (10.94)</td>
<td></td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Parent Education</td>
<td>12.27 (2.37)</td>
<td></td>
<td>14.97 (2.26)</td>
<td></td>
<td>0.78</td>
</tr>
<tr>
<td>Number of cigs/day/household</td>
<td>21.58 (11.92)</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum cotinine (µg/L)</td>
<td>2.67 (2.51)</td>
<td></td>
<td>0.24 (0.37)</td>
<td></td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Blood lead (Pb) (µg/dL)</td>
<td>1.25 (0.67)</td>
<td></td>
<td>0.87 (0.5)</td>
<td></td>
<td>0.14</td>
</tr>
</tbody>
</table>
## Serum Cotinine and Covariates

*Pearson Correlations*

<table>
<thead>
<tr>
<th>Primary Independent Variable</th>
<th>Covariates</th>
<th>Correlation</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum cotinine</td>
<td>Age_yrs</td>
<td>-0.15</td>
<td>0.2996</td>
</tr>
<tr>
<td></td>
<td>Cigs/day/household</td>
<td>0.56</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Parent IQ</td>
<td>-0.49 ⭐</td>
<td>0.0002</td>
</tr>
<tr>
<td></td>
<td>Parent Education</td>
<td>-0.67 ⭐</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Blood Pb</td>
<td>0.53</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
### Finger Tapping Test

**Pearson Correlations**

<table>
<thead>
<tr>
<th>Finger Tapping</th>
<th>Covariates</th>
<th>Correlation</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Hand</td>
<td>Serum Cotinine</td>
<td>-0.25</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>Age_yrs</td>
<td>0.468</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>Blood Pb</td>
<td>-0.362</td>
<td>0.007</td>
</tr>
<tr>
<td>Left Hand</td>
<td>Log Cotinine</td>
<td>-0.306</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Age_yrs</td>
<td>0.542</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>Blood Pb</td>
<td>-0.311</td>
<td>0.02</td>
</tr>
</tbody>
</table>
## Grooved Pegboard Test

### Pearson Correlations

<table>
<thead>
<tr>
<th>Grooved Pegboard</th>
<th>Covariates</th>
<th>Correlation</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant Hand</td>
<td>Serum Cotinine</td>
<td>-0.306</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Age_yrs</td>
<td>0.542</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>Cigs/day/household</td>
<td>-0.264</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Blood Pb</td>
<td>-0.311</td>
<td>0.02</td>
</tr>
<tr>
<td>Non-Dominant Hand</td>
<td>Serum Cotinine</td>
<td>0.231</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Age_yrs</td>
<td>-0.279</td>
<td>0.01</td>
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</tbody>
</table>
# BOT-2 Test

## Pearson Correlations

<table>
<thead>
<tr>
<th>BOT – 2 (Composite Score)</th>
<th>Covariates</th>
<th>Correlation</th>
<th>P - value</th>
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</thead>
<tbody>
<tr>
<td>Fine motor precision</td>
<td>Serum Cotinine</td>
<td>-0.323</td>
<td>0.01</td>
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<tr>
<td>Fine motor integration</td>
<td>Age_yrs</td>
<td>0.486</td>
<td>&lt;0.001</td>
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<tr>
<td>Manual dexterity</td>
<td>Cigs/day/household</td>
<td>-0.28</td>
<td>0.01</td>
</tr>
<tr>
<td>Bilateral Coordination</td>
<td>Parent IQ</td>
<td>0.204</td>
<td>0.07</td>
</tr>
<tr>
<td>Balance</td>
<td>Parent Education</td>
<td>0.372</td>
<td>0.001</td>
</tr>
<tr>
<td>Running speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper-limb coordination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
## Finger Tapping Test
### Multivariable Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Cotinine</td>
<td>-0.03</td>
<td>0.42</td>
<td>0.93</td>
</tr>
<tr>
<td>Age_yrs</td>
<td>2.30</td>
<td>0.87</td>
<td>0.01</td>
</tr>
<tr>
<td>Blood Pb</td>
<td>-3.35</td>
<td>1.42</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**Right Hand**  
R-square 0.27

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Cotinine</td>
<td>0.03</td>
<td>0.44</td>
<td>0.94</td>
</tr>
<tr>
<td>Age_yrs</td>
<td>3.62</td>
<td>0.87</td>
<td>0.01</td>
</tr>
<tr>
<td>Gender</td>
<td>4.53</td>
<td>1.24</td>
<td>0.0007</td>
</tr>
<tr>
<td>Blood Pb</td>
<td>-3.35</td>
<td>1.42</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**Left Hand**  
R-square 0.49
Grooved Pegboard Test

Multivariable Regression

### Dominant Hand
R-square 0.16

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Cotinine</td>
<td>1.28</td>
<td>0.67</td>
<td>0.06</td>
</tr>
<tr>
<td>Age_yrs</td>
<td>-3.42</td>
<td>1.61</td>
<td>0.03</td>
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</tbody>
</table>

### Non-Dominant Hand
R-square 0.18

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Cotinine</td>
<td>1.74</td>
<td>0.90</td>
<td>0.05</td>
</tr>
<tr>
<td>Age_yrs</td>
<td>-3.88</td>
<td>2.12</td>
<td>0.07</td>
</tr>
<tr>
<td>Gender</td>
<td>6.71</td>
<td>3.55</td>
<td>0.06</td>
</tr>
</tbody>
</table>
## Multivariable Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Cotinine</td>
<td>0.05</td>
<td>13.56</td>
<td>0.99</td>
</tr>
<tr>
<td>Age_yrs</td>
<td>4.93</td>
<td>1.17</td>
<td>0.0001</td>
</tr>
<tr>
<td>Parent Education</td>
<td>1.29</td>
<td>0.46</td>
<td>0.007</td>
</tr>
<tr>
<td>Blood Pb</td>
<td>3.15</td>
<td>1.87</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Conclusions

• 50% of parents reported at least one smoker in the household.
• Mean number of cigs/day/house – 22 cigs/day/house.
• Significantly strong *unadjusted* correlations between serum cotinine and….
  – Cigs/day/house, parent IQ, and parent education
• Overall, older children performed better on neuromotor tests.
• Girls performed better in manual dexterity test, while boys in simple motor speed.
• Blood Pb was also significantly associated with poor neuromotor performance.
Future Directions

• Compare neuromotor performance in children with and without detectable levels of serum cotinine.
• Explore the role of SES and SHS exposure with neuromotor performance.
• Explore the relationship between SHS exposure and school achievement using standardized school testing.
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