



BUILDING A FRAMEWORK FOR HEALTHY HOUSING

**Healthy Homes Intervention Expert
Panel Meeting:**

Panel 4 – Structural Deficiencies

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University of Warwick, England**

Our Topics

- Burn Prevention
- Fall Prevention
- Noise Reduction
- Fire Prevention
- Injury Prevention in Hazardous Areas
- Temperature Control



Structural Deficiencies

- Deficiencies for which a builder or landlord (or owner) would take responsibility (design, construction, installation, repair, maintenance).
- Excludes behaviours of household residents such as safely storing poisons, fixing loose rugs, and purchasing non-slip bathmats.
- As well as structural deficiencies, includes monitoring of the structure and behaviour to prevent or correct deficiencies.



“Bucket 1”: Interventions Effective for Reducing Injury

- **Fire Prevention**
 - Working smoke alarms
- **Drowning Prevention**
 - 4-sided fencing around pools
- **Scalds**
 - Legislation for pre-set safe temperatures for water heaters



“Bucket 2”: Promising Interventions Needing More Field Testing

- **Fall Prevention**

- Home safety education to promote stair gates and window guards to prevent child falls
- Home modification to prevent falls in children and older adults - handrails, grab bars, lighting, window guards
- Building codes, e.g., stair & balcony design, window guards



“Bucket 2”: Promising Interventions Needing More Field Testing

- **Fall Prevention (continued)**
 - Community-based, coordinated, multi-strategy initiatives, that include home hazard reduction, targeting older adults



“Bucket 2”: Promising Interventions Needing More Field Testing

Fire Prevention

- Community-based installation of smoke alarms, with education, in high-risk homes
- Building codes and legislation -
 - Smoke alarms, Safe ignition sources (electrical and heating systems)
 - Exits for safe escape, access windows, fire escapes, protected stairways



“Bucket 2”: Promising Interventions Needing More Field Testing

- **Drowning**

- Isolation (4-sided) pool fencing
Ordinances, legislation, building codes to require use
Home- and community-based education/promotion to promote use



“Bucket 2”: Promising Interventions Needing More Field Testing

- **Scalds**
 - Temperature-controlled mixer faucets
 - Voluntary compliance by manufacturers with preset safe temperature on water heaters
 - Home education to reduce temperature of hot water heaters



“Bucket 3”: Interventions in Need of Formative Research

- **Fire Prevention**
 - Design of smoke alarms to optimize efficacy, reliability and long-term function
 - Home- and community-based education / distribution programs to reduce ignition sources (e.g., update wiring, clean chimneys, safe space heaters)
 - Exploration of behaviours to escape fires (in order to inform building design)
 - Acceptability, promotion and adverse effects of automatic fire sprinkler systems



“Bucket 3”: Interventions in Need of Formative Research

- **Fall Prevention**

- What specific home modifications are most effective for reducing older adult falls?
- Effects of community-based, coordinated, multi-strategy initiatives that include home hazard reduction, targeting children

- **Drowning**

- Are pool covers or alarms effective alternatives to pool fencing?
- Do pool covers or alarms add benefit to pool fencing?
- Better designs for bathtubs to protect all ages



“Bucket 3”: Interventions in Need of Formative Research

- **Scalds/burns**
 - Use and acceptability of anti-scald technology
 - Community-based education for safe hot water temperature
 - Community-based, coordinated, multi-strategy initiatives for families with children aged <14 years
 - Design of stoves and stove controls
- **Carbon Monoxide**
 - Behavioural, legislative, design and engineering interventions to reduce CO exposure



“Bucket 3”: Interventions in Need of Formative Research

- **General injuries**
 - Safety-related building codes and legislation: effect of enforcement and/or incentives and/or specific language
 - Interactions among range of structural hazards, e.g., falls & CO
 - Innovation around experimental design and evaluation of residential hazards, e.g., lab testing of electrical wire coating



“Bucket 4”: Interventions Shown to be Ineffective

Older Adult Falls

- Advice/recommendations alone for home modification
- **Fires**
 - Community-based smoke alarm give-away programs
- **Drowning**
 - Three-sided pool fencing is less effective than four sided (isolation) pool fencing and may be harmful



“Bucket 5”: Need more literature or expertise to make recommendations

- Noise
- Temperature
- Fire ignition and spread (engineering, consumer product safety)
- Structural design to prevent falls & scalds (kitchen)
 - Need architects, builders, engineers



Issues, Research Gaps, Challenges, Concerns...

Methodological issues:

- Few studies evaluated injury outcomes and many had a small sample size
- Investigators should develop and use standardized tools and measures of home hazards, interventions and outcomes
- Multi-factorial interventions should be evaluated using a factorial design to assess specific interventions. However, if a multi-factorial intervention is shown to be effective in reducing injuries, it is not essential that the individual components be evaluated separately before the intervention can be recommended for implementation.



Issues, Research Gaps, Challenges, Concerns...

- Methodologic issues (continued):
 - Hazard reduction studies should measure:
 - all applicable outcomes relevant to morbidity and mortality (e.g., stress resulting from loss of property in a house fire; risk of Legionnaires' disease with lower hot water heater temperature)
 - injury outcomes that are directly relevant to the particular hazards being prevented (e.g., effects of reducing hot water temperature on scald burns rather than on total injuries)



Issues, Research Gaps, Challenges, Concerns...

- Federal support of small business innovation research may be a useful approach for intervention development and evaluation
- Cost effectiveness and cost benefits analyses of home safety interventions (e.g., hard-wired smoke detection systems versus automatic sprinkler systems) are needed
- Insurers and other third parties with potential economic interests should be included in development and implementation of interventions to reduce injuries & deaths



Healthy Homes Expert Panel Meeting

Report Out of Findings Panel 1 – Biologic Agents

Jim Krieger, MD, MPH

Public Health – Seattle & King County



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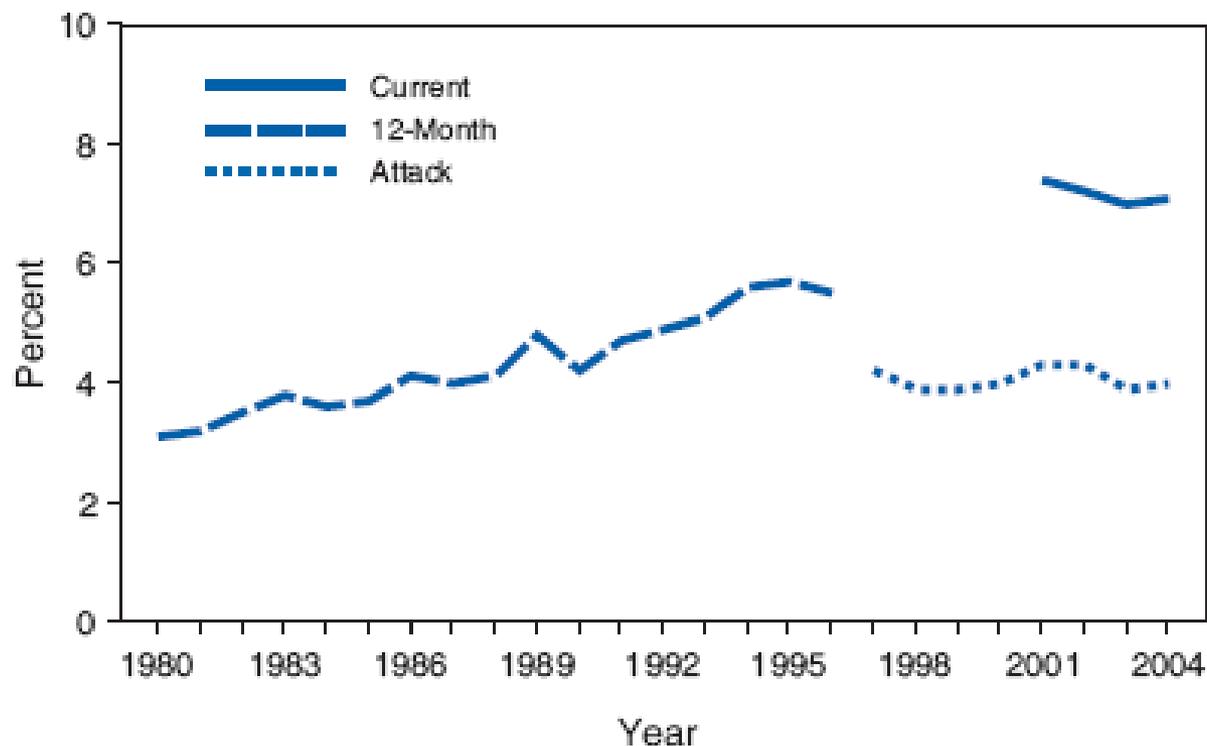


Housing and Health

Many diseases and health behaviors are affected by housing quality:

- ◆ Asthma
- ◆ Injuries
- ◆ Mental Health
- ◆ Brain development
- ◆ Respiratory Infections

Asthma Prevalence Growing



Source: National Health Interview Survey; National Center for Health Statistics.



Normal lung tissue

Asthma



Color plates used with permission from DesJardins and Burton, *Clinical Manifestations & Assessment of Respiratory Disease*, 3E, Mosby, 1995

Asthma Triggers

Allergens

- Dust mites
- Pollens
- Freshly cut grass
- Cockroaches
- Pets (proteins from cats, dogs, birds, rodents, etc.)
- Mice and rats
- Molds and mildew
- Foods (not common)



Housing Conditions and Allergens

Housing Condition	Allergen			
	Mites	Roach	Rodents	Mold
Moisture	X			X
Leaks	X	X	?	X
Structural deficits		X	X	
Flooring	X			
Inadequate heating	X			X

Our Methods

- **Literature search (Medline 1990-2007, English)**
 - ◆ Public Housing, home, intervention studies, health effects, mitigation; program, evaluation, prevention, primary prevention; clinical trials, randomized controlled trials; and domestic; Allergens; Dust; Mites; Asthma; Cockroaches; Animals, Domestic; Mice; Rats
- **Selection of relevant articles**
- **Structured review of selected article**
 - ◆ Design/suitability
 - ◆ Execution
 - ◆ Study size and population
 - ◆ Overall value
 - ◆ Direction of effect and degree of impact

Our Methods

- Review of additional articles from references and panel member suggestions
- Presentations of reviews to expert panel
- Consensus in categorizing interventions according to strength of evidence for either improved *clinical outcomes* or *exposure reduction*
 - ◆ Sufficient evidence
 - ◆ Need more field testing
 - ◆ Need more formative research
 - ◆ Ineffective

Our Methods

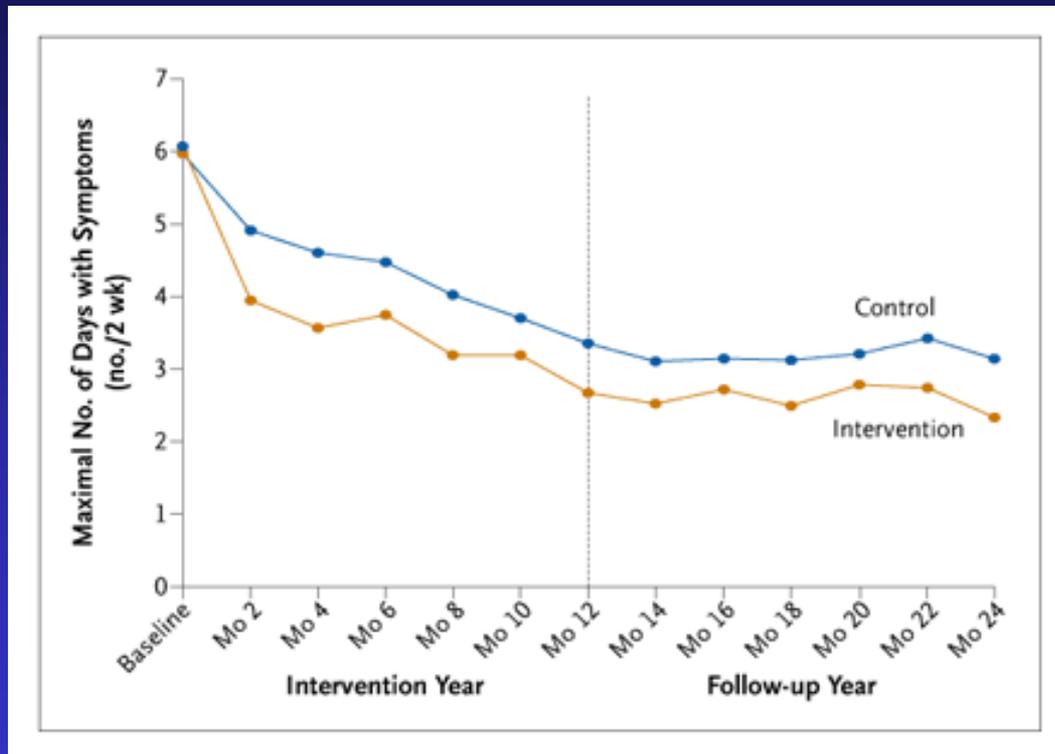
Sufficient Evidence

- **“Improvements in health or leads to changes in behaviors or other factors that have been shown to result in better health.”**
- **Demonstrate independent impacts on health or key factors that will result in better health**
- **Small number of well designed, well executed and consistent studies OR**
- **Larger group of studies which may be less strong in design, execution, and effect but taken together provide convincing evidence**

Sufficient Evidence of Clinical Impact

- **Multi-faceted tailored home interventions for asthma**
 - ◆ Education (Social learning theory)
 - ◆ Mattress and pillow covers
 - ◆ HEPA Vacuum
 - ◆ HEPA Air Filter (subset)
 - ◆ Smoking Cessation
 - ◆ Cockroach Extermination
 - ◆ Bedroom cleaning
- **Examples**
 - ◆ Inner City Asthma Study
 - ◆ Seattle-King County Healthy Homes

****Inner City Asthma Study****



**21 fewer days
with Sx per
year in
intervention
group**

Figure 2. Mean Maximal Number of Days with Symptoms per Two Weeks. The difference between the groups was significant in both the intervention year ($P < 0.001$) and the follow-up year ($P < 0.001$).

Sufficient Evidence of Exposure Reduction

- **Cockroach Mgt**
 - ◆ **Integrated pest management**
 - Household cleaning and tool dispensing
 - Professional cleaning
 - Resident education
 - Baits
 - Structural repairs
- **Interventions to reduce asthma triggers (*when combined*)**
 - ◆ **Mattress encasements**
 - ◆ **Hot wash**
 - ◆ **Eliminating moisture intrusion (limited evidence)**
 - ◆ **Removal of moldy items and/or visible mold (limited evidence)**

Roach Elimination Integrated Pest Management

Treatment 1: IPM
by entomologists

Treatment 2:
Commercial

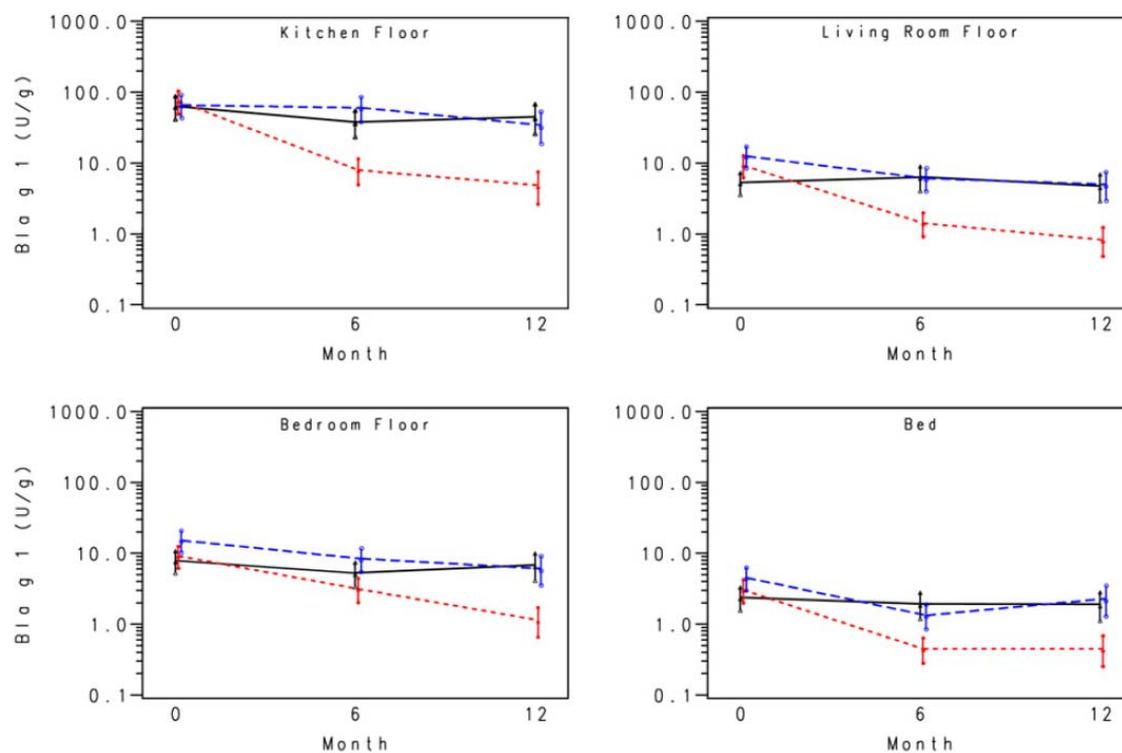
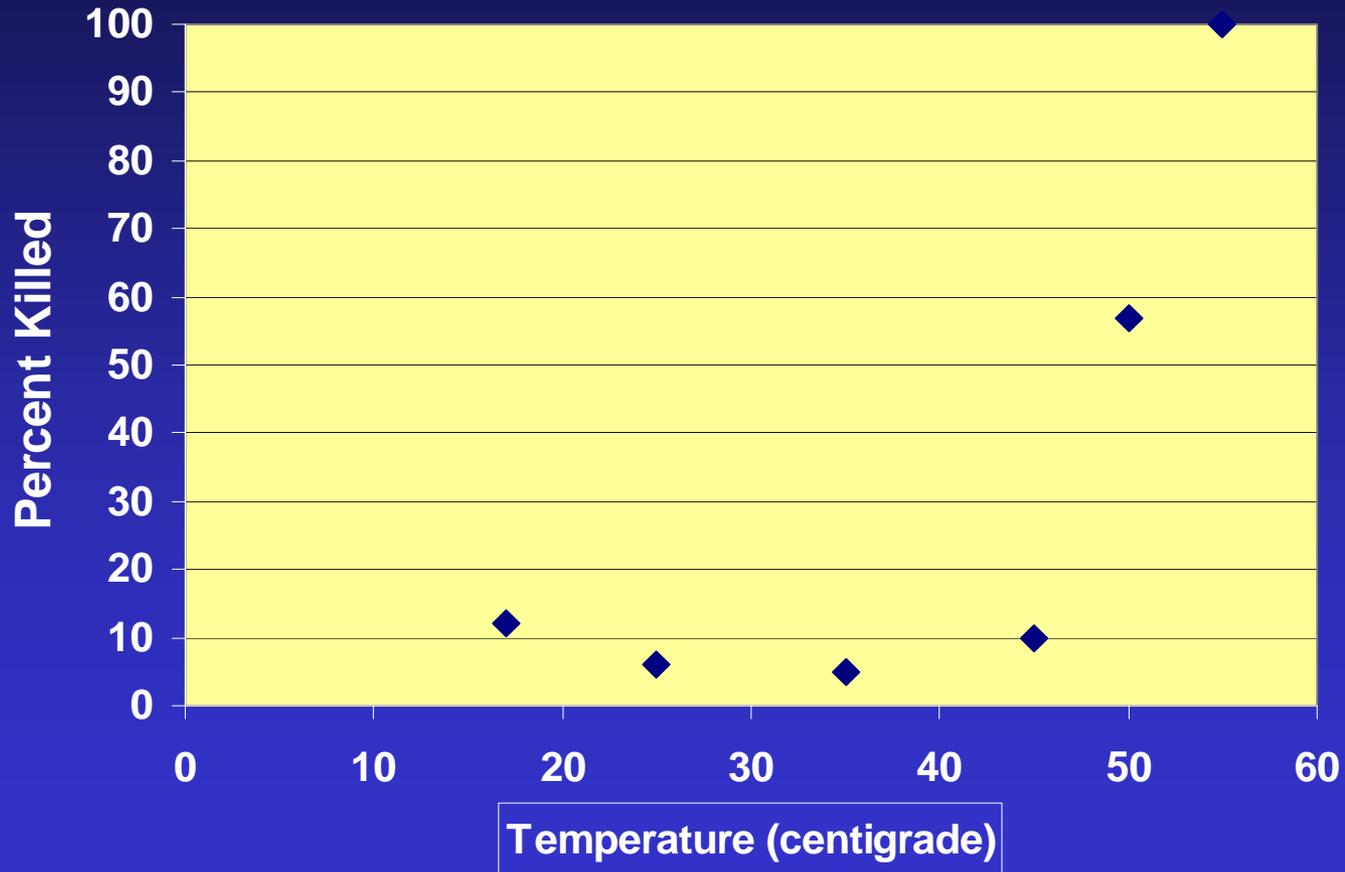


FIG 1. Geometric mean Bla g 1 allergen concentrations (and SEs) from vacuumed dust samples in control (solid line), treatment 1 (red dashed line), and treatment 2 (blue dashed line) homes.

Mite Elimination Hot Washing



Moisture Remediation

Table 4. Mold scores [mean \pm SD (*n*)].

Time point	Control	Remediation	<i>p</i> -Value ^a
Baseline (EV1)	3.03 \pm 1.59 (33)	3.03 \pm 2.16 (29)	0.66
6 months (EV2)	2.72 \pm 1.99 (18)	1.38 \pm 1.75 (26)	0.016
12 months (EV3)	1.68 \pm 1.32 (22)	0.75 \pm 0.99 (24)	0.009
Change EV2 – EV1	–0.28 \pm 2.16 (18)	–1.42 \pm 2.69 (26)	0.09
Test of change ^b	0.56	0.003	
Change EV3 – EV1	–1.45 \pm 2.02 (22)	–2.58 \pm 2.10 (24)	0.07
Test of change ^b	0.0003	< 0.0001	

^aBetween-group differences; Wilcoxon rank-sum test at EV1, EV2, EV3; test from mixed model adjusting for season of the year when comparing changes EV2 – EV1 and EV3 – EV1. ^bWithin-group differences; *p*-value for test of whether change is equal to zero, adjusting for season of the year.

Promising Clinical Impact... Need More Field Testing

- **Moisture control**
 - ◆ Dehumidification
- **Ventilation**
 - ◆ Heat recovery ventilation (mechanical ventilation)
 - ◆ Local exhaust



Ventilation

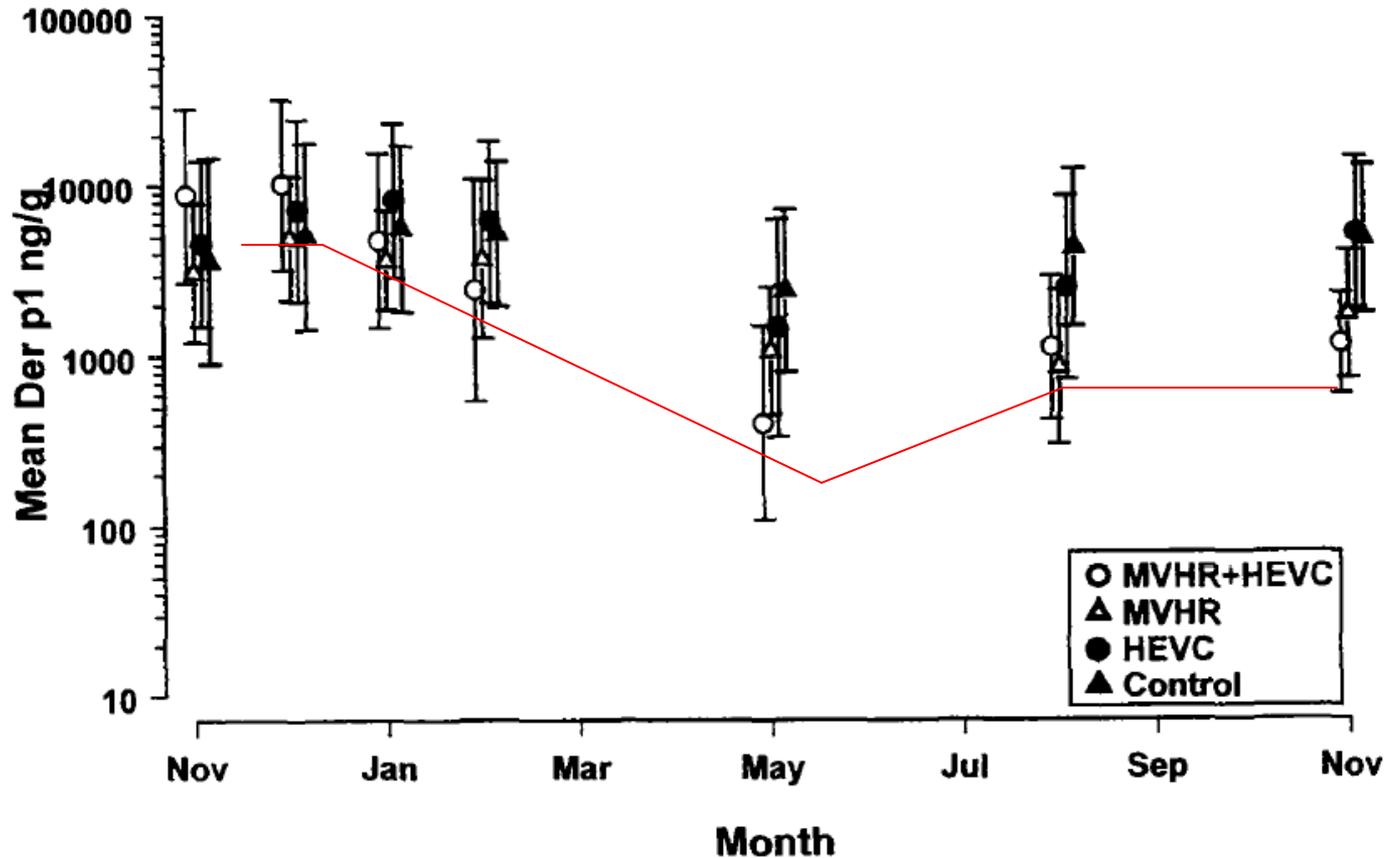


FIG 3. Log Der p 1 (in nanograms per gram of dust) in the bedroom carpet in the 4 groups over the 12-month intervention period. Ninety-five percent confidence intervals are shown.

Promising Exposure Reduction... Need More Field Testing

- **Repeated Dry-Steam Cleaning**
 - ◆ Results transient and cleaning needs repeating
- **Repeated Vacuuming**
 - ◆ Results transient and cleaning needs repeating
- **HEPA Air Cleaners**
 - ◆ Reviewed by panel 2

Steam Cleaning

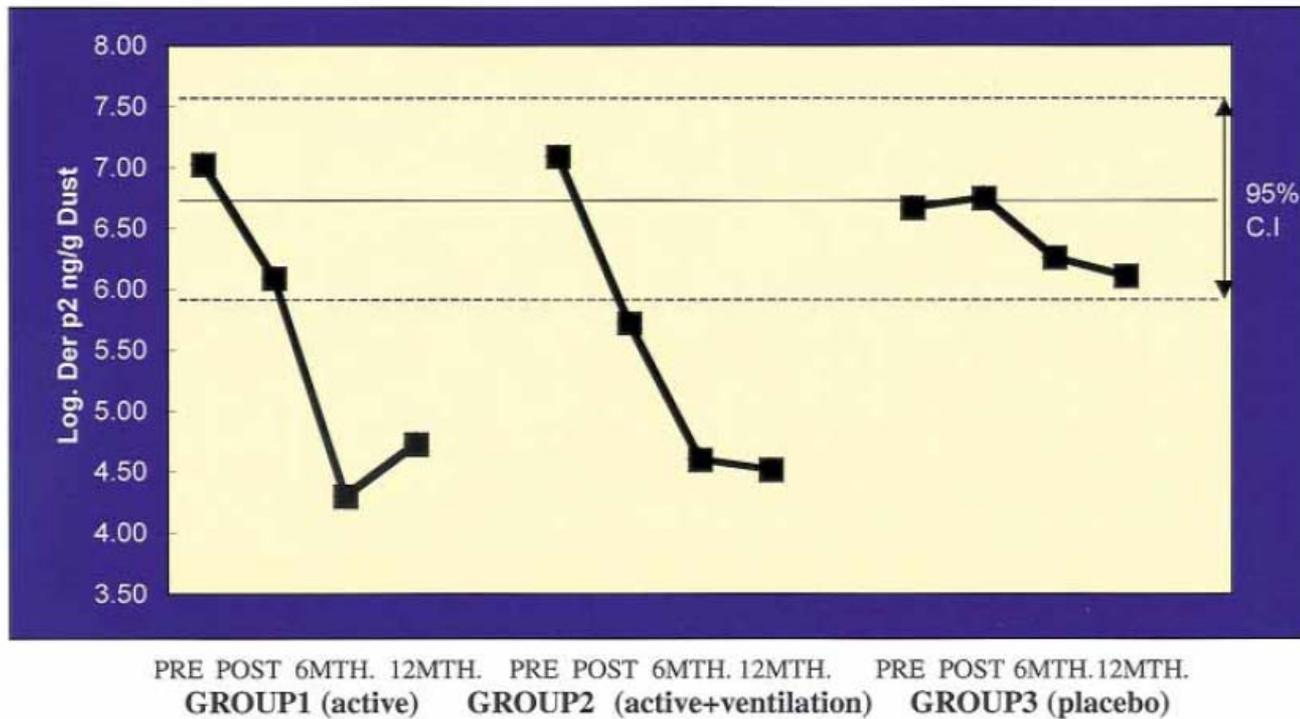


FIG 2. The logarithm-transformed mean and Der p 2 in nanograms per gram of mattress dust and 95% confidence interval constructed from the residual variance to compare the placebo group with the active groups. Der p 2 is a body protein, and the levels may represent the mite population. The posttreatment Der p 2 concentrations of the actively treated groups, but not the sham-treated group, fell below the baseline and remained low for 12 months. There is a significant difference between groups with time ($P = .001$) with ANOVA.

Need of Formative Research

- **Carpet Treatments**
 - ◆ **Carpet composition**
 - ◆ **Carpet removal**
- **Education only**
- **One-time Professional Cleaning**
- **Acaracides**

Ineffective on Clinical Outcomes

- **Not effective in isolation**
 - ◆ Bedding Encasement
 - ◆ Bedding Washing
 - ◆ Upholstery cleaning
- **Ineffective and possibly harmful**
 - ◆ Ozone-emitting air cleaners

Limitations

- **Generalizability**
 - ◆ **Mainly high-risk families**
 - ◆ **More severe asthma**
- **Some studies show exposure reduction and others improved clinical outcome, but few show both**
- **Wide variation in methods used to assess exposures and housing conditions**

Caveats

- Distinguish between “home” and “housing” interventions
- Distinguish between new construction and remediation
- Regional/climate features interact with interventions, making local tailoring important

Research Issues

- **Importance of control group when studying clinical outcomes**
- **Better understanding of correlation between observational, self-report and lab measurements**
- **Agreement on standardized health outcome measures and lab reference standards**
- **Inclusion of multivariate and hierarchical analytic methods**

Conclusions

- **Because homes contain multiple triggers, interventions with sufficient evidence are multi-faceted and holistic.**
 - ◆ Multi-component home educational interventions
 - ◆ Integrated pest management
 - ◆ Integrate mite reduction strategies
- **Several mechanical interventions are promising**
 - ◆ Cleaning
 - ◆ Ventilation
 - ◆ Moisture control



BUILDING A FRAMEWORK FOR HEALTHY HOUSING

2008 National Healthy Homes Conference

Healthy Homes Expert Panel: Panel 5 Results

Intersection between housing and community

Presented by Edmond Shenassa, Panel 5 Chair

Panel 5 Topics

Housing policy

Rental vouchers

Urban design

Connectivity

Density

Mixed Use

Green space

Housing design

Access

Safety

Community

Safety

Poverty

Residential segregation



Bucket 1: Interventions ready for implementation or expansion



Bucket 1

Rental vouchers

Voucher holders are ...

... less likely to suffer from homelessness, overcrowding, and malnutrition

... able to reside in lower-poverty neighborhoods compared to those in public housing



Bucket 2: Promising interventions needing more field testing



Bucket 2

Mixed-income communities

MTO:

Lower obesity; improved mental health

Minority access to suburban neighborhoods may improve employment rates and education access

Negative impacts on boys: higher rates of injury; substance abuse

Latest follow-up: no improvements in asthma, blood pressure, or alcohol use



Bucket 2

HOPE VI – Resident relocation to improve safety

Relocated residents living in neighborhoods with lower poverty and crime rates

Improvements in safety and reduced fear of crime

Low likelihood of return to new mixed-income housing

No impact on: employment rates; racial segregation



Bucket 2

Health Impact Assessments

Can influence developers' proposals to provide for additional affordable housing

An effective planning and policy tool

No data on health impacts



Bucket 3: Interventions in Need of Formative Research



Bucket 3

Universal design

**Urban planning (smart growth; connectivity;
zoning; density bonuses)**

Crime prevention through design

Zoning



Conclusions

- Methodological challenges
- Some support for policies which may impact health indirectly
- Rigorous non-experimental research (e.g., cross-sectoral design) is the best option for evaluating neighborhood level policies

