Detroit-specific Asthma Research and Interventions

Community Action to Promote Health Environments (CAPHE)
Community Action Against Asthma (CAAA)
Healthy Environmental Partnerships (HEP)
Detroit Urban Research Center (DURC)

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Overarching Goal of CAPHE

Develop and implement a scientifically-informed public health action plan (PHAP) designed to reduce exposure to air pollutants and mitigate adverse health effects in Detroit with a particular focus on vulnerable populations.
Aim 3: Develop a multilevel, integrated and scientifically-informed public health action plan to reduce air pollutant exposures and adverse health effects.
Aim 4: Develop & implement campaigns, interventions & policies to promote recommendations in the public health action plan.

Photos 1, 2, 3 and 4: Youth Programming, Detroiters Working for Environmental Justice

CAPHE is developing a Public Health Action Plan Resource Manual to inform the PHAP

1. Introduction and Objectives
2. Background and Context
3. Air Quality, Health and Environmental Justice
4. Exposure and Monitoring
5. Air Pollutant Sources, Exposures and Health Impacts
6. Cumulative Risk: Air Pollution and Population Vulnerability
7. Mitigation Strategies, including point source controls, mobile source controls, diesel retrofits, monitoring, enforcement, *indoor particle filters*, buffers, and more.
Intervention and epidemiological research on environmental triggers of asthma.
Community Action Against Asthma (CAAA)

Overarching Goals of CAAA

Overall goals of the CAAA partnership are to examine how the effects of air quality interact with social and environmental factors with childhood asthma, to test different interventions at reducing impact of environmental triggers, and to consider these findings in designing community and policy interventions.
Asthma Triggers in Homes

Children on average spend between 14 and 18.5 hours per day indoors at home, depending on age.

Indoor asthma triggers include:

• Secondhand smoke
• Dust
• Molds
• Pests
• Pets
• Outdoor air pollution
• Chemical irritants
• Wood smoke
Indoor mold: Environmental Relative Moldiness Index (ERMI)

**Objective:** quantify mold contamination in study participant's homes

- NEXUS participants were children ages 6-14 years with asthma in Detroit, MI
- ERMI study included homes of 112 participants

**Approach:**

- Collected dust samples in bedrooms and living rooms
- Measured 36 indicator species of mold, analysis using quantitative PCR techniques
- Calculated the ERMI for each home
- Examine effect of water damage, age of home, and other factors on concentration of molds found in homes

Kamal et al. 2014. J Env Pub Health
Environmental Relative Moldiness Index (ERMI)
Part of CAAA and NEXUS (EPA)

Findings:

1. Most homes (85%) had exceptionally high ERMI values -- highest quartile nationally.
2. Mold was present throughout the whole house.
3. Concentrations tended to be higher in bedrooms than living rooms (not statistically significant).
4. Age of the home was an important predictor of ERMI.

Highest ERMI values were calculated in older homes (over 75 years old)

Kamal et al. 2014. J Env Pub Health
**Indoor Volatile Organic Compounds (VOCs)**

**Objective:** quantify VOC composition and levels in homes of Detroit children with asthma

**Findings:** A total of 56 VOCs detected
Concentrations generally lower than levels elsewhere in North America.

Major source include cigarette smoking, vehicle related emissions, renovation, solvents, household product and pesticides.

Some VOCs pose cancer risks that exceed guideline levels (naphthalene, benzene, 1,4-dichlorobenzene, isopropylbenzene, ethylbenzene and styrene)

Some very high levels of naphthalene and 1,4-dichlorobenzene in a subset of residences.

Chin et al., Indoor Air, 2013
Objectives:

1. Characterize pollutant exposures in homes of children with asthma living in Detroit, Michigan.

2. Determine effects of providing HEPA filters and room air conditioners in child’s bedroom on indoor pollutant concentrations and exposures.

3. Investigate effects of providing HEPA filters and room air conditioners on children’s respiratory health, e.g., lung function, medication usage, ER visits.
Location of participating households also showing highways and secondary streets, and vehicle-kilometers-driven (VKT) per day within a 100 m buffer of the home (orange circle)

Batterman et al. 2012. Indoor Air
## Home characteristics

<table>
<thead>
<tr>
<th>Home characteristics</th>
<th>Unit</th>
<th>Average</th>
<th>Range</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor area</td>
<td>m²</td>
<td>147</td>
<td>63 - 483</td>
<td>-</td>
</tr>
<tr>
<td>Interior house volume</td>
<td>m³</td>
<td>368</td>
<td>156 - 1192</td>
<td>-</td>
</tr>
<tr>
<td>Single family house</td>
<td></td>
<td>-</td>
<td>-</td>
<td>79</td>
</tr>
<tr>
<td>No. of bedrooms</td>
<td>n</td>
<td>3.0</td>
<td>1 - 6</td>
<td>-</td>
</tr>
<tr>
<td>Heating system (Forced air)</td>
<td></td>
<td>-</td>
<td>-</td>
<td>88</td>
</tr>
<tr>
<td>Central AC</td>
<td></td>
<td>-</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>Furnace filter change frequency</td>
<td>times/yr</td>
<td>2.5</td>
<td>1 - 12</td>
<td>47</td>
</tr>
<tr>
<td>Child's sleeping area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor area</td>
<td>m²</td>
<td>12</td>
<td>4 - 46</td>
<td>-</td>
</tr>
<tr>
<td>Room volume</td>
<td>m³</td>
<td>28</td>
<td>13 - 110</td>
<td>-</td>
</tr>
<tr>
<td>No. of windows</td>
<td>n</td>
<td>1.7</td>
<td>1 - 5</td>
<td>-</td>
</tr>
<tr>
<td>No. of adults</td>
<td>n</td>
<td>1.7</td>
<td>1 - 5</td>
<td>-</td>
</tr>
<tr>
<td>No. of children</td>
<td>n</td>
<td>2.4</td>
<td>1 - 8</td>
<td>-</td>
</tr>
<tr>
<td>Never any smokers indoors</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>55</td>
</tr>
<tr>
<td>Any smokers in household</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60</td>
</tr>
<tr>
<td>No. of smokers</td>
<td>n</td>
<td>1.7</td>
<td>1 - 5</td>
<td>60</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuumed CSA in the last 2 weeks</td>
<td>n</td>
<td>3.1</td>
<td>1 - 5</td>
<td>44</td>
</tr>
<tr>
<td>Swept or dusted CSA in the last 2</td>
<td>n</td>
<td>3.3</td>
<td>1 - 5</td>
<td>100</td>
</tr>
</tbody>
</table>

Batterman et al. 2012. Indoor Air
Monitored environmental parameters

- Particulate matter (PM)
- Particle number (0.3-1.0 µm/1-5 µm)
- Carbon dioxide (CO₂)
- Volatile organic compounds (VOCs)
- Environmental tobacco smoke (ETS)
- Air exchange rates (AERs) in bedroom & living room
- Temperature and RH
- Filter use

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Seasonal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>37</td>
<td>59</td>
<td>94</td>
</tr>
<tr>
<td>Standard</td>
<td>47</td>
<td>90</td>
<td>137</td>
</tr>
<tr>
<td>Enhanced</td>
<td>42</td>
<td>73</td>
<td>115</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>222</td>
<td>346</td>
</tr>
</tbody>
</table>

Batterman et al. 2012. Indoor Air
Trends of fine and coarse PM and filter use

Particle number counts (0.3-1.0 µm)

Particle number counts (1-5 µm)

Air filter use (showing fan speed)

Filter deployed

Batterman et al. 2012. Indoor Air
### Pollutant levels in residences with and without filter

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Without filter</th>
<th>With filter</th>
<th>Statistic</th>
<th>Without filter</th>
<th>With filter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Average</td>
<td>SD</td>
<td>Median</td>
<td>N</td>
</tr>
<tr>
<td><strong>PM (µg/m³)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>35</td>
<td>32.5</td>
<td>14.7</td>
<td>30.4</td>
<td>35</td>
</tr>
<tr>
<td>Standard/Enhanced</td>
<td>79</td>
<td>26.7</td>
<td>25.3</td>
<td>14.2</td>
<td>83</td>
</tr>
<tr>
<td>All</td>
<td>114</td>
<td>28.5</td>
<td>22.7</td>
<td>21.8</td>
<td>113</td>
</tr>
<tr>
<td>0.3-1.0 µm PNC (#/liter)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>35</td>
<td>1,774</td>
<td>1,470</td>
<td>1,306</td>
<td>35</td>
</tr>
<tr>
<td>Standard/Enhanced</td>
<td>78</td>
<td>1,434</td>
<td>1,408</td>
<td>933</td>
<td>83</td>
</tr>
<tr>
<td>All</td>
<td>116</td>
<td>1,298</td>
<td>1,325</td>
<td>846</td>
<td>116</td>
</tr>
</tbody>
</table>

Each house is weighted equally.

Batterman et al. 2012. Indoor Air
Initially high use may reflect a "novelty" effect when the filter was first introduced to the participants, and remained quite high in our weekly visits.

Use dropped in periods between home visits reflecting a "good behavior" effect, reflecting participants' understanding of intended filters use, and “economy” effect associated with perception of filter cost.

Batterman et al. 2012. Indoor Air
Influences on indoor PM levels and filters

Environmental tobacco smoke (ETS)

• Had both survey data & unique ETS tracer (2,5-DMF) to measure smoking.
• Smoking (ETS) increased bedroom PM levels by $12 \pm 35 \mu m/m^3$, comparable to literature findings
• ETS found in 30% of households, and sometimes levels appear equal or higher in child’s bedroom
• Concordance between survey & tracer data is not great, which means that survey data results often is not accurate (exposure misclassification)

Other factors

• Seasonal variation is often strong, e.g., indoor PM levels lower in winter
• Indoor levels affected by outdoor PM concentrations, the number of children in the house, and sweeping/dusting.
• Furnace filters can be very helpful

Batterman et al. 2012. Indoor Air
Health impact assessment (HIA) of indoor filters to reduce asthma impacts among children in Detroit

**Objective:** assess the potential for asthma health benefits of installing filters in children’s homes to reduce exposures to ambient PM$_{2.5}$

- Exposures based on area monitoring data
- Daily mean exposure concentrations at the block level

Local population and health outcome data

- Asthma ED visit data from MDHHS surveillance report (deGuire et al. 2016)
- Exacerbation data (cough, wheeze, shortness of breath) from NEXUS study

Health impact functions

- Concentration-response coefficient from epidemiological studies
- Estimated impacts attributable to PM$_{2.5}$ exposures at homes and schools
- Estimated benefits of using filters to reduce exposures
Health Impact Assessment Study Area

- 255,132 residents under the age of 18
- About 28,000 children with asthma
<table>
<thead>
<tr>
<th>Outcome (age group)</th>
<th>Estimated cases per year</th>
<th>Estimated cases per year due to ambient PM$_{2.5}$ exposure at home</th>
<th>% Attributable</th>
<th>Estimated cases per year due to ambient PM$_{2.5}$ exposure at home after installing filters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma ED visit</strong> (0-17 years)</td>
<td>9,616</td>
<td>374</td>
<td>3.89</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>183</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>96</td>
</tr>
<tr>
<td><strong>Cough</strong> (6-14 years)</td>
<td>1,778,282</td>
<td>138,782</td>
<td>7.80</td>
<td>105,376</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>67,701</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35,939</td>
</tr>
<tr>
<td><strong>Wheeze</strong> (6-14 years)</td>
<td>1,130,220</td>
<td>11,115</td>
<td>0.98</td>
<td>8,352</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,537</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,794</td>
</tr>
<tr>
<td><strong>Shortness of breath</strong> (6-14 years)</td>
<td>1,073,190</td>
<td>14,096</td>
<td>1.31</td>
<td>10,599</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7,012</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,551</td>
</tr>
</tbody>
</table>
Health impact assessment (HIA) of filters to reduce asthma impacts among children in *Detroit schools*

- 392 Schools (75 “near road”)
- 145,593 students
- Considered exposures on school days (excludes weekends and summer vacation)
<table>
<thead>
<tr>
<th>Outcome (age group)</th>
<th>Estimated cases per year</th>
<th>Estimated cases per year due to ambient PM$_{2.5}$ exposure at schools</th>
<th>% Attributable</th>
<th>Filter Efficiency</th>
<th>Filter Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma ED visit (0-17 years)</td>
<td>7,166</td>
<td>46</td>
<td>0.64</td>
<td>35</td>
<td>23</td>
</tr>
<tr>
<td>Cough (6-14 years)</td>
<td>1,778,282</td>
<td>25,735</td>
<td>1.45</td>
<td>19,539</td>
<td>13,179</td>
</tr>
<tr>
<td>Wheeze (6-14 years)</td>
<td>1,130,220</td>
<td>2,061</td>
<td>0.18</td>
<td>1,548</td>
<td>1,034</td>
</tr>
<tr>
<td>Shortness of breath (6-14 years)</td>
<td>1,073,190</td>
<td>2,613</td>
<td>0.24</td>
<td>1,965</td>
<td>1,313</td>
</tr>
</tbody>
</table>
Some conclusions

• Many Detroit homes have high levels of mold in bedrooms, living rooms, and other areas. House age is an important predictor.

• Some homes have very high VOC levels.

• PM exposure is determined by indoor sources (smoking, children, sweeping/dusting), house factors (AER, AC, existing filters), environment (outdoor PM levels, season), and filters (filter type, use).

• Filters in homes can reduce indoor PM concentrations by 25 to 50% or more, but filter use can vary considerably for many reasons.

• The use of stand-alone and enhanced central furnace filters in Detroit homes is a strategy to reduce adverse asthma outcomes among children and adults.

• Use of enhanced filters in schools, particularly schools near major highways and industrial sources, is feasible and beneficial.
Asthma Epidemiology and Health Impact Assessment in Detroit


**VOCs in Detroit Homes**


**Air Filters in Detroit Homes**


**Mold in Detroit Homes**

ASTHMA AND DETROIT PUBLICATIONS

Schools and Traffic in Detroit


