Housing, Health and Disparity: The Role of Indoor Environmental Exposures

Gary Adamkiewicz PhD MPH
Harvard School of Public Health, Boston, MA

Delaware Healthy Homes Summit
June 5, 2012
Environment
- Diet
- Environmental exposures
- Physical activity
- Occupation
- Neighborhood
- Psychosocial stress
- Healthcare
- etc.

Genes • Environment • Diet • Environmental exposures • Physical activity • Occupation • Neighborhood • Psychosocial stress • Healthcare • etc. • Health • disparity linkages
Urban Housing – 19th Century

- Overcrowding
- High rates of infectious disease (epidemics)
  - Cholera
  - Tuberculosis
  - Typhoid fever
- Poor sanitation
- Fire hazards
- Poor lighting
- No ventilation
20th CENTURY
Housing – 20th Century

Lead poisoning

Age of Residence (year built)

From the Third National Health and Nutrition Examination Survey (NHANES III), Phase 2, 1991-1994
Public health in action - lead

(Bellinger DC and Bellinger AM, JCI, 2006)
Lead – Costs and benefits

Links between lead and
• Behavioral problems
• Violent criminal activity
• IQ (effects on educational achievement, earnings)

<table>
<thead>
<tr>
<th></th>
<th>Conservative</th>
<th>Optimistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total benefit</td>
<td>$ 192 billion</td>
<td>$ 270 billion</td>
</tr>
<tr>
<td>Total cost</td>
<td>$ 11 billion</td>
<td>$ 1 billion</td>
</tr>
<tr>
<td>Net benefit</td>
<td>$ 181 billion</td>
<td>$ 269 billion</td>
</tr>
<tr>
<td>Cost/benefit</td>
<td>1 to 17</td>
<td>1 to 221</td>
</tr>
</tbody>
</table>

(Gould, 2009)
in May 2012, CDC concurred or ‘concurred in principle’ with the advisory panel’s recommendations.
**Asthma**

- Prevalence increasing worldwide
- Currently affects 5-10% of US
  - >17 million Americans affected
- Incidence, severity increasing
- Highest in industrialized countries
- Leading chronic illness among children
  - Prevalence among children rose from 3.6% (1980) to 5.8% (2005)*
- In the US, costs exceed $14 billion/yr

*NEJM, 2006*
**Asthma**

- **Children (Ages 1-17):**
  - 0-199% FPL: 23.9%*
  - 200-399% FPL: 16.5%*
  - 400%+ FPL: 12.5%

- **Adults (Age 18 and Over):**
  - 0-199% FPL: 18.8%*
  - 200-399% FPL: 12.5%
  - 400%+ FPL: 8.8%

**Asthma ER visits in California**

UCLA Center for Health Policy Research report
"Income Disparities In Asthma Burden and Care In California“ 2010

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**Study Finds Asthma In 25% of Children In Central Harlem**

By RICHARD PÉREZ-Peña

A study has found that one of every four children in central Harlem has asthma, which is double the rate researchers expected to find and, experts say, is one of the highest rates ever documented for an American neighborhood.

Researchers say the figures, from an effort based at Harlem Hospital Center to test every child in a 24-block area, could indicate that the incidence of asthma is even higher in poor, urban areas than was previously believed.

The Centers for Disease Control and Prevention has estimated that about 6 percent of all Americans have asthma; the rate is believed to be higher for children.

(NYT, 4/19/2003)
Housing/buildings and health – 20th Century

Asbestos

Radon Movement

Radon

Legionnaires disease

SBS
21st CENTURY
Household exposures in the 21st Century
Household exposures in the 21st Century

- ETS
- NO₂, CO
- VOCs
- Lead
- Moisture/Mold
- Formaldehyde
- Allergens
- Pesticides/Chemicals
- Ambient Pollution
Chemicals in our homes
Chemicals in our homes

- flame retardants
- phthalates
- PAH
- PCBs
- pesticides
What determines indoor exposures?
structural factors

human activity

sources

air exchange
### Determinants of Indoor Environmental Quality and Exposure

#### Sources

**Indoor Sources**
- Cooking appliances
- Tobacco smoke
- Cleaning products
- Air fresheners
- Personal care products
- Furnishings
- Pesticides
- Pollutant reservoirs
- Water sources

**Outdoor Sources**
- Traffic
- Industrial Activity
- Residential Activity
- Contaminated soil

#### Structure

**Physical Structure**
- Size/design of structure
- Age
- Size of living space
- Single family vs. multifamily
- Leakage and/or air exchange
- Heating systems
- Mechanical ventilation

#### Behavior

**Source use patterns**
- Cooking appliance usage
- Cooking practices
- Smoking behavior
- Consumer product usage
- Personal care product usage

**Activity Patterns**
- Time spent at home
- Interaction with sources
- Influence on air exchange
## Determinants of Indoor Environmental Exposures

### Housing Characteristic → Hazard

<table>
<thead>
<tr>
<th>Housing Characteristic</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built before 1980, %</td>
<td>Lead paint; structural integrity</td>
</tr>
<tr>
<td>Area of peeling paint larger than $8 \times 11$ in, %</td>
<td>Lead paint</td>
</tr>
<tr>
<td>Any inside water leaks in past 12 mo, %</td>
<td>Mold and moisture; structural integrity</td>
</tr>
<tr>
<td>Neighborhood with heavy street noise or traffic, %</td>
<td>Outdoor air sources—mobile</td>
</tr>
<tr>
<td>Industry or factory within half block, %</td>
<td>Outdoor air sources—stationary</td>
</tr>
<tr>
<td>Unit uncomfortably cold for $\geq 24$ h, %</td>
<td>Supplemental heating; comfort</td>
</tr>
<tr>
<td>Evidence of rodents in unit, %</td>
<td>Allergen exposure; pesticide exposure</td>
</tr>
<tr>
<td>Mean floor area of unit, $\text{ft}^2$</td>
<td>Exposure to indoor air pollutants</td>
</tr>
<tr>
<td>Mean occupant density, no./1000 $\text{ft}^2$</td>
<td>Indoor source strength—various</td>
</tr>
<tr>
<td>Homes with cracks in floor, wall, or ceiling, %</td>
<td>Allergen exposure (pests)</td>
</tr>
<tr>
<td>Homes with holes in floor, %</td>
<td>Allergen exposure (pests)</td>
</tr>
</tbody>
</table>

**ALL ARE STRONGLY ASSOCIATED WITH SOCIOECONOMIC STATUS**
## Determinants of Indoor Environmental Exposures

<table>
<thead>
<tr>
<th>Housing Variable</th>
<th>Low Income</th>
<th>High Income</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built before 1980 (%)</td>
<td>71.56</td>
<td>48.63</td>
<td>1.5</td>
</tr>
<tr>
<td>Area of peeling paint larger than 8 x 11 (%)</td>
<td>3.11</td>
<td>0.99</td>
<td>3.1</td>
</tr>
<tr>
<td>Any inside water leaks in last 12 months (%)</td>
<td>9.14</td>
<td>7.98</td>
<td>1.1</td>
</tr>
<tr>
<td>Neighborhood with heavy street noise/traffic (%)</td>
<td>28.19</td>
<td>16.69</td>
<td>1.7</td>
</tr>
<tr>
<td>Industry/factory within ½ block (%)</td>
<td>6.90</td>
<td>1.74</td>
<td>4.0</td>
</tr>
<tr>
<td>Unit uncomfortably cold for 24+ hrs (%)</td>
<td>10.70</td>
<td>6.71</td>
<td>1.6</td>
</tr>
<tr>
<td>Evidence of rodents in unit (%)</td>
<td>17.77</td>
<td>16.26</td>
<td>1.1</td>
</tr>
<tr>
<td>Mean floor area of unit (ft²)</td>
<td>1524</td>
<td>2853</td>
<td>0.5</td>
</tr>
<tr>
<td>Mean occupant density (number per 1000 ft²)</td>
<td>2.78</td>
<td>1.82</td>
<td>1.5</td>
</tr>
<tr>
<td>Homes with cracks in floor, wall, or ceiling (%)</td>
<td>7.13</td>
<td>3.31</td>
<td>2.2</td>
</tr>
<tr>
<td>Homes with holes in floor (%)</td>
<td>1.85</td>
<td>0.37</td>
<td>5.0</td>
</tr>
</tbody>
</table>

(Low income = <$30k/yr; High income = >$100k/yr)  
(Adamkiewicz et al 2011, using data from AHS, 1999)
Determinants of Indoor Environmental Exposures

ETS
Source
Source usage
Physical Structure
Behavior

Lead
Source
Physical Structure
Behavior
## Indoor Environmental Exposure Disparity

<table>
<thead>
<tr>
<th>Low SES</th>
<th>High SES</th>
</tr>
</thead>
</table>
| • Combustion by-products  
• Lead  
• Allergens  
• Mold  
• Pesticides  
• ETS  
• Formaldehyde  
• Some VOCs  
• PBDEs | Exposures associated w/single family homes  
• Radon  
• VOCs from attached garages |

Modern chemicals (e.g. SVOCs) ??

**MANY CASES OF SOURCE GRADIENTS TOWARD LOW SES**
Moving Environmental Justice Indoors: Understanding Structural Influences on Residential Exposure Patterns in Low-Income Communities

Gary Adamkiewicz, PhD, MPH, Ami R. Zota, ScD, MS, M. Patricia Fabian, ScD, Teresa Chahine, ScD, Rhona Julien, ScD, John D. Spengler, PhD, and Jonathan I. Levy, ScD

The persistence of racial/ethnic and socioeconomic health disparities in the United States remains a significant public health problem. One focus of the environmental justice (EJ) movement has been the contribution of the physical and social environments in shaping adverse health outcomes among poor communities of color. The emphasis of EJ has historically been on outdoor pollution sources such as industry or traffic, in part because of EJ’s origins in addressing historical and continued institutional racism through the siting of industrial facilities, illegal and regulated dumping, and land use planning in communities lacking the political capital that would promote a more equitable distribution of risk.

Although these outdoor sources can clearly influence health disparities given uneven distributions across communities, an underappreciated EJ issue relates to disparities in indoor environments. The indoor environment has not been fully incorporated into the environmental justice dialogue. To inform strategies to reduce disparities, we developed a framework to identify the individual and place-based drivers of indoor environment quality.

Objectives. The indoor environment has not been fully incorporated into the environmental justice dialogue. To inform strategies to reduce disparities, we developed a framework to identify the individual and place-based drivers of indoor environment quality.

Methods. We reviewed empirical evidence of socioeconomic disparities in indoor exposures and key determinants of these exposures for air pollutants, lead, allergens, and semivolatile organic compounds. We also used an indoor air quality model applied to multifamily housing to illustrate how nitrogen dioxide (NO$_2$) and fine particulate matter (PM$_{2.5}$) vary as a function of factors known to be influenced by socioeconomic status.

Results. Indoor concentrations of multiple pollutants are elevated in low-socioeconomic status households. Differences in these exposures are driven by the combined influences of indoor sources, outdoor sources, physical structures, and residential activity patterns. Simulation models confirmed indoor sources’ importance in determining indoor NO$_2$ and PM$_{2.5}$ exposures and showed the influence of household-specific determinants.

Conclusions. Both theoretical models and empirical evidence emphasized that disparities in indoor environmental exposure can be significant. Understanding key determinants of multiple indoor exposures can aid in developing policies to reduce these disparities. (Am J Public Health. 2011;101:S238–S245. doi:10.2105/AJPH.2011.300119)
CASE STUDY
Health in Common Study

4-year study funded by National Cancer Institute (PI: Glorian Sorensen)

OVERALL GOALS OF STUDY

• To study social and physical determinants of cancer risk-related behavior among residents of low-income housing

• Develop intervention to be tested in future study
Health in Common Study

THIS ANALYSIS

• To understand the prevalence of key environmental hazards within low-income housing in the Boston area
• To understand the extent of clustering of these hazards
• To examine associations with self-reported health among residents of these housing units
Study setting

Housing Sites
• Cambridge, Chelsea, Somerville
• 15 public & 5 privately managed
• Family units
• Approx. 40 households per development
• Primary languages spoken at sites: English, Spanish, & Haitian-Creole

Participant eligibility
• Adults 18 years of age and older
• Resident of development
• Speaks English, Spanish, or Haitian-Creole
• Randomly Selected Household Member
Typical Housing Styles
Assessment tools

• Resident Survey (N= 828)
• Visual Inspection (N= 828)
• Manager Interview & Survey (N=20)
• Development Visual Inspection (N=20)
• Neighborhood Assessment (N=479)

Environmental Indices

• Created indices for key hazards / risk factors
  • chemical exposures, mold, ETS, pests, combustion by-products, poor ventilation
• Created summed index
• Examined correlations
• Built model for each index and summed index
• Built model for self-reported health
# Participant characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>153 (19%)</td>
</tr>
<tr>
<td>30-39</td>
<td>218 (26%)</td>
</tr>
<tr>
<td>40-49</td>
<td>169 (21%)</td>
</tr>
<tr>
<td>50-59</td>
<td>145 (18%)</td>
</tr>
<tr>
<td>60+</td>
<td>140 (17%)</td>
</tr>
<tr>
<td><strong>Gender - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>169 (20%)</td>
</tr>
<tr>
<td>Female</td>
<td>659 (80%)</td>
</tr>
<tr>
<td><strong>Race/ethnicity - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>341 (41%)</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>93 (11%)</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>316 (38%)</td>
</tr>
<tr>
<td>Other</td>
<td>74 (9%)</td>
</tr>
<tr>
<td><strong>Income below poverty - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>445 (58%)</td>
</tr>
<tr>
<td>No</td>
<td>327 (42%)</td>
</tr>
<tr>
<td><strong>Survey language - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>445 (54%)</td>
</tr>
<tr>
<td>Spanish</td>
<td>221 (27%)</td>
</tr>
<tr>
<td>Creole</td>
<td>162 (20%)</td>
</tr>
<tr>
<td><strong>Education - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Grade school or below (&lt;8 yrs)</td>
<td>152 (21%)</td>
</tr>
<tr>
<td>Some HS (9-11.5 yrs)</td>
<td>123 (17%)</td>
</tr>
<tr>
<td>High School (12 yrs)</td>
<td>200 (27%)</td>
</tr>
<tr>
<td>More than high school (13+ yrs)</td>
<td>261 (35%)</td>
</tr>
<tr>
<td><strong>Years living in development - n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>382 (48%)</td>
</tr>
<tr>
<td>5-10 years</td>
<td>184 (23%)</td>
</tr>
<tr>
<td>More than 10 years</td>
<td>226 (29%)</td>
</tr>
<tr>
<td><strong>Number of people in apartment</strong></td>
<td></td>
</tr>
<tr>
<td>Mean (SD) [Range]</td>
<td>3.0 (1.5) [1-13]</td>
</tr>
</tbody>
</table>
Environmental Conditions
Environmental Conditions

ETS
Combustion by-products
Chemicals
Mold
Pests
Inadequate ventilation
## Environmental Indices

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental indices [n with problem (%)]</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CHEMICAL</strong></td>
<td>663 (81%)</td>
</tr>
<tr>
<td>Frequent use of pesticides or air fresheners in the homes</td>
<td></td>
</tr>
<tr>
<td><strong>MOLD</strong></td>
<td>358 (43%)</td>
</tr>
<tr>
<td>Visible mold or mold treatment reported by resident or visible mold noted during inspection</td>
<td></td>
</tr>
<tr>
<td><strong>SECONDHAND SMOKE</strong></td>
<td>172 (22%)</td>
</tr>
<tr>
<td>Any reported smoking within the home</td>
<td></td>
</tr>
<tr>
<td><strong>PESTS</strong></td>
<td>443 (54%)</td>
</tr>
<tr>
<td>Frequent sightings of mice, cockroaches or rats</td>
<td></td>
</tr>
<tr>
<td><strong>COMBUSTION BY-PRODUCTS</strong></td>
<td>415 (52%)</td>
</tr>
<tr>
<td>Gas stove without mechanical kitchen exhaust or reported use of gas stove to heat apartment</td>
<td></td>
</tr>
<tr>
<td><strong>INADEQUATE VENTILATION</strong></td>
<td>368 (48%)</td>
</tr>
<tr>
<td>Inadequate kitchen or bathroom mechanical ventilation</td>
<td></td>
</tr>
<tr>
<td><strong>Summed index</strong></td>
<td></td>
</tr>
<tr>
<td>Mean (SD) [Range]</td>
<td>2.9 (1.3) [0-6]</td>
</tr>
</tbody>
</table>
These hazards were likely to be clustered. 46% of homes had four or more hazards.
Models

Site       Household

Environmental Indicators
Models

- Site
- Household

Environmental Indicators → Self-reported health
### Environmental Indices

<table>
<thead>
<tr>
<th>Index</th>
<th>Significant Fixed Effect for 'Site'?</th>
<th>p value</th>
<th>Other significant predictors†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical index</td>
<td>No</td>
<td>NS</td>
<td>-</td>
</tr>
<tr>
<td>Mold index</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Years in complex (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Occupancy (+)</td>
</tr>
<tr>
<td>ETS index</td>
<td>No</td>
<td>NS</td>
<td>Race/ethnicity (↑White)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Survey language (↑English)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Education (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gender (↑Male)</td>
</tr>
<tr>
<td>Pest index</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Age (-)</td>
</tr>
<tr>
<td>Combustion byproducts</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Adult over 65 in household (-)</td>
</tr>
<tr>
<td>Inadequate ventilation</td>
<td>Yes</td>
<td>0.0087</td>
<td>Adult over 65 in household (-)</td>
</tr>
<tr>
<td>Summed index</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Years in complex (+)</td>
</tr>
</tbody>
</table>

*All associations are adjusted for site, age, race/ethnicity, poverty status, survey language, education, having a child under 5 in the household, having an adult over 65 in household, tenure in apartment, and gender. Full models presented as supplemental information.

†p<0.05 for variables listed in this column
# Environmental Indices

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<tr>
<td></td>
<td></td>
<td></td>
<td>Occupancy (+)</td>
</tr>
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<td>Race/ethnicity (↑White)</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Education (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gender (↑Male)</td>
</tr>
<tr>
<td>Pest index</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Age (-)</td>
</tr>
<tr>
<td>Combustion byproducts</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Adult over 65 in household (-)</td>
</tr>
<tr>
<td>Inadequate ventilation</td>
<td>Yes</td>
<td>0.0087</td>
<td>Adult over 65 in household (-)</td>
</tr>
<tr>
<td>Summed index</td>
<td>Yes</td>
<td>&lt;0.0001</td>
<td>Years in complex (+)</td>
</tr>
</tbody>
</table>

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†p<0.05 for variables listed in this column
## Environmental Indices - predictors

<table>
<thead>
<tr>
<th>Associated with housing development</th>
<th>NOT Associated with housing development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mold</td>
<td>Current smoking</td>
</tr>
<tr>
<td>Pests</td>
<td>Current chemical usage</td>
</tr>
<tr>
<td>Combustion by-products</td>
<td></td>
</tr>
<tr>
<td>Inadequate ventilation</td>
<td></td>
</tr>
</tbody>
</table>

Important to think about structural/systemic issues.

Important to think about occupant behavior.
All associations are adjusted for site, age, race/ethnicity, poverty status, survey language, education, having a child under 5 in the household, having an adult over 65 in household, tenure in apartment, gender and ‘ever smoked. *p<0.05

**Odds Ratio**

\[\text{Odds Ratio} = 2.15 \ (1.4, 3.3) \]

\[p<0.001\]
Associations with Self-reported Health

![Graph showing associations with self-reported health]

- Low (<3)
- Medium (3)
- High (>3)
Study Conclusions

• **Environmental hazards are common** in low-income housing

• Strong evidence for **clustering by site** for hazards with clear ties to structure or operations at the building/development level

• Associations with self reported health are significant for ETS and for a summed measure of environmental hazards
Disparity ‘stories’

- Pesticides
- Smoking
- Energy
Pesticides in the home

75% of U.S. households use pesticides

Potential Health Effects

• **Acute Exposure** – irritation to the eyes, nose and throat; acute central nervous system (CNS) damage, e.g., headaches, dizziness, blurred vision

• **Chronic Exposure** – fetal development, damage to CNS, immune system, kidneys, reproductive system and increased risk of cancer
Pesticides in the home – a changing landscape

Organochlorines

Organophosphates

Pyrethroids

Banned:
- DDT (1972)
- chlordane (1998)

Banned:
- diazinon (2001)
- chlorpyrifos (2000)

Current ingredients:
- permethrin
- cypermethrin
- etc.
## ‘Legacy’ Exposures

Pesticides detected in dust samples (2006-7)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Roxbury MA</th>
<th>Gadsden County FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorpyrifos</td>
<td>64 %</td>
<td>99 %</td>
</tr>
<tr>
<td>Diazinon</td>
<td>21 %</td>
<td>45 %</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>6 %</td>
<td>27 %</td>
</tr>
<tr>
<td>Chlordane</td>
<td>14 %</td>
<td>35 %</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>35 %</td>
<td>96 %</td>
</tr>
<tr>
<td>cis/trans-permethrin</td>
<td>88 %</td>
<td>100 %</td>
</tr>
<tr>
<td>DDT</td>
<td>44 %</td>
<td>25 %</td>
</tr>
</tbody>
</table>
‘Legacy’ Exposures

Pesticides detected in dust samples (2006-7)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Roxbury MA</th>
<th>Gadsden County FL</th>
<th>Date banned/restricted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorpyrifos</td>
<td>64 %</td>
<td>99 %</td>
<td>2001</td>
</tr>
<tr>
<td>Diazinon</td>
<td>21 %</td>
<td>45 %</td>
<td>2004</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>6 %</td>
<td>27 %</td>
<td>restricted use</td>
</tr>
<tr>
<td>Chlordane</td>
<td>14 %</td>
<td>35 %</td>
<td>1988</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>35 %</td>
<td>96 %</td>
<td>NA</td>
</tr>
<tr>
<td>cis/trans-permethrin</td>
<td>88 %</td>
<td>100 %</td>
<td>NA</td>
</tr>
<tr>
<td>DDT</td>
<td>44 %</td>
<td>25 %</td>
<td>1972</td>
</tr>
</tbody>
</table>
Understanding trends
Other studies

Pesticide loadings of select organophosphate and pyrethroid pesticides in urban public housing

RHONA JULIEN¹, GARY ADAMKIEWICZ⁰, JONATHAN I. LEVY⁰, DEBORAH BENNETT⁰,².

Prenatal Insecticide Exposures and Birth Weight and Length among an Urban Minority Cohort

Robin M. Whyatt,¹ Virginia Rauh,¹ Dana B. Barr,² David E. Camann,³ Howard F. Andrews,¹ Robin Garfinkel,¹ Lori A. Hoepner,¹ Diukka Diaz,¹ Jessica Dietrich,¹ Andrea Reyes,¹ Deliang Tang,¹ Patrick J. Kinney¹ and Frederica Perera²

¹Columbia University, USA; ²Battelle Children’s Institute, USA

Impact of Prenatal Chlorpyrifos Exposure on Neurodevelopment in the First 3 Years of Life Among Inner-City Children

Virginia A. Rauh, ScD³, Robin Garfinkel, PhD³, Frederica P. Perera, DrPH³, Howard F. Andrews, PhD³, Lori Hoepner, MPH³, Dana B. Barr, PhD, DLS³, Ralph Whitehead, MPH³, Deliang Tang, DrPH³, Robin W. Whyatt, DrPH³

³Columbia Center for Children’s Environmental Health, Mailman School of Public Health, Columbia University, New York, New York; ⁴National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, Georgia

The authors have indicated they have no financial relationships relevant to this article to disclose.
What to do??

**INTEGRATED PEST MANAGEMENT**

- Focuses on what pests need for survival
  - Food
  - Water
  - Shelter
  - Access

- Minimizes use of ‘high exposure’ formulations
  - Foggers, aerosols, ‘street’ pesticides

- Uses ‘low exposure’ formulations
  - Baits, gels, traps

- Encouraged by HUD
Energy and our homes

Air exchange in US Homes

What about disparities?

(From Chan et al. 2003, LBL)
Energy Use in our Homes

(Tyrone Turner, National Geographic, March 2009)
Energy Use in our Homes

How Energy Is Used in Homes (2005)

- Space Heating: 41%
- Lighting and Other Appliances: 26%
- Water Heating: 20%
- Air Conditioning: 8%
- Refrigeration: 5%


Energy Use in Commercial Buildings, 2003

- Space Heating: 36%
- Lighting: 21%
- Other: 9%
- Air Conditioning: 8%
- Water Heating: 8%
- Ventilation: 7%
- Refrigeration: 6%
- Computers & Office Equipment: 3%
- Cooling: 3%

Source: U.S. Energy Information Administration, 2003 Commercial Building Energy Consumption Survey; Table E1A (September 2008).
Climate Change, the Indoor Environment, and Health by Committee on the Effect of Climate Change on Indoor Air Quality and Public Health, By Institute of Medicine

Released June 2011

http://www.iom.edu/Activities/PublicHealth/ClimateIndoorAir.aspx
Achieving multiple goals

• Safe
• Affordable
• GREEN
• Sustainable
• Renewable
• Energy-efficient
• High performance
• HEALTHY

(Getty/EHP, 2008)
Trade-offs

Contaminant levels vs. Ventilation

Energy usage / costs

Must think about related benefits of IEQ
Trade-offs

Remember – the home is a system!

• Weatherization can improve IAQ, but can also lead to problems
• Renovations can change dynamics
• **Air sealing** can lead to increased humidity, increased environmental exposures, backdrafing, and changes in airflow patterns which decrease IAQ
Secondhand smoke / ETS

Environmental Tobacco Smoke (ETS)

- Secondhand smoke contains more than 4,800 chemicals, of which at least 60 are known to cause cancer
Secondhand smoke / ETS

- There is **no safe level of secondhand smoke exposure.** Period.

- **Health effects:**
  - lung infections
  - ear problems
  - SIDS
  - asthma
  - lung cancer (20-30% increase)
  - coronary heart disease (25-30% increase)

- Some groups may be more **susceptible**
Smoke-free housing

- Smoke travels between units through air ducts, cracks in the walls and floors, elevator shafts, and electrical lines; and,
- Ventilation systems and engineering fixes do not eliminate secondhand smoke; so,
- Eliminating indoor smoking in multiunit housing is the only way to completely protect people from exposure
All buildings have unintended air pathways
In multifamily, this occurs
  • between units
  • between units and common areas
  • between units and outdoors

Common pathways:
  • pipe penetrations
  • doors/windows

There is no effective way to eliminate all paths for SHS movement

• Eliminating indoor smoking in multiunit housing is the only way to completely protect people from exposure
Smoke-free housing

Recent study: NCI-funded study of housing developments in Cambridge, Somerville and Chelsea

Major findings
- Measurable levels of nicotine in all but one non-smoking unit
- In some units, equivalent to almost a cigarette per day
- Residents who reported smelling cigarettes smoke from other units frequently had higher levels of nicotine in the air
Smoke-free housing

Recent study: NCI-funded study of housing developments in Cambridge, Somerville and Chelsea

These results are consistent with SHS moving between units or between common areas and units.
So, what to do?
Making change

**Programs, policies, systems**

- Keys to success:
  - Address root causes
  - Understand systems
  - Every **encounter** is an opportunity
    - people
    - Homes
  - Need new partnerships

**Households, families**
Making change

Boston Housing Authority

- Integrated Pest Management
- Green and Healthy Housing
- Smoke-Free Housing (10.1.12)
BIG PICTURE

• Health disparities can be driven by environmental exposure disparities

• Environmental exposures are driven by sources, structure and behavior

• Housing hazards and environmental exposures tend to cluster within communities

• How do we move forward?
  • ADDRESS ROOT CAUSES
  • ADDRESS MULTIPLE HAZARDS
  • SUPPORT PROGRAMS
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  - Glorian Sorensen, John D. Spengler, Amy E. Harley, Anne Stoddard, May Yang, Marty Alvarez-Reeves, Reggie Tucker-Seeley, Lorraine Wallace, Ruth Lederman, Mike Massagli
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