

A Randomized Controlled Study to Identify the Allergen Concentrations in Homes of Children with Asthma in Milwaukee, WI

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ABSTRACT

Objective:

To identify and reduce allergens in the homes of asthmatic children by home environmental intervention and nurse case management services in the Milwaukee area.

Methods:

151 dwellings were enrolled in the study and placed into either an environmental intervention/case management or control group. Dust samples were collected from 3 different living areas at specified times over a 12 month period. The samples were desiccated, sieved and weighed. A portion of the sieved sample was extracted in PBS before conducting ELISA assays for 7 different allergens linked to asthma.

Results:

A reduction in the dust load from baseline to post-intervention in the intervention group was observed in some instances, but no significant changes were observed in the control group. Allergen detection, in decreasing frequency, in 151 dwellings were: mouse, 100 (68%); dust mite der f1, 68 (45%); cockroach, 64 (42%); dog, 54 (36%); cat, 31 (21%); dust mite der p1, 6 (4%).

Conclusion:

The utility of measuring allergen concentrations in conjunction with home environmental intervention and nurse case management requires further study. Such efforts could potentially identify offending asthma-causing allergens and be used to reduce children's exposure to dust-related allergens in the home. More studies are needed to understand the effect of decreased home allergen exposure on patients with asthma.

INTRODUCTION

Asthma is a chronic respiratory disease characterized by episodes or attacks of inflammation and narrowing of small airways in response to asthma "triggers." Asthma attacks can vary from mild to life-threatening and involve shortness of breath, cough, wheezing, chest pain or tightness, or a combination of these symptoms. A few 2002 asthma statistics from CDC¹ include the following facts:

- 20 million people had asthma
 - 6.1 million children
 - Non-Hispanic blacks and American Indians prevalence was 30% higher and Puerto Ricans 80% higher than non-Hispanic whites.
- 1.9 million visits to emergency departments for asthma
- Hospitalizations were highest among children 0-4 years old
 - Asthma hospitalization rate for blacks was 225% higher than for whites.
- 4,261 people died from asthma - 187 children aged 0-17 years
- Wisconsin averages 6,350 asthma-diagnosed hospitalizations annually with an estimate of 114,000 asthma cases in children under 18 years²

Asthma is an increasingly prevalent chronic illness, affecting inner city children at much higher rates than the general population³. Exposure to indoor allergens, such as cockroach and mouse allergens commonly found in inner-city housing, has been linked to both the development and exacerbation of asthma⁴. There is evidence that some home environmental treatments may reduce allergen concentrations and therefore the number of asthmatic episodes suffered by the child⁵. Studies have also shown the benefits of education and case management in reducing environmental triggers in the home⁶.

The City of Milwaukee Health Department (MHD), in partnership with the Medical College of Wisconsin, Fight Asthma Milwaukee and the National Center for Healthy Housing, developed a randomized, longitudinal control study to assess the value of environmental interventions and nursing case management services on settled dust loads and the amount of allergens in the homes of asthmatic children.

OBJECTIVE

To identify allergens in the homes of Milwaukee asthmatic children and study the effects of reducing dust and various allergen levels by home environmental intervention and nursing case management services.

MATERIALS AND METHODS

Figure 1

City of Milwaukee Public Health Laboratory
Timeline/Logistics for Allergen Test Development
Healthy Homes Asthma Grant

Year	Month	Event
2002	Apr	Lab Proposal
2002	May	
2002	Jun	Lab logistics planning begins
2002	Jul	
2002	Aug	Equipment bids sent
2002	Sep	
2002	Oct	
2002	Nov	
2002	Dec	
2003	Jan	Chemist assigned
2003	Feb	Plate reader received
2003	Mar	
2003	Apr	Chemist trained at Johns Hopkins Lab
2003	May	
2003	Jun	
2003	Jul	
2003	Aug	Conference calls/lab study designs started
2003	Sept	Plate washer received
2003	Oct	Chemist trained at VA Medical Center First environmental samples collected
2003	Nov	
2003	Dec	Test standardization begins Note: isoteric test, no standards/controls = lengthy validation
2004	Jan	
2004	Feb	
2004	Mar	Precision, accuracy, validation achieved
2004	Apr	Study sample testing begins
2004	May	
2004	Jun	First study sample results reported
2004	Jul	60% of sample backlog testing completed
2006	Apr	Testing ends

Study subject selection. Enrollment of 183 children and 151 homes occurred over 18 months, recruited from four pediatric clinics servicing low income children in areas that have the highest asthma hospitalization rates in Milwaukee. Of 290 homes initially screened, 121 met inclusion requirements for statistical analysis and were randomly assigned to either a control (N=64) or an environmental intervention/case management group (N=57) (Table 1).

Sample collection. Dust samples were collected from floors in the kitchen, child's bedroom and the TV room at baseline, immediate post-intervention (intervention group only), 3 months, 6 months, and 12 months by using a specialized dust collector attached to the vacuum cleaner (Johns Hopkins DACI lab, Baltimore, MD).

Sample processing. Dust samples were desiccated, sieved and weighed. A portion of the sieved sample was extracted in PBS-Tween 20 (pH 7.4) and stored at -20°C until tested.

Allergens. Seven (7) different allergens were tested during the study (Table 2). The TV room floor was analyzed for the presence of dust mites (*der f1*, *der p1*), cockroaches (*bla g1*, *bla g2*), mouse (*mus m1*), dog (*can f1*) and cat (*fel d1*). The kitchen floor was analyzed for the cockroach and mouse allergens and the child's bedroom floor was analyzed for dust mites. Over 6,500 allergen assays were run.

Allergen analysis. ELISA assays were used as the method of analysis, using allergen detection kits from Indoor Biotechnologies (Charlottesville, VA) and analyzed on a Bio-Tek PowerWave XS plate reader using Bio-Tek's KCJunior microplate data analysis software (Winoski, VT).

Validation and quality assurance. Due to lack of available reference materials, five split field samples were analyzed by MHD, Indoor Biotechnologies and the University of Cincinnati's Kettering laboratories (Cincinnati, OH) to verify laboratory reproducibility. In order to assure assay quality and accuracy, each plate was set up to include a set of two samples of known value sent by the Battelle Laboratory (Columbus, Ohio) and a replicate analysis of an earlier positive sample to monitor laboratory performance during the study. Shared split samples were analyzed both by the City of Milwaukee Health Department and the University of Cincinnati throughout the study.

Table 1

Control Group	Intervention Group
• Minimal educational materials	• Minimal educational materials
• Bed/pillow casings	• Bed/pillow casings
• Lead abatement (as needed)	• Lead abatement (as needed)
	• Multiple nursing care management visits
	• Minor home repairs (as needed)
	• Specialized cleaning
	• Integrated pest management (as needed)

Figure 2

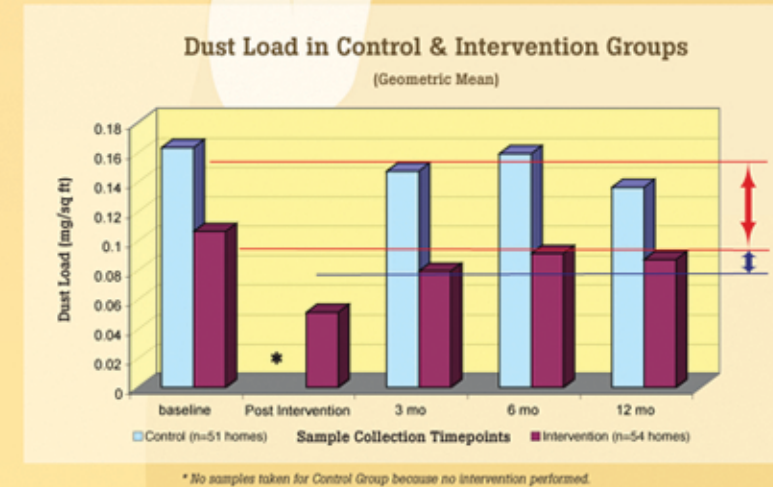


Figure 3

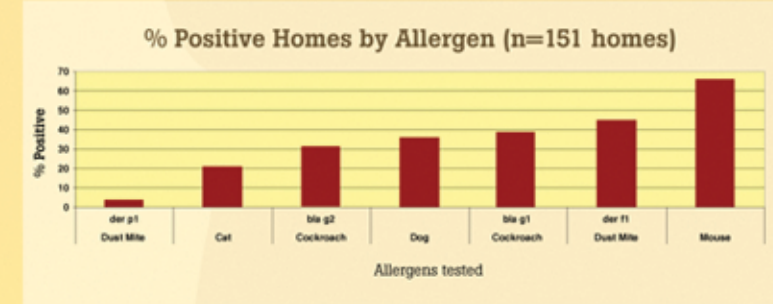
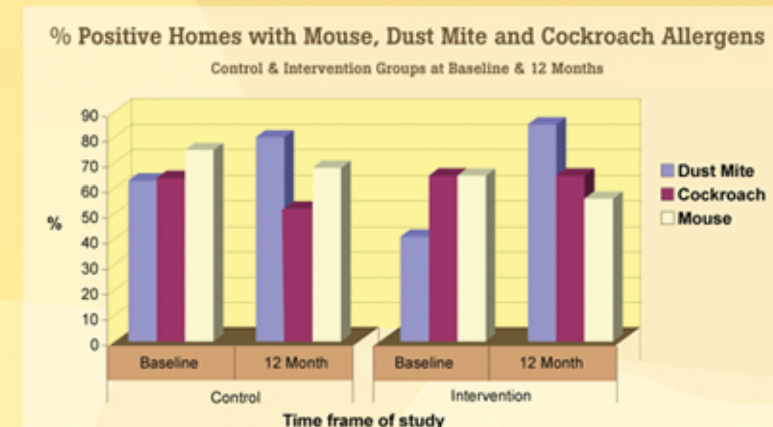


Figure 4



RESULTS

- Homes with high baseline dust loads remained higher throughout the study than the homes that started with a low baseline level, although intervention resulted in a significant drop in dust from baseline (Fig. 2).
- Dust levels rose slowly after intervention, but stayed below baseline levels. (Fig. 2).
- A significant reduction in the dust load from baseline to post-intervention in the homes of the intervention group was observed, which remained unchanged in the homes of the control group (Fig 2).
- The dust loads were significantly higher in winter samplings than during summer.
- The mouse allergen was the most frequently detected (68%), followed by dust mite (45%) and cockroach (42%) allergens. (n = 151 homes) (Fig. 3).
- Allergen concentrations in any particular home did not vary significantly throughout the study, with or without intervention. (Fig. 4).
- There was a significant reduction in post-intervention prevalence of persistent asthma symptoms compared to the control group

CONCLUSIONS

- Nurse case management and home environmental intervention may significantly reduce dust load, limiting children's exposure to allergens and decrease asthma or related respiratory illness in the community.
- Monitoring concentrations of recognized home allergens in asthmatic children may provide some insight into the dynamics of asthma triggers.
- To better validate analysis of environmental allergens there is a need for reference controls or known standards.
- The public health laboratory can play a key role in evaluating and understanding the causes of asthma as well as the effectiveness of asthma interventions.

REFERENCES

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4. Eggleston et al. 2001. J Allergy Clin Immunol. Vol. 107(3 Suppl), p 403
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6. Petronella et al. 2003. Nurs Clin North Am. Vol. 38(4), p 725.

ACKNOWLEDGMENTS

1. Funded by US Department of Housing & Urban Development (HUD) Healthy Homes Demonstration grant to the City of Milwaukee Health Department (# WILH0108-02)
2. The residents and home-owners in Milwaukee area who kindly allowed their homes to be included in this study
3. The staff of MHD for collecting the dust samples for the study
4. DACI lab, Johns Hopkins University (Baltimore, MD); Kettering laboratories, University of Cincinnati, Cincinnati, OH; Battelle laboratory (Columbus, OH); National Center for Healthy Housing (Columbia, MD)
5. Nancy Hills, MHD Graphics

Table 2

WHO Allergen Designation	Related Allergen	Description
<i>Der f</i>	Dust Mite (<i>Dermatophagoides farinae</i>)	<i>Der f</i> measures the dust mite, <i>Dermatophagoides farinae</i> . <i>Der f</i> is found in most homes in the United States.
<i>Bla g</i>	Cockroach (<i>Blattella germanica</i>)	<i>Bla g</i> measures the amount of German cockroach allergen in the home. German cockroach is very prevalent throughout the United States.
<i>Can f</i>	Dog (<i>Canis familiaris</i>)	<i>Can f</i> measures the amount of dog allergen in the home.
<i>Fel d</i>	Cat (<i>Felis domesticus</i>)	<i>Fel d</i> measures the amount of cat allergen in the home.
<i>Mus m 1</i>	Mouse (<i>Mus musculus</i>)	<i>Mus m 1</i> measures the amount of mouse allergen in the home.

Sample of an Allergens Result/Report Form

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Allergen Test Report Form
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