Indoor Air Quality and Children’s Health

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April 2018
This material was supported by the American Academy of Pediatrics (AAP) and funded (in part) by the cooperative agreement FAIN: 5 NU61TS000237-04 from the Agency for Toxic Substances and Disease Registry (ATSDR).

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing partial funding to ATSDR under Inter-Agency Agreement number DW-75-95877701-4. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.
What is Environmental Medicine?

“If you want to learn about the health of a population, look at the air they breathe, the water they drink, and the place that they live.”

Hippocrates

Air, Water, Places
What’s making my child’s asthma so bad?
### Table 2. Pediatrician Self-Reported Baseline Knowledge of Environmental Asthma Triggers.

<table>
<thead>
<tr>
<th>Response</th>
<th>Group 1 Faculty Champions</th>
<th>Group 2 Faculty Champions</th>
<th>Pearson $\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco smoke exposure</td>
<td>59%</td>
<td>43%</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Animal allergens</td>
<td>41%</td>
<td>34%</td>
<td>NS</td>
</tr>
<tr>
<td>Mold exposure</td>
<td>38%</td>
<td>27%</td>
<td>NS</td>
</tr>
<tr>
<td>Cockroach exposure</td>
<td>34%</td>
<td>24%</td>
<td>NS</td>
</tr>
<tr>
<td>Dust mites</td>
<td>34%</td>
<td>24%</td>
<td>NS</td>
</tr>
<tr>
<td>Outdoor air pollution</td>
<td>33%</td>
<td>28%</td>
<td>NS</td>
</tr>
<tr>
<td>Indoor chemical use</td>
<td>27%</td>
<td>23%</td>
<td>NS</td>
</tr>
</tbody>
</table>

Abbreviations: EPA, Environmental Protection Agency; NS, nonsignificant.

*a* Adapted from Roberts et al.\(^{22}\)

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James R. Roberts; Nicholas Newman; Leyla E. McCurdy; Jane S. Chang; Mauro A. Salas; Bernard Eskridge; Lisa De Ybarondo; Megan Sandel; Lynnette Mazur; Catherine J. Karr; *Clin Pediatr (Phila)* 55, 1271-1278.

DOI: 10.1177/0009922815621033

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National Asthma Education and Prevention Program Expert Panel Report-3:

Guidelines for the Diagnosis and Management of Asthma

http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm
Six Priority Messages

1. Use inhaled corticosteroids
2. Use a written asthma action plan
3. Assess asthma severity
4. Assess and monitor asthma control
5. Schedule periodic asthma visits
6. Control environmental exposures
How do environmental exposures cause asthma attacks?

- Act as triggers in individuals with hyperresponsiveness
- Worsen airway inflammation
- Increase the immune response to inhaled allergens
Environmental asthma triggers

- Indoor Pollutants
Indoor pollutants may be more important than outdoor pollutants!

*Americans spend more than 90% of their time indoors (home, work, school, daycare)

- Biologic allergens
  - Dust mites
  - Cockroaches
  - Pets – animal dander
  - Mold

- ETS
- Irritant chemicals (cleaners)
- Particulate matter (combustion: gas stove, wood stove, kerosene heaters)
Sufficient evidence of Causal Relationship
- Cats
- Cockroaches
- Environmental Tobacco Smoke (preschoolers)
- Household dust mites

Sufficient evidence of an Association
- Dogs
- Mold
- Oxides of nitrogen

Limited evidence of Association
- Formaldehyde, fragrances

Committee on the Assessment of Asthma and Indoor Air; Division of Health Promotion and Disease Prevention; Institute of Medicine, 2000.
Particulate Matter

- Human-made sources:
  - industrial emissions and combustion by-products from incinerators, motor vehicles, and power plants

- Indoor sources:
  - cigarette smoking, cooking, wood and other biomass burning in stoves and fireplaces
  - cleaning activities that re-suspend dust particles (e.g., sweeping)
  - penetration of outdoor particles into the indoor environment

**Figure 1.**

Comparison of particulate matter (PM) concentrations simultaneously measured indoors, immediately outdoors, and at a central monitoring site.
Healthy effects of PM

- School-age children in Seattle: indoor PM$_{2.5}$ exposure associated with decreased pulmonary function
- Koenig et al: PM$_{2.5}$ from indoor sources more potent in decreasing lung function than outdoor-derived PM
- A California study of 19 predominantly white children: significant decrements in lung function (FEV$_1$) associated with indoor PM
Oxides of nitrogen - NOx

- Gas ranges used for home heating
- Improperly vented fireplaces
- Malfunctioning furnaces
- Wood-burning stoves
- Poorly-ventilated kerosene or gas space heaters
Risk of asthma symptoms per 20-ppb increase in NO$_2$ exposure, adjusted for PM$_{2.5}$; second hand smoke; distance from the curb; type of street in front of house; season of sampling; age, sex, and race of child; and mother's education level.
Indoor Allergens: Mold

- 60 species of molds are allergenic
- Common allergenic species: penicillium, aspergillus, cladosporium, alternaria
Mold prevention

- Eliminate water leaks
- Dehumidify to <50%
- Air conditioning
- Increased ventilation
- Avoid use of humidifiers and vaporizers

Clean with chlorine bleach mixed 1:10 with water
http://www.epa.gov/mold/moldguide.html
Volatile Organic Compounds

- Key Signs/Symptoms
  - conjunctival irritation
  - nose, throat discomfort
  - headache
  - allergic skin reaction
  - dyspnea
  - nausea, emesis
  - epistaxis (formaldehyde)
  - fatigue
  - dizziness

https://www.epa.gov/indoor-air-quality-iaq/indoor-air-pollution-introduction-health-professionals#volatile
Volatile Organic Compounds

Present in:

- personal items such as scents and hair sprays
- household products such as finishes, rug and oven cleaners, paints and lacquers (and their thinners), paint strippers, pesticides (see below)
- dry-cleaning fluids
- building materials and home furnishings
- office equipment such as some copiers and printers
- office products such as correction fluids and carbonless copy paper
- graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions

https://www.epa.gov/indoor-air-quality-iaq/indoor-air-pollution-introduction-health-professionals#volatile
Exposure history questions for VOCs

- Reside in mobile home or new home containing large amounts of pressed wood products?
- Recently acquired new pressed wood furniture?
- Job or a vocation include clerical, craft, graphics, or photographic materials?
- Chemical cleaners used extensively in the home, school, or workplace?
- Remodeling recently been done in home, school or workplace?
- Recently used pesticides, paints, or solvents?
Environmental History Form for Pediatric Asthma Patient

Specify that questions related to the child's home also apply to other indoor environments where the child spends time, including school, daycare, car, school bus, work, and recreational facilities.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is your child's asthma worse at night?</td>
<td>Q</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Is your child's asthma worse at specific locations?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>If so, where?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is your child's asthma worse during a particular season?</td>
<td>Q</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>If so, which one?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is your child's asthma worse with a particular change in climate?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>If so, which?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you identify any specific trigger(s) that makes your child's asthma worse?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>If so, what?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have you noticed whether dust exposure makes your child's asthma worse?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Does your child sleep with stuffed animals?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Is there wall-to-wall carpet in your child's bedroom?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Have you used any means for dust mite control?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>If so, which ones?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have any furry pets?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do you see evidence of rats or mice in your home weekly?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do you see cockroaches in your home daily?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do any family members, caregivers or friends smoke?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Does this person(s) have an interest or desire to quit?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Does your child/teens/smoke?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do you see or smell mold/mildew in your home?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Is there evidence of water damage in your home?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do you use a humidifier or swamp cooler?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Have you had new carpets, paint, floor refinishing, or other changes to your house in the past year?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Does your child or another family member have a hobby that uses materials that are toxic or give off fumes?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Has outdoor air pollution ever made your child's asthma worse?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Does your child limit outdoor activities during a Code Orange or Code Red air quality alert for ozone or particle pollution?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do you use a wood burning fireplace or stove?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Do you use unvented appliances such as a gas stove or gas dryer?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Does your child have contact with other irritants (e.g., perfumes, cleaning agents)?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>What other concerns do you have regarding your child's asthma that have not yet been discussed?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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