Correlational study associating individual educational program (IEP) numbers and toxics sites with multiple exposure scores in a Mid-west regional area using GIS as a supportive tool.

2019 Iowa Governor’s Conference on Public Health
Collaborators

• Mr. Shane McClintock, M.S. – Director of Environmental Health, Clinton County Iowa

• Dr. Junu Shrestha, Ed.D. – Assistant Professor, Environmental Health, University of Illinois Springfield

• Dr. Catherine Zeman, Ph.D. – Professor and Director, Environmental Health, Public Health and PH Education, HRCS
Methodology

- Correlational analysis
- Develop an algorithm and GIS mapping for looking at exposure assessment through multiple lenses and as a multi-site phenomena with particular focus on children’s learning.
  - District
  - School
  - Home
- Data Sources
  - EPA and IA DNR official site reports
  - Various GPS polygon and point data (state and local)
  - IEP records from School Districts
  - U.S. Census Data
- Weakness common to all correlational analysis, no individual exposure and outcome association
CERCLIS Listed vs. Superfund Sites

• Comprehensive Environmental Response Compensation and Liability Act, 1980
• Superfund and CERCLIS Listed sites are two separate things.
• The Cedar Valley has 1 Superfund site and at least 39 additional CERCLIS listed sites.
  • It took several years to gather the information from EPA regional and DNR State.
    • Detailed information on the contaminants that brought the sites onto the listing.
    • Interest in both acute and chronic neuro-toxins
• First contacted the local EPA regional field office in Kansas City on how to get local data of contaminated sites.
  • EPA office only maintains information on Superfund and Brownfield sites and recommended contacting the Iowa Department of Natural Resources (IDNR) for actual identification of possible contaminated sites.
• IDNR was very helpful and recommended using their Facility Explorer program to see which facilities in the area were contaminated sites.
• Facility Explorer lists all sites which have been tested, both from soil and water, as well as some air.
Facility Explorer
How Sites were Identified (continued)

• Unfortunately, no easy way to disseminate information on chemicals exposure to water and soil.

• Information was gathered by searching through reports, one-by-one, until all chemicals above Maximum Contaminant Level (MCL) were identified.

• Tier II and Tier III were only reports with usable information.
Table Overviewing the sites

- Arranged by site with:
  - GPS Location
  - Chemicals/Metals in soil & water
  - Reason the site was picked as contaminated
GIS Data Collection

- Coordinates and polygon feature class of each contaminated sites in Cedar Falls/Waterloo Area.
- Polygon Feature Class of each School District (Elementary, Middle, and High School)
- Recording contaminants- heavy metals, PAH, and Solvents.
- Individual Education Plan (IEP) of each School District.
- Demographics: Age, Education, Race/Ethnicity, Income, Poverty percentage.
- Data on students enrolled in free or reduced lunch program in each school district.
- Polygon feature class of the age of houses in Cedar Falls and Waterloo.
Data Source

• Contaminated sites - Mr. Shane McClintock from his Master’s Thesis.
• IEP- Cedar Falls and Waterloo Community School District Offices.
• Demographics-United States Census Bureau, 2015 Census data.
• Students enrolled in free or reduced lunch program - Iowa Department of Education, 2016-2017 database.
• School District - www.locatemyschool.com
• Age of houses - Black Hawk County Real Estate Mapping.
GIS Tools and Methodology

• Converted GIS data into appropriate format for analysis.
• Used Geoprocessing tools – Intersect, Buffer, and Union.
• Python Script for repetitive data analysis.
• Table analysis and management tool for joining existing excel sheet and then geocoding for mapping techniques.
• Spatial analysis tools – distance mapping between schools and contaminated sites.
• Map layout tool to create final maps.
Superfund and Cerclis listed sites in the cedar valley

- Red areas indicate contaminated sites.
Constellation of Contaminants

- Did neurotoxic substances predominate enough to warrant continued analysis?
Children ages 4-17: Approximately 11% of children 4-17 years of age (6.4 million) have ever been diagnosed with ADHD, according to parent report from 2011-12. ... The percent of children with an ADHD diagnosis continued to increase, from 7.8% in 2003 to 9.5% in 2007 and to 11.0% in 2011-12. CDC - Jan 24, 2018
ADD/ADHD By Demographic

- Average age 7 yrs. Range 3-6 yrs.
- 42% increase in diagnoses over the last 8 years
- Males 3x the risk of Females
- Anglos 9.8%, African American 9.5%, Latinos 5.5%
- 6.1% of diagnosed medicated
  - Side effects:
    - Involuntary movements, hallucinations, anger/aggression, mania, seizures, syncope, dyspnea, death

*Healthline, Dr. Timothy Legg, May 2018*
ADD/ADHD By Demographic

• Highest Drugging (9-10%)
  • Arkansas
  • Indiana
  • Iowa
  • Kentucky
  • Louisiana
  • North Carolina

• Lowest Drugging (2-3%)
  • Alaska
  • California
  • Colorado
  • Hawaii
  • New Jersey
  • Nevada
  • Utah

*Healthline, Dr. Timothy Legg, May 2018*
Method Specific to exposure score

• Identified known neurotoxins
  • Metals – neurodevelopmental toxin (M) = 1
  • PAH - teratogenic neurodevelopmental toxin (PAH) = 0.5
  • Solvents – known acute neurotoxin (Slv.) = 0.25
  • Total toxics score was formulaically represented as:
    • \[ Tts = (Mtl. (1+x^∞) + PAH(0.5+y^∞) + Slv.(0.25+z^∞)), \text{ toxics score per site} \]
• Weighting factors assigned based on known neurological impacts of toxins via published literature invitro, invivo, and epidemiological.
At what point does risk of IEP cross the mean?

- At about a 12-14 total toxics score for the given school district the mean variance of number of students having an IEP is **24X greater** than students from districts below this score. The finding is very highly statistically significant.
Is there a significant difference between cedar falls and waterloo?

• There is a 4x greater mean variance of individuals having an IEP if you are coming from a school district in the Waterloo area (based on IEP as percentage of each school) and this is statistically significant.

• If the ANOVA is used the $f$ drops to 3.8 and $f_{prob}$ to 0.06.
Whole Model Regression

**Actual by Predicted Plot**

- **Before 1960 Actual vs. Before 1960 Predicted**
  - $P<.0001$, $R^2=0.73$, $RMSE=1188.6$

- **Housing Age < 1975 Actual vs. Housing Age < 1975 Predicted**
  - $P<.0001$, $R^2=0.77$, $RMSE=1438.8$

- **Toxic Score Actual vs. Toxic Score Predicted**
  - $P<.0001$, $R^2=0.50$, $RMSE=10.438$
## Toxic score by Demographic Variable ANOVA

<table>
<thead>
<tr>
<th>Demographic</th>
<th>N</th>
<th>DF</th>
<th>F Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native American</td>
<td>25</td>
<td>1</td>
<td>24.4</td>
<td>0.0001</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>25</td>
<td>1</td>
<td>14.9</td>
<td>0.0008</td>
</tr>
<tr>
<td>Redcd./Free Lunch</td>
<td>25</td>
<td>1</td>
<td>14.5</td>
<td>0.0009</td>
</tr>
<tr>
<td>Asian</td>
<td>25</td>
<td>1</td>
<td>13.8</td>
<td>0.0011</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>25</td>
<td>1</td>
<td>9.9</td>
<td>0.0044</td>
</tr>
<tr>
<td>Black</td>
<td>25</td>
<td>1</td>
<td>5.9</td>
<td>0.0225</td>
</tr>
<tr>
<td>White</td>
<td>25</td>
<td>1</td>
<td>4.6</td>
<td>0.0417</td>
</tr>
</tbody>
</table>
### Toxic score by Demographic Variable Whole Model

<table>
<thead>
<tr>
<th>Demographic</th>
<th>N</th>
<th>DF</th>
<th>RSq</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native American</td>
<td>25</td>
<td>1</td>
<td>0.50</td>
<td>0.0001</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>25</td>
<td>1</td>
<td>0.38</td>
<td>0.0008</td>
</tr>
<tr>
<td>Redcd./Free Lunch</td>
<td>25</td>
<td>1</td>
<td>0.38</td>
<td>0.0009</td>
</tr>
<tr>
<td>Asian</td>
<td>25</td>
<td>1</td>
<td>0.37</td>
<td>0.0011</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>25</td>
<td>1</td>
<td>0.29</td>
<td>0.0044</td>
</tr>
<tr>
<td>Black</td>
<td>25</td>
<td>1</td>
<td>0.20</td>
<td>0.0225</td>
</tr>
<tr>
<td>White</td>
<td>25</td>
<td>1</td>
<td>0.16</td>
<td>0.0417</td>
</tr>
</tbody>
</table>
### IEP score by Demographic Variable Whole Model

<table>
<thead>
<tr>
<th>Demographic</th>
<th>N</th>
<th>DF</th>
<th>RSq</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free /Rdcd. Lunch</td>
<td>25</td>
<td>1</td>
<td>0.61</td>
<td>0.0001</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>25</td>
<td>1</td>
<td>0.51</td>
<td>0.0001</td>
</tr>
<tr>
<td>Black</td>
<td>25</td>
<td>1</td>
<td>0.42</td>
<td>0.0003</td>
</tr>
<tr>
<td>Native American</td>
<td>25</td>
<td>1</td>
<td>0.38</td>
<td>0.0009</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>25</td>
<td>1</td>
<td>0.36</td>
<td>0.0012</td>
</tr>
<tr>
<td>Asian</td>
<td>25</td>
<td>1</td>
<td>0.30</td>
<td>0.0035</td>
</tr>
<tr>
<td>White</td>
<td>25</td>
<td>1</td>
<td>0.23</td>
<td>0.0126</td>
</tr>
</tbody>
</table>
Visuals by Poverty, Toxics, IEP score, select Demographics (Census)

- Census tracs, poverty
- Circles contaminated site scores
- Triangles IEP numbers
Visuals by Black Pop., Toxics, IEP Score and select Demographics (Census)

- Census tracs, Black population
- Circles contaminated site scores
- Triangles IEP numbers
Visuals by Poverty, Toxics, IEP score, select Demographics

- School Districts
- Concentration of larger darker triangles (more IEPs) larger darker circles (higher toxics score) and school districts with higher poverty
Visuals by Free/Reduced Lunch, Toxics, IEP score, select Demographics

- School Districts
- IEP correlates with school districts having higher percentages of free or reduced price lunches
School Districts
Concentration of larger darker triangles and circles with school districts containing higher percentages of African American students. These same geospatial correlations are evident at the middle and high-school levels.
Systems oriented problems must have systems oriented solutions

- Social/Policy
  - Screening programs
  - HUD remediations (Home)
  - Multiple exposure models tied to policy

- Individual
  - Remediation (Home)
  - Dietary/hygiene

- Community Institutional
  - Health Department screening/Screening before school diagnosis
  - Screening and intervention at 10ug/dl BLL, switch to 2 ug/dl, BLL
Human biotransformation system
Dietary interventions
Collective advocacy and prevention
Community Toxics Prevention: Individual Actions

- Awareness
  - Presentations, games, events, PIEER, CEL
  - Develop more targeted, nuanced curriculum
  - Dietary education, PIEER, CEL, and FRED
  - Teacher Education

- Understanding

- Concrete Actions

- Support

- Food Availability/Advocacy
  - Farmer’s Markets
  - Dollars for the LFP voucher purchase

- Impact Evaluation
Thank-you for your time!

Questions?