Controlled Studies of Environmental Allergen Remediation in U.S. Homes:

Cockroach Allergen

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Outline for Today’s Talk

1. Cockroaches
2. Relationships with allergy and asthma
3. NIEHS remediation studies
Cockroaches: Their Behaviors and Their Allergens
Common Indoor Cockroaches

American

Oriental

Brown-banded

German

University of Nebraska-Lincoln
http://pested.unl.edu/comproa.jpg
The German Cockroach
(Blattella germanica)

University of Nebraska-Lincoln
http://pested.unl.edu/gerroa.jpg
Cockroaches need a food source
Cockroaches need a water source
Cockroaches need shelter
Cockroach Allergens

• German cockroach
  – Bla g 1
  – Bla g 2
  – Bla g 4
  – Bla g 5
  – Bla g 6
  – Bla g 7

• American cockroach
  – Per a 1
  – Per a 3
  – Per a 7

Bla g 2 molecular model
Detectable concentrations of cockroach allergen were found in at least one sampling location of an estimated 63% of U.S. homes.

**Table 1.** Estimated distribution of cockroach allergen concentration and load in U.S. homes.

<table>
<thead>
<tr>
<th>Sampling location</th>
<th>No. of homes sampled</th>
<th>Percent detectable (SE)</th>
<th>Percent &gt; 2.0 [U/g (SE)]</th>
<th>Percent &gt; 8.0 [U/g (SE)]</th>
<th>Median(^a) detectable concentration (U/g)</th>
<th>Median(^a) detectable load (U/m(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom bed</td>
<td>767</td>
<td>6.1 (0.8)</td>
<td>1.3 (0.4)</td>
<td>0.5 (0.2)</td>
<td>0.292</td>
<td>0.037</td>
</tr>
<tr>
<td>Bedroom floor</td>
<td>762</td>
<td>17.6 (1.6)</td>
<td>6.7 (0.8)</td>
<td>3.2 (0.7)</td>
<td>0.769</td>
<td>0.251</td>
</tr>
<tr>
<td>Kitchen floor(^b)</td>
<td>764</td>
<td>28.5 (1.9)</td>
<td>13.4 (1.3)</td>
<td>9.5 (1.0)</td>
<td>1.376</td>
<td>—</td>
</tr>
<tr>
<td>Living room floor</td>
<td>763</td>
<td>44.4 (2.1)</td>
<td>10.7 (1.5)</td>
<td>2.7 (0.7)</td>
<td>0.927</td>
<td>0.152</td>
</tr>
<tr>
<td>Living room upholstery(^b)</td>
<td>729</td>
<td>38.4 (2.0)</td>
<td>8.8 (1.2)</td>
<td>1.1 (0.4)</td>
<td>0.779</td>
<td>—</td>
</tr>
</tbody>
</table>

Cohn et al. EHP 2006
Predictors of Blag 1 in U.S. Homes

- High-rise apartments
- Urban settings
- Older homes
- Low household income
- Reported problems with cockroaches
Allergy Skin Test Positivity to German Cockroach in the U.S.

- Who tests positive to cockroach allergen?
  - 26% of total population
  - 41% of asthmatics
  - 50% of minorities with asthma

Data: Third National Health and Nutrition Examination Survey
Prevalence of a Positive Skin Test Reaction in the U.S.

Third National Health and Nutrition Examination Survey
Arbes et al. JACI 2005
HEALTH

Allergy study: Roaches worse than furry pets

Wednesday, March 9, 2005 Posted: 11:15 AM EST (1615 GMT)

WASHINGTON (Reuters) -- Cockroaches worsen asthma symptoms in children far more than furry pets or dust mites, U.S. researchers reported Tuesday.

High-rise apartments in Northeastern U.S. cities were the worst places for the allergic effects of cockroaches, the team at the University of Texas Southwestern Medical Center in Dallas found. Single-family houses were the worst for dust mites -- microscopic creatures that live in bedding and furniture.
Study Finds Asthma In 25% of Children In Central Harlem

By RICHARD PÉREZ-PEÑA
Published: April 19, 2003

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 have doubled since 1980, but no one knows why. New York City is thought to have a higher rate than other major cities, but that, too, is something of a mystery. The disease kills 5,000 people nationally each year.

Previous studies have pointed to rates above 10 percent, and as high as the high teens, in the South Bronx, Harlem and a few other New York City neighborhoods where a long list of environmental factors put people at higher risk. Several asthma researchers say they know of no well-documented level above 20 percent in the United States.
NIEHS Cockroach Allergen Remediation Trials
NIEHS Cockroach Allergen Remediation Trials

- Study 1: Tested a complex intervention
- Study 2: Continuation of Study 1
- Study 3: Tested extermination alone
## Study 1: Design

### Intervention Arm
- 16 homes
- Intervention
  - Cockroach control
  - Family education
  - Professional cleaning
- Sampled dust and trapped roaches at 0, 2, 4, and 6 mons.

### Control Arm
- 15 homes
- No intervention
- Sampled dust and trapped roaches at 0 and 6 months

All homes were within multiunit apartment buildings in a metropolitan area in North Carolina. All had 50-500 trapped cockroaches at baseline.
Study 1: Intervention

• Professional Cockroach Control
  – Conducted by an entomologist from NCSU
  – Monitored cockroach infestation with traps
  – Placed insecticide baits (2% hydromethylnon)

• Professional Home Cleaning
  – Cleaned home thoroughly
  – Washed bed linens and blankets
  – Covered mattresses

• Household Education
  – Remove food sources (provided with food containers)
  – Eliminate water sources
  – Wash bedding weekly (provided with detergent, covers)
  – Vacuum floors (provided with a new vacuum cleaner)
Study 1: Bla g 1 Results

- Living Room Floor and Sofa
- Kitchen Floor
- Bedroom Bed
- Bedroom Floor
Study 1: Conclusions

• Large reductions in Bla g 1 can be achieved

• Optimal reductions in Bla g 1 require:
  – Control of cockroaches
  – Intensive professional cleaning
  – Occupant education
Study 2: Design

- Continuation of Study 1
- Re-enrolled households for an additional 6 mos.
- Original intervention homes
  - Provided extermination at 6 and 9 months as needed
  - No other intervention component was provided
- Control homes
  - Provided extermination at 6 and 9 months as needed
  - No other intervention component was provided
Study 2: Bla g 1 Results

- Living Room Floor and Sofa
- Kitchen Floor
- Bedroom Bed
- Bedroom Floor

Graphs showing the change in Bla g 1 U/g over months for different areas.
Cockroach control alone may be sufficient for large reductions in cockroach allergen.

Large cost savings in a public health program could be realized if professional cleaning was not required.

Results need to be confirmed.

Arbes et al. JACI 2004
Study 3: Objectives

- To examine whether extermination alone can reduce cockroach allergen in inner-city homes
- Determine whether who is doing the extermination matters
  - Entomologist (NCSU) versus
  - Commercial companies
## Study 3: Design

### NCSU Arm
- 20 homes
- NCSU provided roach control
- Trapped at 0, 1, 3, 6, 9, and 12 months
- Sampled dust at 0, 6, and 12 months

### Commercial Arm
- 20 homes
- 12-month pest control contract
- Trapped at 0, 1, 3, 6, 9, and 12 months
- Sampled dust at 0, 6, and 12 months

### Control Arm
- 20 homes
- No intervention
- Sampled dust and trapped at 0, 6, and 12 months

All homes were within multiunit apartment buildings
Metropolitan area in North Carolina
All had 50-1000 trapped cockroaches at baseline
Results: Cockroach Counts

![Graph showing the median cockroach count over months for different treatments. The graph compares Control, Commercial, and NCSU treatments. The median cockroach count decreases over time for all treatments, with the NCSU treatment showing the steepest decline.](image-url)
Results: Blag 1 Reductions

Bed

Bla g 1 (Units/gram)

0 6 12

Month

Bedroom Floor

Bla g 1 (Units/gram)

0 6 12

Month

Family Room

Bla g 1 (Units/gram)

0 6 12

Month

Kitchen

Bla g 1 (Units/gram)

0 6 12

Month

Control  Commercial  NCSU
Conclusions

• Relative to control arm at 12 months:
  – NCSU arm had significant reductions from baseline at all locations
  – Commercial arm never significantly beat the controls
• Appears that reductions were dependent upon:
  – Intensity of the pest control
  – Whether infestations were monitored with traps
  – Insecticides and formulations used in pest control
Overall Conclusions

- Exposure and sensitization to cockroach allergen are strong risk factors for asthma
- Cockroach control alone can achieve large reductions in cockroach allergen
- Unknowns
  - Whether the cockroach allergen reductions were low enough to have a clinical benefit
  - Whether an environmental intervention targeting only cockroach allergen could result in reduced asthma morbidity among inner-city children