Cincy Cockroach Reminds of Dangers of Poor Pest Control

Baits are essential to effective cockroach control. In housing, they have generally replaced fogs and sprays. However, cockroaches are adapting to avoid the baits – reducing the baits' effectiveness. Property managers need to adopt an integrated pest management (IPM) program that includes housekeeping, maintenance, and targeted monitoring, to reduce the need for chemical controls, including baits.

Cincinnati housing has its own cockroach strain. Dubbed the "Cincy cockroach" in a 2004 report by researchers at Purdue University, the cockroaches developed "bait aversion." The cockroaches avoided gel baits with certain sweeteners most cockroaches cannot resist.[1] The sugars are fructose, glucose, maltose, and sucrose. Cincinnati is not alone. A gel bait manufacturer reports that bait-averse cockroaches are in every major city.[2] Put simply, the cockroaches lost the "sweet tooth" that made them so vulnerable to the pesticide in the baits.

The Cincy cockroach also developed a limited resistance to two common active ingredients in baits – abamectin and fipronil. Resistance means that the species has evolved so the active ingredients are not as effective against the pest.

The researchers, Changlu Wang, Michael Scharf, and Gary Bennett, published a follow-up study in 2006.[3] The researchers found that, in breeding the Cincy cockroach with a cockroach strain without the bait aversion characteristic, some of the offspring had bait aversion. The trait was inheritable. Once the trait is inheritable, then it is likely to spread.

The researchers found that the Cincy cockroaches paid a price for this new genetic trait – the egg cases were smaller and had lower number of eggs in each case.[4]

Why Cockroaches?

Live cockroaches, as well as their remains and feces, cause asthma attacks in people sensitive to cockroach allergens according to a 2000 Institute of Medicine Report. The Inner City Asthma Study found that more than 60% of inner city children were sensitive to cockroach allergens. Asthma is a costly disease that disrupts a family and undermines a child's ability to learn. There is growing evidence that mice might have a similar effect.

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IPM is a commonsense approach to pest management to keep pests out, reduce their harborage, food and water, and, where necessary, use low risk pesticides.

[1] Wang, Scharf, and Bennett, 2004, *Behavioral and Physiological Resistance of the German Cockroach to Gel Baits*, J. Econ. Entomol. 97(6): 2067-2072. See http://entnemdept.ufl.edu/Wang_et_al_(gel_bait_aversion).pdf

[2] Email correspondence with Gordon Morrison of Bayer Environmental Science. See also Miller and McCoy, 2005, *Comparison of commercial bait formulations for efficacy against bait averse German cockroaches*. pp. 115-121. Proceedings of the 5th International Conference on Urban Pests. Singapore. Bao, and Macom, 2005, *Resurrection of bait aversion and management strategies for the German cockroach*. pp. 73-79. Proceedings of the 5th International Conference on Urban Pests. Singapore.

[3] Wang, Scharf, and Bennett, 2006, *Genetic Basis for Resistance to Gel Baits, Fipronil, and Sugar-Based Attractants in German Cockroaches*, J. Econ. Entomol. 99(5): 1761-1767. See www.level1diet.com/research/id/475930.

[4] Wang, Scharf, and Bennett, 2004, *Behavioral and Physiological Resistance of the German Cockroach to Gel Baits*, at 2067.

Fortunately, the bait manufacturers modified their bait formulations to attract strains of bait-averse cockroaches. They used new active ingredients to address the resistance issue. The researchers found that these reformulated baits were effective.[5]

In the 2004 study, the researchers concluded that "First, rotating gel baits containing different active ingredients apparently will not circumvent this form of resistance. Second, cockroaches will likely develop similar behavioral resistance in response to other inert gel bait matrix ingredients after repeated exposure. Although better control can be achieved by changing the bait matrix, efficacy is likely to diminish over time if current management practices are not revised."[6]

This news is not a surprise. Studies in 1995 and 1997 demonstrated that cockroaches were beginning to adapt through bait aversion.[7]

The lesson remains: Chemical controls as the first – or only – line of defense against residential cockroach infestations are not and effective means of pest management. Cockroaches have an uncanny ability to adapt to pesticides just as bacteria adapt to antibiotics if not effectively eliminated. .

The warning is especially serious in light of two reports on the health threats posed by cockroaches. In 2000, the National Academy of Science concluded that cockroaches and the debris they leave behind trigger asthma attacks in sensitive children.[8] The 2005, Inner City Asthma Study found that more than 60% of inner city children have been sensitized to cockroach allergens – most likely as a result of early and sustained exposure.[9] Children in public housing are most likely to live in the inner city. Controlling cockroaches is an important method to protect these children from asthma attacks.

We have compelling reasons to use the best available tools to protect residents from cockroaches – for their health today and for the future.

Integrated pest management (IPM) is the best available approach to pest management. Studies by Purdue University at Gary Housing Authority in Indiana[10] and the experiences of many pest management professionals in the field make this point clear. Traditional pest control is less effective than IPM. Because it controls cockroaches more effectively, IPM:

- Makes better use of limited resources;
- Reduces cockroaches in housing;
- Helps prevent asthma attacks among residents;
- Improves the quality of life for residents; and
- Provides effective long-term pest control, meaning fewer call-backs and complaints.

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[5] Id. See Miller and McCoy 2005; Bao and Macom 2005.
[6] Id at 2071.
[7] Ross and Silverman, 1995, *Genetic studies of a behavioral mutant, glucose aversion, in the German cockroach*, Journal of Insect Behavior, 8(6): 825-834 and Ross, M. H., and J. Silverman. 1995a. *Genetic studies of a behavioral mutant, glucose aversion, in the German cockroach*, J. Insect Behav. 8: 825Ð834.
[8] Institute of Medicine, 2000, *Clearing the Air: Asthma and Indoor Air Exposures. Executive Summary* Institute of Medicine, ISBN 0-309-06496-1. See www.nap.edu/books/0309064961/html/.
[9] Rebecca Gruchalla, et al, 2005, *Inner City Asthma Study: Relationships among sensitivity, allergen exposure, and asthma morbidity*, J. Allergy Clin. Immunol.
[10] Changlu Wang and Gary W. Bennett, 2006, *Comparative Study of Integrated Pest Management and Baiting for German Cockroach Management in Public Housing*, J. Econ. Entomol. 99(3): 879-885.

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This case study was prepared by the National Center for Healthy Housing through a contract with U.S. Environmental Protection Agency's Office of Pesticide Programs and Battelle.

Comparison of Cost and Effectiveness for Cockroach Control

Two leading researchers on pest control in public housing studied the effectiveness and costs of implementing progressive pest control interventions based on integrated pest management (IPM). The studies show that vacuums and baits are much more effective at controlling cockroaches than traditional baseboard, and crack and crevice treatments. They also show that the more elements of IPM used, the more effective it will be. The studies indicate IPM costs more initially but, over time, can actually lower monthly pest management costs. However, this analysis did not include the benefits to residents (e.g., reduced asthma or stress) from effective pest control and reduced burden on staff and management in responding to pest complaints. Property managers and pest management professionals need to use the latest methods to effectively control cockroaches.

In a 2004 study, Dini Miller of Virginia Tech and Frank Meek of Orkin compared IPM-based methods that relied on cockroach vacuums, baits and insect growth regulators (IGRs) with traditional approaches that include baseboard spraying and borate dusts for cracks and crevices.[1] They found that the Integrated Pest Management-based (IPM-based) approach was dramatically more effective than traditional methods. Pesticide use was cut by more than 50 times from 827 grams per unit to less than 15 grams per unit. Eighty percent of the units were cockroach-free after one year compared with 6 percent before IPM treatment. The number of cockroaches trapped per unit dropped almost as dramatically. While the total cost per unit for IPM-based treatment over a year was more - $25.70 v. $10.43 – primarily due to the initial vacuuming, **at the end of the study, the monthly cost per unit was approximately 60% less - $0.87 for IPM v. $1.52 for traditional control.**

In 2006, Purdue University's Changlu Wang and Gary Bennett compared a broader IPM program to a bait-only treatment for cockroach control.[2] In essence, they added education, trapping, and housekeeping intervention to the IPM-based approach used by Miller and Meek. They did everything reasonably expected of a pest management professional. However, they did not incorporate critical maintenance steps, which include sealing cracks, eliminating moisture intrusion, and physically blocking cockroach entry and movement.

Why Cockroaches?

Live cockroaches, as well as their remains and feces, cause asthma attacks in people sensitive to cockroach allergens according to a 2000 Institute of Medicine Report. The Inner City Asthma Study found that more than 60% of inner city children were sensitive to cockroach allergens. Asthma is a costly disease that disrupts a family and undermines a child's ability to learn. There is growing evidence that mice might have a similar effect.

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IPM is a commonsense approach to pest management to keep pests out, reduce their harborage, food and water, and, where necessary, use low-risk pesticides.

In this study, pesticide use decreased by more than two-thirds, and at one point all of the IPM-based units were cockroach free. Only one unit had a serious housekeeping relapse after showing initial promise. Although the IPM method cost nearly doubled the bait-only methods over the six months of the project - $65 to $35, it is likely more aggressive management support for housekeeping and better maintenance would have reduced this difference, especially over time.

Neither study calculated the following cost savings from IPM:

- Benefits to the health and well-being of residents from a cockroach-free home;

[1] Miller, D. M., and F. Meek.,2004, Cost and efficacy comparison of integrated pest management strategies with monthly spray insecticide applications for German cockroach control in public housing, J. Econ. Entomol. 97: 559-569. See web.ento.vt.edu/ento/project.jsp?projectID=21.
[2] Wang and Bennett, 2006, Comparative Study of Integrated Pest Management and Baiting for German Cockroach Management in Public Housing, J. Econ. Entomol, 99: 879-885. See www.beyondpesticides.org/documents/IPMstudyPurdue.pdf

- Reduced burden on management and staff in responding to tenant complaints about pest infestations;
- Reduced burden on families responding to asthma attacks or taking time to file a complaint with management;
- Long-term benefits in reducing likelihood of developing "bait averse" cockroaches; and
- Broader benefits beyond pests – such as reduced mold – from better housekeeping and maintenance that would result from IPM.

Table 1 provides a summary comparison of each of the studies against the ten program elements established by the U.S. Department of Housing and Urban Development on February 3, 2006, and revised on May 27, 2007, for an effective IPM program.[3] The costs for each method are at the end. Results are in italics. However, a few items deserve note:

1. Both studies addressed buildings as a whole. All units were treated with one method or the other.
2. The Portsmouth, Virginia, study lasted one year – January to December. The Gary, Indiana, study started in May and ended in November. Cockroaches are especially hard to control during the hot, humid summer.
3. The Portsmouth, Virginia, researchers did not focus on changing resident behavior. In contrast, the Gary, Indiana, researchers educated residents and referred residents with housekeeping issues to a mandatory four-hour training program. One resident was evicted for lease violations related to housekeeping. The researchers applied 25% of the pesticides (215 of the 879 grams) used in the Partial IPM Program on this one unit.
4. The schedule of treatments varied between the studies. The Gary, Indiana, researchers added treatment after two weeks and did not treat for the fifth and sixth months. The Portsmouth, Virginia, researchers monitored the units and intervened as needed each month.
5. The Gary, Indiana, researchers assessed sanitation. They scored each unit on a scale of 1 to 5 with 5 being severely dirty. The scoring considered three factors: amount of clutter, amount of trash on floor, and amount of food on floor and kitchen counter. The Portsmouth, Virginia, researchers did not assess sanitation.
6. The sanitation score for units treated with the IPM Approach improved from 3.8 to 2.4 – a statistically significant difference. The score from 4.0 to 3.2 in the Bait-Only Approach units but was not statistically significant. The improvement indicates initial cockroach cleanout and resident education makes a difference in unit sanitation.

[3] U.S. Department of Housing and Urban Development, 2006, *Guidance on Integrated Pest Management*, Notice PIH 2006 – 11(HA). See www.hud.gov/offices/pih/publications/notices/07/pih2007-12.pdf.

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COMPARISON OF GARY, INDIANA, AND PORTSMOUTH, VIRGINIA, PEST CONTROL STUDIES TO HUD'S IPM PROGRAM ELEMENTS SHOWING IPM METHODS ARE MORE EFFECTIVE AND COST LESS..					
HUD IPM Program Elements *(Results of Study in Bold Italics)*		**Gary IN / Purdue Study**		**Portsmouth VA / Virginia Tech Study**	
		IPM Program (all elements but pest exclusion & maintenance)	Bait and Growth Regulators	Vacuum Trapping, Bait & Growth Regulators	Traditional Spray & Dust
1. Communicate Policies Communicate Housing Authority's IPM policies and procedures to: • All building occupants • Administrative staff • Maintenance personnel • Contractors.		Communicated to residents and staff in the impacted buildings. Seminars for resident managers and community program staff on IPM.		Communicated to residents and staff in the impacted buildings.	
2. **Identify Problems** Identify pests and environmental conditions that limit the spread of pests.		Comprehensive initial assessment for 66 units in 12 buildings.		Comprehensive initial assessment for 100 units in 22 buildings.	
3. **Monitor and Track** Establish an ongoing monitoring and record keeping system for: • Regular sampling and assessment of pests • Surveillance techniques • Remedial actions taken • Assessment of program effectiveness.	*Results at End of Study*	Assessed at weeks 2, 4, 8, 12, 16, and 29 with 6 glue traps. Scored sanitation on a 1 to 5 scale on three variables. 5 is worst		Assessed monthly with 3 glue traps. No scoring of sanitation.	
	Sanitation	***Improved significantly from 3.8 to 2.4***	***Improved moderately from 4.0 to 3.2***	***Not Assessed.***	
	Severity of Infestation	***Units without heavy infestations improved from 65% to 97%***	***Units without heavy infestations improved from 66% to 84%***	***Adjusted # trapped per unit improved 60%***	***Adjusted # trapped per unit improved 15%***
	No trapped roaches	***Improved from 59% to 84%***	***Improved from 56% to 72%***	***Improved from 6% to 80%***	
4. **Set Thresholds for Action** Determine, with involvement of residents: • Pest population levels – by species – that will be tolerated • Thresholds at which pest populations warrant action.		Tolerance set at zero cockroaches.		Tolerance set at zero cockroaches.	
		Flushing and vacuuming dropped if < 12 trapped roaches/ unit. ***One unit vacuumed twice and another three times.***	No changes.	Treatment reduced to 3 months if < 3 trapped roaches per unit.	No changes.

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5. **Improve Non-Pesticide Methods** Improve: • Mechanical pest management methods • Sanitation • Waste management • Natural control agents that have been carefully selected as appropriate in light of allergies or cultural preferences of staff or residents.	Cleanout initially and when > 11 trapped roaches per unit using backpack vacuum and limited pyrethrin & piperonyl butoxide flush. Sticky traps capture remaining cockroaches.	No changes.	Cleanout initially and at 6 months using backpack vacuum in kitchen and bathroom.	No changes.
6. **Prevent Pest Entry and Movement** • Monitor and maintain structures and grounds including o Sealing cracks o Eliminating moisture intrusion and accumulation • Add physical barriers to pest entry and movement.	*None*		*None*	
7. **Educate Residents and Update Leases** • Develop an outreach/educational program • Ensure that leases reflect residents' responsibilities for: o Proper housekeeping o Reporting presence of pests, leaks, and mold.	Residents given educational packet and educated again during visit. One resident in each building asked to educate peers.	*None*	*None*	*None*
8. **Enforce Lease** Enforce lease provisions regarding resident responsibilities such as: • Housekeeping • Sanitation • Trash removal and storage.	Sanitation score given to property mgmt. Residents with poor sanitation (score of 4 or 5) required to attend 4-hour housekeeping class. One resident evicted.	*None*	*None*	*None*

COMPARISON OF GARY, INDIANA, AND PORTSMOUTH, VIRGINIA, PEST CONTROL STUDIES TO HUD'S IPM PROGRAM ELEMENTS SHOWING IPM METHODS ARE MORE EFFECTIVE AND COST LESS..					
HUD IPM Program Elements ***(Results of Study in Bold Italics)***		**Gary IN / Purdue Study**		**Portsmouth VA / Virginia Tech Study**	
		IPM Program (all elements but pest exclusion & maintenance)	Bait and Growth Regulators	Vacuum Trapping, Bait & Growth Regulators	Traditional Spray & Dust
9. **Use Pesticides Only When Necessary** Use pesticides only when necessary, with preference for products that, while producing the desired level of effectiveness, pose the least harm to human health and the environment, and, as appropriate, notifying PHA management before application.		Baits and insect growth regulators used as needed. No sprays or fogs used.		Baits and insect growth regulators used as needed.	Sprays for baseboard. Dusts for cracks and crevices.
		879 grams used per unit over 29 weeks	***780 grams used per unit over 29 weeks***	***14.8 grams used per unit over 52 weeks***	***827 grams used per unit over 52 weeks.***
10. **Post Signs** Provide and post 'Pesticide Use Notification' signs or other warnings.		Notified at visits		Notified at visits	
Total Cost Per Unit Over Length of Study		***Total Over 29 Weeks***		***Total Over 52 Weeks***	
	Labor	***$49***	***$22***	***$20.90***	***$10.03***
	Pesticides	***$16***	***$12***	***$ 4.80***	***$ 0.43***
	Total	***$65***	***$35***	***$25.70***	***$10.43***
Treatment Cost Per Unit at End of Study		***Last Visit***		***Last Visit***	
	Labor	***$ 0.74***	***$ 2.12***	***$ 0.69***	***$ 1.50***
	Pesticides & Traps	***$ 0.53***	***$ 0.53***	***$ 0.18***	***$ 0.02***
	Total	***$ 1.27***	***$ 2.65***	***$ 0.87***	***$ 1.52***

Pests Persist in Federally Subsidized Housing

Cockroaches and rodents are persistent problems in some federally-subsidized housing. The problem is not uniform. Some public housing authorities have few problems. Others have serious problems. Public housing authorities need an integrated pest management program to reduce pests and keep pest problems away.

More than half of public housing residents surveyed by the U.S. Department of Housing and Urban Development (HUD) in 2004 reported problems with rodents and insects indoors. Almost 10% said rodents and insects indoors were always a problem.[1] HUD asked 446,884 public housing and multi-family project-based Section 8 housing residents "How often, if at all, are any of the following a problem in your property: rodents and insects (indoors)?" More than 34% responded. They said:

- Never 48.16%
- Sometimes 35.07%
- Most of the time 7.34%
- Always 9.42%

Despite the pervasiveness of the problem, insect infestation was #24 in the top 25 of physical problems cited by HUD.[2] Fourteen of the other top 25 problems including four of the top 5 could contribute to insect infestations.

The problems can be much worse for some public housing authorities, based on a recent study in Gary Housing Authority in Gary, IN funded by HUD's Office of Healthy Homes and Lead Hazard Control. In 2006, Purdue University researchers, Wang, El-Nour, and Bennett, inspected units and interviewed residents in 358 randomly selected apartments.[3] 42% of the apartments had a resident reported they had doctor-diagnosed asthma.

Based on interviews and visual inspection at Gary Housing Authority, the researchers found:

- 71% of the units infested by cockroaches, mice, ants, spiders, or flies
- 49% of units infested by the German cockroach (primarily in the kitchen)
- 36% of units infested by mice (mice infestation was associated with existence of diagnosed asthma)
- 26% of units infested by the Oriental cockroach
- 21% of units infested by ants.

Why Cockroaches?

Live cockroaches, as well as their remains and feces, cause asthma attacks in people sensitive to cockroach allergens according to a 2000 Institute of Medicine Report. The Inner City Asthma Study found that more than 60% of inner city children were sensitive to cockroach allergens. Asthma is a costly disease that disrupts a family and undermines a child's ability to learn.

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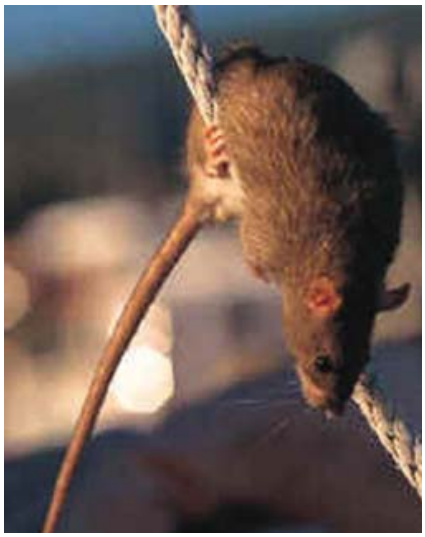
[1] Real Estate Assessment Center, U.S. Department of Housing and Urban Development, *How the RASS Survey Measures Up,* (2006). See page 10 at www.hud.gov/offices/reac/products/rass/PDFs/survey.pdf. For more information on the Customer Satisfaction Survey, go to www.hud.gov/offices/reac/products/prodrass.cfm.

[2] Real Estate Assessment Center, U.S. Department of Housing and Urban Development, *Uniform Physical Condition Standards (UPCS) – Most Frequently Cited Deficiencies,* (2006). See or www.hud.gov/offices/reac/products/pass/2005-8-31_upcs_deficiency_list.xls. The information is based on 44,000 inspections (14,000 public housing and 30,000 project-based, Section 8 property from mid-2000 to September 2006). For more information on the Physical Assessment Subsystem, go to www.hud.gov/offices/reac/products/prodpass.cfm

[3] Wang, C., Abou El-Nour, M., Bennett, G, *Survey Of Pest Infestation, Asthma, And Allergy In Low-Income Housing,* publication scheduled for 2007.

These rates confirmed previous studies in 2002 to 2004.



Unfortunately, Gary Housing Authority residents did not always report the problem despite getting free pest control service upon request. In one complex, only 22% of the residents (35 of 159 cockroach-infested units) reported the problem to management. 41% of residents considered the pest control services to be fair or poor.

Despite the low reporting levels, researchers found that 72% of the Gary Housing Authority units had evidence of pesticide use to control cockroaches including:

- 67% of units had cockroach bait residue
- 10% of units had cockroach bait stations
- 6% of units had pesticide dust residue (including boric acid).

But the pesticides were not always fresh or properly used. Clearly residents took matters into their own hands.

- 80% reported using cockroach controls methods. The most common cockroach control was baits but included surface sprays and space sprays (insect bombs).
- 58% tried to control mice.

Despite their heavy reliance on pesticides and the poor results, Gary Housing Authority residents knew more was needed.

- 68% of residents identified the need for home repairs to control pests.
- 51% of resident saw need for more frequent inspection or treatment (26% of residents received treatment at least monthly whether they did it on their own or by a professional).
- 18% of residents suggested cleaning up inside and outside of apartments (60% had trash or food residue on floor or counter).
- 10% of residents suggested servicing the whole building rather than selected individual units.

The researchers analyzed dust samples in 101 of the apartments in Gary Housing Authority. They found cockroach allergens (Bla g 1) in 98% of the kitchen dust samples. Monitoring traps captured cockroaches in 85% of the units. One-third of the dust samples had critical levels of cockroach allergens (≥ 8 U/g of Bla g 1). At these levels, residents are likely to have an allergic reaction in susceptible people.

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INTEGRATED PEST MANAGEMENT INTERVENTIONS FOR HEALTHIER HOMES

In Cleveland, Collaboration Makes a Difference

Through integrated pest management (IPM) conducted in a collaborative approach that includes residents, property management, and the pest control operator, previously intractable roach infestations may be virtually eliminated. The success of a Cleveland, Ohio IPM pilot described in this case study was the result of an ongoing, labor-intensive, aggressive, and precision-targeted IPM strategy sustained over several months. The heat-gun approach to flushing cockroaches was effective and avoided exposure to chemical flushing agents. A person did not need a pest control license to use it. (Baiting was done by a licensed pest control contractor.) The labor-intensive approach, combined with the high degree of cooperation from the team and the residents, cannot be achieved or replicated overnight. However, it demonstrates that there is a viable alternative to traditional pest control methods that may reduce resident exposure to pesticides. Property managers and public housing authorities need to consider IPM to more effectively control cockroaches.

Environmental Health Watch (EHW) conducted a study of the efficacy of IPM in an affordable housing development in Cleveland, Ohio to address pest infestations that may have contributed to asthma in residents of this housing development. Asthma rates have increased dramatically during the last 20 years of the 20th Century. Asthma is a major public health concern, especially for children. Removing the threat of roaches and their debris (which contains the allergens) can benefit children with asthma. EHW worked with Cuyahoga Metropolitan Housing Authority, Greater Cleveland Asthma Coalition, the United States Department of Agriculture (USDA) Research Station in Gainesville, Florida, and the Johns Hopkins Allergy and Asthma Center.

EHW's goal was to explore methods to reduce cockroach allergen contamination in low-income public housing. The study focused on three multi-family complexes operated by Cuyahoga Metropolitan Housing Authority (CMHA) in Cleveland, Ohio. The cockroach control intervention was "precision-targeted integrated pest management (IPM)" – a modification of the standard cockroach IPM strategy – designed by the USDA Imported Fire Ants and Household Insects Research Unit. USDA's approach increases the usual level of cockroach monitoring so that a detailed spatial analysis of harborages and feeding points can be used for more precise placement of pesticides.

Why Cockroaches?

Live cockroaches, as well as their remains and feces, cause asthma attacks in people sensitive to cockroach allergens according to a 2000 Institute of Medicine Report. The Inner City Asthma Study found that more than 60% of inner city children were sensitive to cockroach allergens. Asthma is a costly disease that disrupts a family and undermines a child's ability to learn. There is growing evidence that mice might have a similar effect.

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IPM is a commonsense approach to pest management to keep pests out, reduce their harborage, food and water, and, where necessary, use low risk pesticides.

Outreach Efforts

CMHA sent a letter to participants introducing the program. It followed with a phone call to the residence. If the phone call was not successful, CMHA went door-to-door in the buildings to engage tenants. Staff visited participants' homes to provide them with a detailed description of the activities that would take place during the project and the incentives residents would receive for their participation.

Participants were given incentives that included:

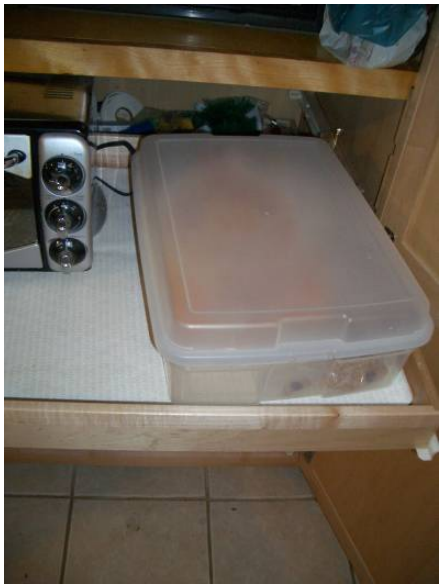
- A $15 food certificate from a local supermarket for each visit to the unit
- A new vacuum cleaner to encourage them to minimize food debris in their units.

During the course of the intervention, as EHW health educators and the tenants identified specific needs unique to each unit, EHW gave additional incentives, including garbage bags, smaller garbage cans, or food storage containers, to help reduce the likelihood of renewed pest infestation.

Identifying the Level of Infestation

EHW and CMHA measured initial roach infestation in four ways:

1. Roaches captured on sticky traps;
2. Roaches flushed from harborages;
3. Occupant reports of roaches; and
4. Staff observations.



Due to the large amounts of food debris available in some units that might have kept roaches from being lured by sticky traps, EHW found that flushing was the most effective means of measuring the true level of infestation.

Stu Greenberg of Environmental Health Watch described the flushing approach as "reconnaissance by fire." Using a heat gun with a PVC collar to prevent burns, EHW conducted an "active inspection" of the units by passing the gun along baseboards, electrical outlets, light fixtures, tables, door frames and anywhere else roaches might be hiding. Aware of the risk that the heat might simply push the roaches in deeper, the results were nonetheless very good. A large number of roaches came out and were vacuumed up along with a great amount of allergenic debris, helping to identify harborages not traditionally targeted by the pest control contractor.

The heat gun was not only effective in simply drawing out roaches, it also proved an effective recruiting tool. Skeptical tenants, convinced that roach infestation was an intractable problem, became much more enthusiastic about the IPM strategy after they saw that it was radically different from other methods. As Mr. Greenberg explained, once tenants realized that heat gunning and vacuuming of roaches had a real effect, they "saw hope" that the problem could really be managed, if not solved all together. The tangible results encouraged tenants to actively participate in meeting their responsibilities under the program.

Working Together to Implement the Program

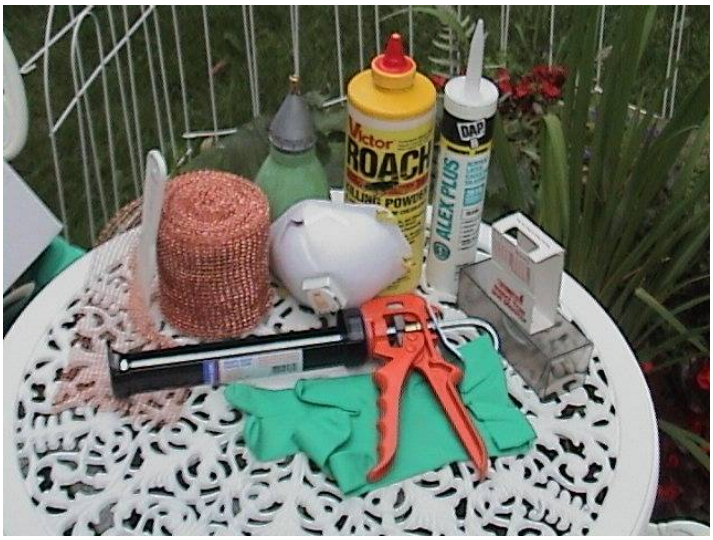
Effective implementation of the IPM strategy was a team effort that required the housing authority, the tenants, and pest control contractors to play an active role in combating the infestation. An integrated strategy could not be effective without all participants doing their part.

Tenants became much more enthusiastic when they saw progress being made. Progress encouraged them to cooperate with the pest control contractor, enable the housing authority to make necessary repairs to their units, and most importantly, to create an unwelcoming environment for roaches.

CMHA repairs to the units, including caulking holes in walls and floors to prevent harborages where food debris could collect, and fixing plumbing and other systems that provided a safe harbor for roaches. CMHA's work required the participation of all of the housing authority staff, from the building's environmental supervisor, who served as entrée to tenants and liaison with operations and management staff, to those staff and contractors responsible for building maintenance and repair.

The maintenance workers who interacted with the residents in the course of their repair work, were enthusiastic about participating in a project that could reduce their exposure to roaches. Furthermore, they helped the team better understand where to place roach bait and how to identify harborages. The old strategy of simply placing a couple of traps in kitchen cupboards and baiting the hinges was not doing the trick.

The one unit that did not produce the desired results was the rare instance where the tenants refused to be cooperative. While, for most residents, the real success of the heat gunning method was enough for them to enlist in the rest of the IPM strategy, residents of this one unit with a long-term history of heavy infestation, refused to change their behavior to stop roach infestations. The unit had serious repair problems, but the tenants did not cooperate with CMHA. In spite of 12 site visits by the team, the tenants did not remove food debris or work with the other participants. The roach infestation continued.



The team sprayed no pesticides the process. It did not use foggers, "roach bombs," or chemical flushing. To counter infestations, EHW used low-toxicity and low-volatility gel baits and bait stations supplemented with boric acid. Because the heat gunning identified specific harborages, bait placement could be more precise.

Objectives and Outcomes

The objective was a 95% reduction in the roach population, as measured by the number of roaches trapped and flushed. The team achieved that objective in all but one case (the uncooperative tenants) and required one to four flush/vacuum/bait visits.

Of the 18 housing units that were part of the program, the team initially saw live roaches in eleven of them (generally an indication of heavy infestation) and saw dead roaches in 16 units. The team identified building defects (holes in walls, plumbing leaks, etc.) in 13 of the 18 units and food debris and excess clutter in 10 of the 12 units.

The initial roach counts in the units varied widely. Six units had counts of 243 cockroaches or greater. Two had more than 1,000! In one of these, due to failure of tenant cooperation, the intervention reduced trapped cockroaches by 80%. In the other unit, good tenant cooperation resulted in a 97% reduction. The substantial reduction was due to multiple flush/vacuum/bait visits. In most cases, two or three visits were enough to achieve the 95% reduction. Three units achieved a 100% reduction.

Overall, the combination of cockroach infestation reduction through precision-targeted IPM (including hot air flushing, HEPA vacuuming and baiting), a one-time professional cleaning based on the HUD lead dust cleaning protocol, resident education, and continuing cleaning effort by residents, resulted in substantially reduced cockroach allergens to levels below those associated with asthma attacks. Go to www.ehw.org/Asthma/ASTH_home1.htm#Pests for a copy of the report.

Lessons for Future Interventions

This small exploratory project demonstrated that previously intractable roach infestations could be virtually eliminated through a labor-intensive, aggressive and precision-targeted IPM strategy sustained over several months. It required cooperation from the public housing management, maintenance and environmental staff, and from the tenants.

This labor-intensive experiment, combined with the high degree of cooperation from the team and the residents, cannot be achieved nor replicated overnight. However it demonstrates that there is a viable alternative to traditional pest control methods. What is more, lead dust cleaning techniques were found effective in reducing cockroach allergen levels.

The project demonstrated that effective roach control requires a division of responsibility among the housing authority, the pest control contractor, and the tenant. The housing authority has to provide and maintain the dwelling unit free from defects that support roach infestation. The pest control contractor has to thoroughly inspect the entire unit to determine roach harborages, reservoirs, entry points, food and water resources, use safe and effective treatments to get rid of the roaches, and provide ongoing monitoring. Finally, the tenants must maintain housekeeping practices that do not support roach infestation, and they must cooperate with pest control efforts by the contractor.

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National Center for Healthy Housing

INTEGRATED PEST MANAGEMENT INTERVENTIONS FOR HEALTHIER HOMES

Boston Public Housing: Partnerships & Policy Advances

Traditional pest control in low-income multifamily housing, with initial flush out and periodic spray, has failed to eliminate pests long-term. As a consequence, residents may take pest control into their own hands, using over-the-counter, restricted and illegal pesticides. A series of integrated pest management (IPM)-based initiatives at Boston Housing Authority serves as a model for other public housing authorities. The model uses peer educators and increasingly standardized approaches to IPM training, contracts, data collection, and teams. Public housing authorities can adapt the lessons learned to their situation.

Why Cockroaches?

Live cockroaches, as well as their remains and feces, cause asthma attacks in people sensitive to cockroach allergens according to a 2000 Institute of Medicine Report. The Inner City Asthma Study found that more than 60% of inner city children were sensitive to cockroach allergens. Asthma is a costly disease that disrupts a family and undermines a child's ability to learn. There is growing evidence that mice might have a similar effect.

This case study is one of a series addressing integrated pest management (IPM) in low income housing. To access the series, visit www.healthyhomestraining.org/ipm/studies.htm.

IPM is a commonsense approach to pest management to exclude pests, reduce their harborage, food and water, and, where necessary, use low risk pesticides.

The Healthy Public Housing Initiative: Research for Action and Community Empowerment (2000-2004)

The Healthy Public Housing Initiative (HPHI) is a community-university-city agency collaborative (Collaborative) formed to improve resident respiratory health and building conditions in Boston public housing using an IPM intervention in 44 apartments of 57 asthmatic children enrolled in the project. It includes Boston Housing Authority (BHA), the City of Boston Public Health Commission, the New England Asthma Regional Council, Tufts University, Harvard University and Boston University.[1]

The package of IPM interventions included:

- Educating and assisting residents with sanitation, clutter control, and preparation for IPM application;
- Deep cleaning with a vacuum equipped with a high-efficiency particulate air (HEPA) filter[1];
- Monitoring for roaches with sticky traps;
- Flushing out cockroach harborages;
- Exclusion by sealing holes and cracks; and
- Application of gel baits and boric acid.

The Collaborative conducted pre- and post-study interviews with residents over the course of a year and had monthly standardized interviews with residents to capture data on the change in asthma symptoms, caretaker quality of life, doctors' visits and hospitalizations for asthma. The Collaborative also collected dust samples in apartments for cockroach allergens and pesticide residues as part of our study.

Key Findings

1. **Traditional approaches to pest control are ineffective, especially for cockroaches.** [3]
   - Nearly 50% of the BHA homes tested in HPHI showed cockroach allergen levels in excess of asthma sensitivity exposures;
   - Nearly 60% of the tested children showed allergic sensitivity to the most prevalent cockroach antigen.

[1] HEPA filters are designed to remove 99.97% of fine particulates. Fine particulates are dangerous because they penetrate deep into the lungs.

- Pest-related allergen levels correlated to lack of housing renovation, holes in walls, poor housekeeping practices, and season of the year.[2]
- Every BHA home tested showed evidence of between three and eight pesticides used, at least one of which is either banned or restricted to non-residential use.
- BHA residents in our study have a higher rate of pesticide use than the national average.

2. **A package of IPM interventions designed to reduce allergen burden and re-infestation was effective and improved both environmental and health indicators**. The Collaborative's intense cleaning and cockroach control reduced allergen loads in all homes. The reduced allergen levels were sustained over four months and then began to rise, showing the need to implement the intervention on a regular basis to maintain results.[4] During the period of IPM intervention, asthmatic children involved in the study reported a significant reduction in asthma symptoms, including coughing and wheezing, activity limitations, and poor sleep quality.[5]

Every home tested showed evidence of between three and eight pesticides used, at least one of which is either banned or restricted to non-residential use.

3. **Residents are central to successful IPM in their housing developments**. HPHI trained more than 20 public housing residents to conduct housing surveys and inspections as both health advocates and IPM educators.

Second Generation IPM in Boston Housing Authority (2005)

The research results spurred the Collaborative to launch two pilot projects which refined the IPM model developed in the research project.

1. IPM Educator Pilot in Charlestown Housing Development

The Collaborative designed this pilot to measure the effectiveness of training and employing an IPM peer educator on residents' preparation for IPM and on cockroach control.

Cyfluthrin, a neurotoxin that is the active ingredient in the roach powder Tempo, is used in its undiluted, powder form by some residents, and is sold illegally in some neighborhood bodegas with no health and safety information.

Thirty-four moderately-infested and highly-infested units in BHA's Charlestown Family Development received baseline assessment and three applications of gel baits, with two to four weeks between applications, by a pest management professional. Before the first pest control application, residents received written notice to prepare their units for treatment, a routine industry method of alerting residents to prepare for pest control treatment. Before the second and third gel bait treatments, an IPM peer educator:

- Instructed residents in how to prepare for IPM treatment;
- Educated them on pest biology and habits;
- Explained the role of sanitation and clutter in infestation; and
- Used a HEPA vacuum to remove dead insects and allergens in dust.

The IPM treatment with peer education resulted in a significant decrease in cockroach activity in the infested apartments, whereas IPM treatment with a written notice but without peer education did not have a significant decrease. All of the units that were both clean and prepared for IPM treatment were much improved and had little or no pest activity by the end of the study. In contrast, 100% of units that were both not clean and not prepared for IPM treatment showed no improvement in pest infestation at the end of the study.[6]

2. IPM Pilot in Holgate Apartments Senior Housing

The Collaborative conducted a second pilot project in an 85-unit housing development, Holgate Apartments. Holgate Apartments are reserved for elderly and disabled people. The Collaborative trained and employed two residents as IPM Educators. It formed an IPM team including BHA management and maintenance personnel.

The team received a short training on IPM, and the role of the IPM Educators and the pest control operator. Over a period of five to six months, peer educators visited every apartment to:

- Monitor baseline infestation;
- Educate residents;
- Schedule treatments for infested apartments;
- Assist with HEPA vacuuming and preparation for IPM treatment;
- Call in work orders for repairs; and
- Elicit resident feedback on program satisfaction.

Results showed that by the end of the pilot program, units with little or no pest activity increased from 77% to 100% and the common areas with little or no pest activity improved from 0% pre-IPM to 100% post-IPM. In six of the units visited, IPM educators arranged for needed social services for the residents, another benefit of this model program.

Healthy Pest-Free Housing Initiative (2006-2009)

With five years of promising results, the Collaborative received funding to scale up IPM in the Boston Housing Authority (BHA) with an ambitious schedule to implement IPM in 15 family developments over the course of three years. The Healthy Pest-Free Housing Initiative (HPFHI), as the demonstration is called, established the following goals:

- Improve asthma and overall health;
- Eliminate cockroach and rodent infestation;
- Reduce pesticide use and exposure;
- Maximize resident peer education; and
- Promote IPM in public policy on housing and health.

The HPFHI activities are ongoing. They include:

- Hire and train 10 BHA residents to be employed as health advocates and IPM educators for their peers. These IPM Educators provide residents with multi-lingual health education on asthma and information about IPM; assist residents with reducing clutter and placing work orders; and serve as a bridge for residents to other needed health and social services.
- Develop a multilingual, multimedia public health information campaign for BHA residents. The Safe Pest Control Campaign reaches all the BHA developments and includes posters, flyers, and videos in several languages to educate residents about IPM and health risks associated with exposure to pesticides, with emphasis on illegal and restricted pesticides.
- Train BHA managers, staff and resident leaders in the model IPM program as they prepare to implement it in their developments. Work with BHA to set up a database to track baseline housing conditions and IPM results; develop a model IPM contract; and prepare an IPM orientation for new residents.
- Distribute up to 800 Healthy Home Kits. The kits include important information and supplies for safer pest management and for reducing asthma triggers in the home.
- Develop a pesticide "buy-back" program, to eliminate potentially toxic substances from the home environment in all developments. Residents participating in the buy-back will receive free pest control equipment and supplies.

HPFHI Preliminary Results: Year 1

The IPM team in each development includes the housing manager and maintenance staff, the IPM contractor, the peer educator, and the residents. The team collected baseline data on infestation, sanitation, clutter, repairs needed, and any unique social needs. The IPM contractor and development manager developed a list of "focus units." Focus units are those units in need of continued IPM treatment, peer education, social services, and repair.

> *"This demonstration project builds on an earlier initiative, which proved that including residents as full partners to educate their neighbors is the most successful method of addressing health related issues in public housing,"*
>
> *Sandra B. Henriquez*
> *BHA Administrator*

The Collaborative assigned peer educators to work with the residents of these focus units to educate them about IPM, advocate for other needed services, and ensure that work order repairs are made. A comparative study of work orders for pest problems in the 12 months before and after the IPM program is being conducted to help evaluate the effectiveness of the IPM program in both the Charlestown Family Development and the Holgate Apartments. Other components of evaluation include a comparison of pest control contract and services costs and a comparison of unit inspection findings pre-and post-IPM.

Related Initiatives

The Collaborative's work has resulted in a number of initiatives that reach well-beyond the Boston Housing Authority.

1. Healthcare Funding for IPM Intervention

The New England Asthma Regional Council (ARC) identified a need to create policies that would support sustainable financing mechanisms to address environmental controls in the home. ARC has spearheaded discussions with the healthcare payer and healthcare purchaser communities about supporting policies for delivering and/or paying for home-centered environmental interventions. These interventions include IPM services and supplies.

Healthcare payers have indicated they are receptive to addressing environmental triggers, but want guidance on what are considered to be best practices and how implementing the practices will affect their bottom line. To that end, ARC has produced the entitled "Investing in Best Practices for Asthma: A Business Case for Education and Environmental Interventions."[7] The business case documents the health and cost benefits associated with offering asthma education programs and home-based interventions to reduce environmental triggers.

2. Training Center for Healthy Housing and IPM

The Center for Healthy Homes and Neighborhoods in the Boston University School of Public Health offers trainings in New England as a member of the National Healthy Homes Training Center & Network. The Center has developed and offered IPM courses for managers of low-income, multifamily housing, including public housing authorities, community development corporations, and Section 8 programs. The Center has provided one-day and two-day trainings in IPM to:

- Large and medium public housing authorities in six New England cities, with the goal of launching IPM programs in those housing developments;
- Two community-based organizations; and
- Local health officers in Massachusetts.

The following table compares the two IPM interventions in Boston Housing Authority to the ten key elements for an effective IPM program based on the U.S. Department of Housing and Urban Development's *Guidance on Integrated Pest Management* issued on February 3, 2006 and renewed May 27, 2007. The two initiatives are the Healthy Public Housing Initiative (HPHI) from 2000 to 2004 and the Healthy Pest-Free Housing Initiative (HPFHI) from 2006 to 2009. The results for HPFHI are not yet available.

COMPARISON OF TWO PHASES OF IPM INITIATIVES WITH BOSTON HOUSING AUTHORITY		
HUD IPM Program Elements *(Results of Study in Bold Italics)*	**Healthy Public Housing Initiative 2000-2004**	**Healthy Pest-Free Housing Initiative 2006-2009**
1. Communicate Policies Communicate Housing Authority's IPM policies and procedures to: • All building occupants • Administrative staff • Maintenance personnel • Contractors.	Researchers talk to managers and residents about IPM intervention program.	BHA told administration to managers and maintenance staff about policies and held community meeting for residents with manager and IPM contractor.
2. Identify Problems Identify pests and environmental conditions that limit the spread of pests.	Conducted comprehensive initial visual assessment of 44 units in three developments.	Conducted comprehensive visual assessment of all units, common areas, yards, and basements in five developments annually for three years.
3. Monitor and Track Establish an ongoing monitoring and record keeping system for: • Regular sampling and assessment of pests; • Surveillance techniques • Remedial actions taken • Assessment of program effectiveness.	Monitored traps every two weeks and intervened as necessary ***Research Results: Allergens reduction in all homes sustained for four months, after which they began to rise. Statistically significant reduction in asthma symptoms during study period.***	• Developed short list of units with persistent pest problems and monitored these units. Inspected every 2 to 3 weeks and treated with gel baits until no infestation. • Provided data on sanitation, infestation, repairs, and social services needs to building manager after every visit.
4. **Set Thresholds for Action** Determine, with involvement of residents: • Pest population levels – by species – that will be tolerated • Thresholds at which pest populations warrant action.	• Set tolerance at zero pests. • Acted on evidence/presence of pest	No change from initial study.
5. **Improve Non-Pesticide Methods** Improve: • Mechanical pest management methods • Sanitation • Waste management • Natural control agents	• Vacuumed units with vacuum with HEPA filter. • Educated residents to improve sanitation and to prepare for IPM treatment. • Provided residents with plastic containers for food and garbage.	Same as initial study but also worked with residents needing more education, repairs, and social services.
6. **Prevent Pest Entry and Movement** • Monitor and maintain structures and grounds including o Sealing cracks o Eliminating moisture intrusion and accumulation • Add physical barriers to pest entry and movement.	• Sealed cracks and small holes with copper mesh and expanding foam. • Reported water leaks to BHA for repair	No change from initial study.

COMPARISON OF TWO PHASES OF IPM INITIATIVES WITH BOSTON HOUSING AUTHORITY		
HUD IPM Program Elements *(Results of Study in Bold Italics)*	**Healthy Public Housing Initiative 2000-2004**	**Healthy Pest-Free Housing Initiative 2006-2009**
7. **Educate Residents and Update Leases** • Develop an outreach/educational program • Ensure that leases reflect residents' responsibilities for: o Proper housekeeping o Reporting presence of pests, leaks, and mold.	• Educated residents through peer educators and research staff regarding sanitation preparation, and hazards of pesticides, and assisted with work orders. • Ensured lease spells out resident responsibilities for housekeeping and reporting.	No change from initial study.
8. **Enforce Lease** Enforce lease provisions regarding resident responsibilities such as: • Housekeeping • Sanitation • Trash removal and storage.	• BHA enforced lease where necessary.	No change from initial study.
9. **Use Pesticides Only When Necessary** Use pesticides only when necessary, with preference for products that, while producing the desired level of effectiveness, pose the least harm to human health and the environment, and, as appropriate, notifying PHA management before application.	• Flushed and vacuumed where high infestation. • Worked with residents to improve sanitation. • Excluded pests. • Where evidence of infestation, applied get baits and boric acid.	Same as initial study but added rodent control using traps and tamper-resistant bait boxes.
10. **Post Signs** Provide and post 'Pesticide Use Notification' signs or other warnings.	Notice given	No change from initial study.
Treatment Cost Per Unit at End of Study	**Cost information not collected.**	**Not yet available.**
Total Cost Per Unit Over Length of Study	**Cost information not collected.**	**Not yet available.**

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CHAMACOS: A Community-University Partnership

Pesticide exposures are a key concern in many agricultural communities. Residents who live in these communities may be exposed to pesticide spray drift from nearby applications or volatilization from chemicals that evaporate into the air. Additional exposures to farmworkers and their families can occur when pesticide residues from work are inadvertently transported into their homes on the workers' clothing and skin. As a result, children could be exposed to pesticides brought into their homes. Many agricultural communities are composed of low income families who often live in substandard and overcrowded housing. These living conditions promote pest infestations and potentially expose residents to additional pesticide use in their homes. Public health, education, farming, and housing professionals need to integrate the lessons learned from this research into programs promoting farmworker health and safety..

In the last 20 years, a growing awareness has emerged about the need to conduct environmental health research in partnership with communities. Community-based Participatory Research (CBPR) empowers community members to become active participants in the research process and enables university investigators to gain a more comprehensive understanding of environmental exposures and risks. Furthermore, CBPR permits research findings to be translated into actions and strategies to reduce exposures and improve public health.

Major Accomplishments

- Documented poor housing quality, pesticide exposures that exceed national reference levels, and potential adverse effects on child development.
- Conducted successful community-based intervention studies to reduce pesticide exposures to children from occupational take-home pathways and home pesticide use to control pest infestations.

This case study is one of a series addressing integrated pest management (IPM) in low income housing. To access the series, visit www.healthyhomestraining.org/ipm/studies.htm.

IPM is a commonsense approach to pest management to keep pests out, reduce their harborage, food and water, and, where necessary, use low risk pesticides.

The University of California, Berkeley Center for Children's Environmental Health Research (CCEHR) is one of a dozen centers funded by the U.S. Environmental Protection Agency (EPA) and the National Institute of Environmental Health Sciences (NIEHS) in 1998.

The CCEHR's central project was CHAMACOS – the Center for the Health Assessment of Mothers and Children of Salinas. CHAMACOS means small child in Mexican Spanish. It is a community-university partnership investigating allergen exposures and the potential effects of pesticides on growth, neurodevelopment, and respiratory disease in children residing in the Salinas Valley, an agricultural region in California. CHAMACOS intervention, outreach, and education programs aim to reduce children's exposures to pesticides and other potentially toxic chemicals. The ultimate goal of CHAMACOS is to identify and understand children's exposure pathways and their health effects so that effective and age-appropriate interventions can be designed and implemented to reduce the prevalence of environmentally induced disease.

Research Studies

The CHAMACOS Partnership enrolled 600 pregnant women between 1999 and 2000. Researchers followed the children born from these pregnancies. They had extensive contacts with participants using questionnaires, home inspections, environmental and biological sample collections, neurodevelopmental assessments, and lung function tests. They published their findings related to pesticide use, housing quality, environmental exposures to current and historic use pesticides, behavioral risks, and health outcomes in the eight research articles cited in this case study.

Participants were primarily low-income, Mexican immigrants working in agriculture. Poor housing quality was common. For example, cockroach and rodent infestations were present in 60% and 33% of homes, respectively, and as were peeling paint (58%), mold (43%), rotting wood (11%), water damage (25%), and high resident density (76%).[1] Levels of disrepair and crowding in homes were associated with pest infestations and home pesticide use.[1] Half of all households used pesticides. Of these households, over 60% used pyrethroids and less than 10% used organophosphates (OP) such as malathion or carbamates.[1] Spray cans were the most common application method (30%).[1] Less than 10% of participants used products likely to reduce household pesticide exposure such as gels or bait stations.[1] House dust samples contained agricultural and home use pesticides.[2]

Pregnant women in the study had higher levels of organophosphorus pesticide metabolites in their urine compared to women of child bearing age in the U.S. population.[3] Although approximately 58% of pregnant women lived with three or more agricultural workers, their households had not received education about methods to reduce pesticide exposure taken home by agricultural works on their bodies, clothes, shoes or equipment. This exposure is called take-home pesticide exposure.[4] For example, 46% of these women lived in homes where people wore their work shoes or clothing into the home and 44% washed work and family clothing together.[4]

The researchers found that pesticide exposures to pregnant women were associated with children's development. For example, mothers with higher levels of urinary OP metabolites were more likely to give birth earlier and their babies were more likely to have abnormal reflexes.[5-6] Pre-natal urinary OP metabolites levels were also associated with poorer mental development and pervasive development problems at 24 months of age.[7]

Intervention Studies

With input from its community partners, CHAMACOS researchers developed two intervention studies aimed at reducing take-home pesticide exposures. One was a home-based education intervention that focused on changes in household behaviors to reduce take-home exposures from residues on farmworker clothing. The CHAMACOS Partnership strongly supported this study, but concerns were raised about focusing solely on strategies that put the burden of exposure reduction on the family. Thus, the Partnership developed a second intervention that involved growers in an effort to reduce pesticide residues on worker's clothing and skin before the worker returned home.

Field-Based Intervention

The field-based intervention focused on reducing malathion exposures to strawberry harvesters and the potential for take-home exposures to their families. Malathion is an OP pesticide. Among the 130 farmworkers who participated in this intervention, almost half had never received training related to pesticides and over two-thirds reported that they never had talked to their bosses about pesticides. The components of this intervention included the provision of:

1. Warm water to increase hand washing (investigators learned from the community that many farmworkers avoid washing their hands with cold water because they believed that cold water causes arthritis);
2. Changeable outer clothing and routine laundering to prevent contamination of clothes;
3. Disposable gloves;
4. Closed laundry bags and shoe bins to promote "safe storage" of work clothing and work shoes, and
5. Regular in-field health and pesticide education.

Malathion, a pesticide commonly used on strawberries, or the urinary metabolite MDA, was measured in urine, hand rinse, clothing patch, and skin patch samples collected to assess the efficacy of the intervention. Participants who wore gloves had much lower levels of malathion on their hands compared to those who did not wear them.[8] Additionally, harvesters who wore gloves had about half the urinary MDA levels compared to those who did not wear them.[8] Thus, glove use reduced exposures as well as skin loading that could be carried home. Clothing prevented virtually all accumulation of malathion on skin elsewhere on workers' bodies. The researchers found that malathion collected on work clothing and that removing the coveralls would

likely reduce take-home pesticide exposures.[8] The intervention group who wore coveralls most likely prevented the accumulation of malathion on their regular work clothing.

Farmworkers reported that they preferred to wash their hands with warm water.[8] This practice could increase hand washing among workers and result in a reduction of both personal exposure and potential take-home exposure to families members. The use of gloves and hand washing to minimize pesticide residues on workers' hands, as well as coveralls to prevent pesticide accumulation on clothing, is likely to reduce the potential for pesticide exposure to families and children among strawberry harvesters entering fields after expiration of the post-harvest interval (72 hours). CHAMACOS is currently working with partners such as growers and agricultural officials to incorporate these intervention practices in the fields.

Home-Based Intervention

For the home-based intervention, we used an in-depth pesticide education program conducted within farmworker households to:

1. Explain what pesticides are;
2. Educate about farmworker rights related to pesticides;
3. Describe exposure routes and health effects of pesticides on children;
4. Demonstrate the concept of pesticide residue using fluorescent tracers;
5. Educate about strategies to prevent pesticide residues on the worker's clothing from entering homes (e.g., removing work clothing and shoes before entering the home);
6. Educate about integrated pest management (IPM) strategies to reduce pest infestations in the home;
7. Develop a household-specific Home Action Plan to reduce pesticide levels in the home and protect children from exposures;
8. Identify successes and barriers to implementing the Home Action Plan; and
9. Provide household resources that assist participants in taking action on pesticide exposure

The preliminary analysis indicates that significant improvements in exposure-related behaviors occurred, such as workers removing their shoes before entering the house and washing work and family clothing separately. Future analyses will focus on measurements of pesticide metabolites in children and pesticide concentration levels in house dust.

Community Education and Outreach

The CHAMACOS Partnership developed a number of initiatives to serve the community that include workshops, trainings, and multi-media materials. Go to ehs.sph.berkeley.edu/chamacos/english/pages/EduMaterial.php to view the materials.

Community Presentations

Presentations have been given to over 4000 people in the California's Salinas Valley. Participants at these forums include farm workers, community advocates, educators, and childcare center providers. Some of the materials developed and distributed include:

- Things you can do to control pests (household maintenance practices);
- Alternatives to pesticide use in the home and garden;
- Least toxic approaches to pesticide use (limit use to gel and bait stations, types of least toxic pesticides, and ways to protect children when pesticides are used);
- Reducing take-home pesticide exposures from the fields (prevent work clothes from entering the home, separate storage and laundering of work clothes, and wash clothing immediately after work);
- How to protect yourself from pesticide exposure in the fields; and
- Rights of agricultural workers.

Prenatal Environmental Health Education

In partnership with Clinica de Salud del Valle Salinas, CHAMACOS developed an innovative, computer-based prenatal environmental health program to educate pregnant women about environmental health issues. CHAMACOS designed the program for a low-literacy audience in Spanish on a touch-screen computer with voice-over narration for all written materials. Through this mechanism, pregnant women can easily navigate over 60 screens that address a variety of issues including preventing pesticide exposure, IPM, lead, allergens, and other topics. CHAMACOS is working with state officials to make this module a reimbursable health education service under the California Comprehensive Peripartum Services Program, which provides prenatal care and education to low-income California women.

Environmental Health Education for Childcare/Preschool Settings

Anecdotal discussions indicated that pest infestations and other environmental health concerns are prevalent in local childcare centers and preschools. This situation may be related to the poor housing stock in many neighborhoods. To address this concern, CHAMACOS and its partners developed a workshop to train childcare providers about environmental health issues and how to improve the quality of their facilities. Specific topics addressed include pest infestations, pesticide use, IPM, lead, mercury, and air quality.

Healthy Homes Training Partnership

In a follow-up to the documentation of severe housing quality problems among low-income Salinas Valley residents, CHAMACOS is working with local community groups to develop a research, training, and advocacy program to address the relationship between housing quality and health. In partnership with Alameda County's Lead Poisoning Prevention Program, CCEHR became one of the first training partners in California of the National Healthy Homes Training Center and Network (Training Center). The Training Center developed several courses designed to teach public health and housing professionals to take a holistic approach when identifying and resolving problems that affect the health of residents. The CHAMACOS Partnership offered its first training in March 2007. Participants included the Environmental Health Division of the Monterey County Health Department and community advocacy groups. It also developed a one-day healthy homes course that addresses agricultural, low-income, and Latino communities. The course is offered in Spanish and is targeted to housing and health promoters, community advocates, educators, and housing managers who work directly with agricultural populations.

Lessons for the Future

The CHAMACOS partnership can serve as a model of how researchers from universities can work with communities to increase knowledge about local public and environmental health concerns. The partnership already established will build technical knowledge and create a permanent infrastructure in the Salinas Valley and throughout California. Interventions need to occur at several levels. Efforts to change individual behaviors, as well as changes in policy and work practices are needed so the burden of protecting families and children is not placed solely on individuals. These efforts take time. However, the dissemination of knowledge and understanding gained through multiple efforts can lead to concrete changes that improve public and environmental health in the most affected communities.

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