Effect of Weatherization Combined With Community Health Worker In-Home Education on Asthma Control

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Objectives. We assessed the benefits of adding weatherization-plus-health interventions to an in-home, community health worker (CHW) education program on asthma control.

Methods. We used a quasi-experimental design to compare study group homes (n = 34) receiving CHW education and weatherization-plus-health structural interventions with historical comparison group homes (n = 68) receiving only education. Data were collected in King County, Washington, from October 2009 to September 2010.

Results. Over the 1-year study period, the percentage of study group children with not-well-controlled or very poorly controlled asthma decreased more than the comparison group percentage (100% to 28.8% vs 100% to 51.6%; $P = .04$). Study group caregiver quality-of-life improvements exceeded comparison group improvements ($P = .002$) by 0.7 units, a clinically important difference. The decrease in study home asthma triggers (evidence of mold, water damage, pests, smoking) was marginally greater than the comparison group decrease ($P = .089$). Except for mouse allergen, the percentage of study group allergen floor dust samples at or above the detection limit decreased, although most reductions were not statistically significant.

Conclusions. Combining weatherization and healthy home interventions (e.g., improved ventilation, moisture and mold reduction, carpet replacement, and plumbing repairs) with CHW asthma education significantly improves childhood asthma control. (*Am J Public Health.* 2013;104:e57–e64. doi:10.2105/AJPH.2013.301402)

Asthma is a major public health and environmental justice issue associated with multiple interacting environmental and other factors. Asthma prevalence and morbidity among all US children have increased dramatically in the past 2 decades and remain high.[1] Asthma disproportionately affects disadvantaged populations, who have a higher prevalence of the disease[1–4] and experience more severe impacts.[5–12] Being poor or a person of color is associated with increased rates of sensitization to several asthma-associated allergens.[13–20] Sensitization to airborne allergens is one of the main risk factors for developing asthma and its complications.[21–23]

Disparities in asthma morbidity and allergic sensitization may be due, in part, to disproportionate exposure to indoor environmental asthma triggers associated with substandard housing.[12,24,25] Moisture and dampness, poor ventilation, crowding, residence in multiunit dwellings, deteriorated carpeting, and structural defects can contribute to high levels of indoor asthma triggers.

In its Guide to Community Preventive Services,[26] the US Centers for Disease Control and Prevention (CDC) summarized studies[27–35] showing that home visits, in particular those performed by community health workers (CHWs) and addressing multiple asthma triggers, improve self-management behaviors, reduce exposure to triggers, decrease symptoms and urgent health care use, and increase quality of life. The US Department of Housing and Urban Development (HUD),[36] US Environmental Protection Agency,[37] and CDC[26] recommend home visits, and the National Asthma Education and Prevention Program[38] recommends that home visits be considered, but notes that this area needs more research.

The historical Seattle–King County Healthy Homes II (HH-II) project studied the effectiveness of CHW home visits for controlling asthma.[39] CHWs provided in-home education and helped participants implement action plans that addressed multiple triggers. The study found that the CHW home education program was relatively inexpensive, significantly reduced asthma morbidity and trigger exposure, and improved caregivers' quality of life. The HH-II study also found that adding CHW home visits to clinic-based asthma education yielded a clinically important increase in asthma-symptom-free days and modestly improved caretakers' quality of life.[39] However, the homes of many low-income asthmatic children needed structural interventions beyond the scope of the home visit program.

In this Highline Communities Healthy Homes Project, we used a quasi-experimental design to determine whether adding weatherization-plus-health structural interventions to an existing home CHW home visit program resulted in greater reductions in asthma morbidity and exposure to home asthma triggers than reductions achieved for the historical HH-II comparison group receiving CHW home education visits alone. Over 100 000 homes are weatherized each year,[40] yet we found no studies that examined the impact of weatherization work on resident asthma outcomes.

METHODS

We collected study data in homes of low-income children in the Highline communities in southwest King County, Washington. Enrollment of children and homes occurred between October 2009 and September 2010. Interested families having 1 or more children who used asthma medication during the school day and who had a medical verification of asthma diagnosis were referred by school district nurses to the public health department for phone eligibility screening. Families were eligible if they met the following study and weatherization program requirements:

- currently lived in Highline School District and intended to remain in the same home for at least 1 year;
- spoke English, Spanish, or Vietnamese;
- had 1 or more children with asthma who were 3 to 17 years old at enrollment;
- had not participated in other asthma programs in the past 3 years;
- had a child whose asthma control level met the National Heart, Lung, and Blood Institute (NHLBI)'s 2007 definition of not-well-controlled or very poorly controlled asthma[41];
- resided in a rental property and the owner was willing to participate; and
- were low income as defined by both HUD and weatherization programs (at or below HUD 80% annual median income and 60% of state median income or 200% of federal poverty level).

The county housing authority aided enrollment, using its weatherization permission form to ask whether any household member had respiratory issues and referring potential participants to the public health department. The housing authority sent weatherization application forms to those who passed the phone screening.

Participants drawn from the previous HH-II study served as this study's historical comparison group. Comparison group enrollment occurred between November 2002 and October 2004, with CHW home visits ending in November 2005. CHWs for both the study and comparison groups received the same training and followed similar home visit protocols. Comparison group eligibility criteria (similar to the study group criteria) were as follows: children aged 3 to 14 years with not-well-controlled or very poorly controlled asthma; income below 200% of the 2001 federal poverty threshold or child enrolled in Medicaid; caretaker's primary language English, Spanish, or Vietnamese; and residence in King County, Washington. The HH-II research team recruited comparison group children primarily through community and public health clinics.

Community Health Worker Home Visit Intervention

For both study and comparison groups, a CHW from the public health department obtained informed consent and conducted a baseline assessment of the home environment and a health interview, described elsewhere.[39,42] Over a 1-year period, the CHW made an average of 4 additional home visits to provide education and supplies. For the education component, the CHW worked with each family on a tailored set of actions to reduce asthma triggers, based on standard protocols,[39,42] including tailored educational messages and demonstrations about medical management of asthma and trigger reduction. During the first education visit, the CHW provided allergen-impermeable bedding encasements for the study child's bed, a low-emission vacuum, vacuum bags, a cleaning kit, a peak flow meter so the caregiver could periodically monitor the asthmatic child's breathing, an inhaler spacer if needed, an asthma medication and action plan storage box, and low-literacy educational materials. At the exit visit, approximately 1 year after the first visit, a CHW repeated the home environment assessment and the health interview.

Weatherization-Plus-Health Structural Interventions

County housing authority personnel conducted a weatherization-plus-health audit that determined the scope of structural interventions. The "weatherization" part included diagnostic home air tightness measurements, combustion safety testing, a heating system assessment, and an assessment of moisture-related problems. The housing authority used the US Department of Energy–approved Targeted Residential Analysis Energy Tool (TREAT) software to determine weatherization work specifications, including energy upgrades, related repairs, and health and safety improvements, with work varying in intensity and cost depending on the type of dwelling (apartments vs duplexes or single-family homes).

The "health" part of the audit included an assessment of asthma triggers that could be treated through additional structural interventions beyond routine weatherization, primarily in the bedroom and main play areas of the child with asthma. Weatherization-plus-health interventions performed in at least 35% of the study group homes are listed in Table 1. The median total cost of weatherization-plus-health interventions was $4200 for apartments and $6300 for duplexes or single-family dwellings.

Environmental Measures

In the study and comparison groups, the CHW completed a home environment checklist and an interview with the primary caregiver, both described elsewhere,[39,43] to assess home conditions and identify the presence of 6 asthma triggers: pets, smoking inside the home, cockroaches, rodents, mold, and water damage. At baseline and exit visits, we calculated a "trigger score" for each home, with scores ranging from 0 to 6 depending on the number of triggers identified by methods described elsewhere.[43]

In a subset of study homes, we used a standard HUD method[44] to assess exposure to asthma-related allergens (dust mite, cockroach, and mouse) through floor dust vacuum sampling in the study child's bedroom, living room, and kitchen at baseline and exit visits. We marked an area of approximately 3 sq ft adjacent to upholstered furniture in the living room and adjacent to and slightly under the bed in the child's bedroom, with each area vacuumed for approximately 2 minutes. On bare floors, we sampled more than one 3 sq ft area if needed to collect sufficient dust for analysis. In the kitchen, we sampled the floor perimeter along the base of walls, appliances, and cabinets. Laboratory analysis was by the Multiplex Array for Indoor Allergen (MARIA) method (Indoor Biotechnologies, Charlottesville, VA) for dust mite allergens Der f1 and Der p1, Mite Group 2 (combination of Der f2 and Der p2), cockroach allergen Bla g2, and mouse allergen Mus m1.

Clinical Outcome Measures

Using interview data, we classified each participating child's asthma as well controlled, not well controlled, or very poorly controlled in accordance with NHLBI guidelines.[41] The interview included the Pediatric Asthma Caregiver's Quality of Life Questionnaire score,[45] ranging from 1 to 7, with higher scores indicating better quality of life and a change of 0.5 units being clinically significant. Interview data included use of asthma-related urgent clinical care during the previous 12 months (including an overnight stay in hospital, emergency room visit, or unscheduled clinic visit)

TABLE 1—Most Frequently Performed Weatherization-Plus-Health Structural Interventions: Highline Communities Healthy Homes Project, October 2009–September 2010

	Dwellings With Task, %	
Task	Apartments (n = 11)	Duplexes and Single-Family Dwellings (n = 23)
Install bathroom fan timer(s)	82	87
Replace bathroom fan(s)	64	74
Insulate water pipes	27	78
Replace carpet[a]	91	48
Install CO detector	18	74
Repair or replace ductwork[b]	27	61
Insulate home[c]	18	61
Reduce air infiltration	18	57
Install smoke detector(s)	18	48
Weather-strip door(s)	18	48
Insulate or seal ductwork[d]	0	52
Replace light fixture(s)	18	43
Install CFLs	18	35
Install crawl space vapor barrier	9	35
Repair electrical issue(s)	18	30
Repair plumbing	9	35
Install door sweep	0	35
Replace door(s)	0	35
Replace kitchen range hood	18	26
Replace dryer hood	9	26

Note. CO = carbon monoxide; CFL = compact fluorescent lamp. The table presents interventions performed in at least 35% of study group dwellings. A full list of weatherization-plus-health interventions is available as a supplement to the online version of this article at http://www.ajph.org.
[a]In various homes, carpets were replaced with low-volatile-organic-compound (low-VOC) carpets, laminate flooring, vinyl, refinished hardwood, or a combination of carpet and laminate.
[b]Includes replacing bathroom fan duct, installing passive roof vent, venting kitchen exhaust fan, cleaning dryer duct, installing heat vent, repairing baseboard heater, repairing dryer vent, repairing duct and heating, ventilation, and air conditioning (HVAC), replacing crawlspace duct, replacing duct, venting bathroom fan, and replacing dryer duct, to improve ducts and vents.
[c]Includes insulating attic, walls, ceiling, or crawlspace, or a combination of these locations, all done to prevent air leakage into or out of the home.
[d]Includes insulating HVAC ducts, sealing ducts, and insulating furnace walls, all done to prevent energy leakage from various heating and air conditioning systems.

and self-reported asthma attacks in the previous 3 months.

Statistical Analysis

We used the χ^2 test to determine whether there was a difference in baseline demographic and other characteristics between the study and comparison groups (Table 2). Type of residence was the only significant difference between the 2 groups, with 32% of study group children living in apartments compared with 53% of comparison group children ($P = .049$). Because type of home could influence the type of weatherization-plus-health interventions conducted in a given dwelling, we adjusted for these differences using propensity score weighting, controlling for the differences between the 2 groups; this resulted in an unbiased estimation of the treatment effect. To create the propensity score, we used a logistic regression model to predict the log-odds of being in the study group vs the comparison group. The regression model was based on child's age (3–6 vs ≥ 7 years), apartment versus house, winter (December 21–March 20) data collection period (yes vs no), and year of construction (1940–1959, 1960–1979, or 1980–2009).

We used propensity score weighting for all analyses except for descriptive statistics about the structural interventions (Table 1) and baseline household demographics (Table 2). Although propensity score weighting was unnecessary for within-group comparison of baseline versus exit visit data, we used it for consistency.

For yes-or-no interview questions, we used the McNemar test to test the hypothesis that the percentage of people within each group who answered yes to a question was different at baseline versus exit visit. When all people had the same responses at both times, we could not calculate the P value. We used a logistic model to test whether or not the log-odds of yes answers was different for the study vs comparison groups, controlling for the baseline response for each variable.

For categorical variables with answers representing some order of intensity (e.g., very sure, somewhat sure, not sure at all), we used the Cochran-Mantel-Haenszel row mean score to test whether responses were the same at the baseline and exit visits. For questions involving the number of days, quality-of-life scores, number of visits, and number of triggers, we used the paired t test to test whether there was a significant change in the means from baseline to exit visit. For these same variables, we used the 2-sample t test to determine whether the mean change from baseline to exit visit was significantly different between the study and comparison groups. For all tests, we defined statistical significance as $P < .05$.

We used McNemar's test to determine whether the percentage of allergen samples with concentrations at or above the detection limit (DL) was the same at baseline and exit visits.

RESULTS

The study team enrolled 45 households, of which 34 were retained through the 1-year follow-up visits (76% retention rate). The 34 study households had low annual incomes, and the education of most caregivers was either less than high school or a high school diploma or GED (Table 2). Almost half (47%) of enrolled children were Hispanic, 21% were Vietnamese, and 18% were African American.

TABLE 2—Baseline Household Characteristics: Highline Communities Healthy Homes Project, October 2009–September 2010

Characteristic	Study Group (n = 34), %	Comparison Group (n = 68), %	P[a]
Child's age, y			.327
3–6	41	51	
7–17	59	49	
Dwelling type			.049
Single-family	68	47	
Apartment (≥ 3 units)	32	53	
Caretaker's education			.79
< high school	44	41	
High school graduate or GED	21	21	
Some college	35	35	
College graduate		3	
Child's race/ethnicity			.74
African American	18	16	
Hispanic	47	46	
Other Asian/Pacific Islander	6	10	
Other or unknown	3	7	
Vietnamese	21	12	
White	6	9	
Child's asthma control			.779
Not well controlled	50	53	
Very poorly controlled	50	47	
Child's gender			.253
Male	68	56	
Female	32	44	
Primary language in home			.953
English	50	49	
Spanish	32	35	
Vietnamese	18	16	
Season of data collection			.241
Not winter	71	81	
Winter[b]	29	19	

[a]Based on χ^2 test to determine whether study group baseline characteristics were different from those of the comparison group.
[b]December 21 to March 20.

Fifty percent of households reported English as the primary language, 32% reported Spanish, and 18% reported Vietnamese. The average time between the baseline and exit data collection visits for the study group was 12 months (range = 11–15 months), compared with 14 months (range = 8–24 months) for the comparison group.

Clinical Outcomes

Between baseline and exit visits, the percentage of study group children whose asthma was either not well controlled or very poorly controlled significantly improved, from 100% to 28.8% ($P < .001$; Table 3). The comparison group also had a significant improvement, from 100% to 51.6% ($P < .001$); however, the study group's absolute percentage reduction was significantly greater than that of the comparison group ($P = .04$). Moreover, the study group's improvement in caregivers' quality of life exceeded that observed for comparison group caregivers ($P = .002$) by 0.7 units, a clinically important difference.

For the following measures, the study group showed greater improvement than the comparison group, but the across-group difference in improvement did not reach statistical significance:

1. percentage of children with urgent clinical care visits in the previous 12 months;
2. mean symptom-free days in previous 2 weeks;
3. mean days of limited activity in previous 2 weeks;
4. mean days of rescue medicine use in previous 2 weeks; and
5. mean nights with symptoms in previous 2 weeks.

The improvement in the mean number of asthma attacks in the previous 3 months for the comparison group marginally exceeded that of the study group ($P = .092$).

Asthma Triggers

The percentage of study group homes with visible evidence of mold, and of those with water damage, condensation, leaks, or drips, significantly decreased from baseline to exit (Table 4; $P < .001$ and $P = .01$, respectively). The percentage of study group homes with visible evidence of rodents marginally decreased ($P = .087$). Although the decline in the percentage of homes with indoor smoking was not significant ($P = .128$), a low percentage of caregivers reported indoor smoking at baseline (6.9%), and by the end of the study, no caregivers reported indoor smoking. Although visible signs of cockroach exposure appeared to increase from baseline to exit (14.3% to 25.3%), this increase was not significant ($P = .17$).

Study group improvements in mold and water damage issues significantly exceeded those of the comparison group ($P = .078$ [marginally significant] and 0.029, respectively). The decline in overall exposure of study group children to asthma triggers (baseline and exit trigger scores = 1.8 and 0.8, respectively) was marginally significantly greater than that of comparison group children (baseline and exit trigger scores = 1.2 and 0.7, respectively; $P = .089$).

Allergens

Overall, Bla g2 was infrequently detected in study group homes (n = 16), with median

TABLE 3—Children's Asthma Clinical Outcomes: Highline Communities Healthy Homes Project, October 2009–September 2010

	Study Group					Comparison Group					
Outcome	No. of Children	Baseline, % or Mean	Exit, % or Mean	Percentage-Point Change (95% CI)	P^a	No. of Children	Baseline, % or Mean	Exit, % or Mean	Percentage-Point Change (95% CI)	P^a	Study vs Comparison P^b
Asthma not well controlled or very poorly controlled, %	33	100	28.8	-71.2 (-87.1, -55.2)	< .001	68	100	51.6	-48.4 (-60.7, -36.2)	< .001	.04
Urgent clinical care in previous 12 mo, %	34	93.5	61.8	-31.7 (-47.8, -15.5)	.01	61	89.9	66.2	-23.6 (-36.5, -10.7)	.003	.553
Symptom-free days in previous 2 wk, mean	34	8.4	11.9	3.5 (2.0, 5.0)	< .001	68	8.8	11.8	3.1 (1.7, 4.5)	< .001	.673
Asthma attacks in previous 3 mo, mean	34	1.7	0.9	-0.8 (-1.5, -0.1)	.027	66	3.5	1.2	-2.3 (-4.0, -0.7)	.006	.092
Caretaker's quality of life, mean	34	5.1	6.7	1.6 (1.3, 2.0)	< .001	68	5.3	6.2	0.9 (0.6, 1.2)	< .001	.002
Days activity limited in previous 2 wk, mean	34	3.2	0.5	-2.7 (-3.8, -1.6)	< .001	68	2.5	0.9	-1.6 (-2.6, -0.6)	.002	.139
Days rescue medicine used in previous 2 wk, mean	34	5.7	1.7	-4.0 (-6.1, -2.0)	< .001	68	5.0	2.2	-2.8 (-4.2, -1.4)	< .001	.338
Nights with symptoms in previous 2 wk, mean	34	2.8	0.4	-2.4 (-3.5, -1.3)	< .001	68	2.9	1.2	-1.7 (-2.8, -0.5)	.005	.376

Note. CI = confidence interval.
[a]Based on paired *t* test comparing within-group change from baseline to exit visit.
[b]Based on 2-sample *t* test comparing within-group change across groups or logistic regression comparing exit visit values adjusted for baseline values across groups.

levels at baseline and exit visits less than its DL of 0.196 μg/g. Although Bla g2 was generally less frequently detected at the exit visit (6%, 6%, and 0% ≥ DL in child's bedroom, kitchen, and living room, respectively) than the baseline visit (6%, 19%, and 12% ≥ DL, respectively), these decreases were not significant. Dust mite allergen, particularly Der p1 (the predominant dust mite species in the Seattle area[46]) and Mite Group 2, was detected more frequently than Bla g2. The percentage of Der p1 results equal to or greater than the DL significantly decreased from baseline (75%) to exit visit (44%) in the living room ($P = .059$ [marginally significant]), but there was no significant change in the child's bedroom (75% to 69%). The percentage of Mite Group 2 sample results equal to or greater than the DL significantly decreased between baseline and exit visits in both the child's bedroom (94% to 75%, $P = .083$ [marginally significant]) and the living room (75% to 44%, $P = .025$). Mus m1 showed a significant increase in the percentage of results equal to or greater than the DL in both the kitchen (25% to 62%, $P = .014$) and living room (37% to 81%, $P = .008$); however, the majority of Mus m1 results were very low, with medians at or just above the DL of 0.002 in all locations. A summary of baseline and exit visit allergen concentrations is available as a supplement to the online version of this article at http://www.ajph.org.

DISCUSSION

This study suggests that adding weatherization-plus-health structural interventions to an existing CHW educational asthma home visit program results in greater benefits in asthma control and asthma-related quality of life. There were also improvements in mold, water damage, and child exposure to asthma triggers over and above those found in households receiving CHW education visits alone.

This study complements the Breathe Easy Home (BEH) study, which examined the impact of CHW education and newly constructed asthma-friendly homes and used the same historical comparison group. Similar to our study, the BEH Study found significant improvements in children's asthma control, asthma-symptom-free days, frequency of urgent clinical care visits, and caretakers' quality of life[43];

TABLE 4—Asthma Triggers Found in Homes: Highline Communities Healthy Homes Project, October 2009–September 2010

	Study Group					Comparison Group					
Outcome	No. of Homes	Baseline, % or Mean	Exit, % or Mean	Change (95% CI)	P^a	No. of Homes	Baseline, % or Mean	Exit, % or Mean	Change (95% CI)	P^a	Study vs Comparison P^b
Any pet, %	34	27.1	24.0	-3.2 (-19.2, 12.9)	.729	55	17.2	29.9	12.7 (-1.4, 26.8)	.098	.326
Mold, %	34	53.5	7.0	-46.5 (-63.9, -29.2)	< .001	68	48.7	21.0	-27.7 (-42.1, -13.3)	.001	.078
Cockroaches, %	34	14.3	25.3	11.0 (-4.4, 26.5)	.17	63	13.1	12.0	-1.2 (-13.2, 10.9)	.856	.11
Rodents, %	34	15.6	2.2	-13.4 (-25.3, -1.6)	.087	61	6.7	3.5	-3.2 (-9.7, 3.3)	.371	.424
Smoking inside home, %	34	6.9	0.0	-6.9 (-15.7, 1.9)	.128	65	1.8	3.2	1.4 (-1.5, 4.3)	.419	.998
Water damage, condensation, leaks, or drips, %	34	60.6	24.1	-36.4 (-54.9, -18.0)	.01	68	34.4	4.9	-29.5 (-2.5, -16.6)	< .001	.029
Trigger score[c], mean	34	1.8	0.8	-1.0 (-1.4, -0.5)	< .001	68	1.2	0.7	-0.5 (-0.8, -0.2)	.001	.089

Note. CI = confidence interval.
[a]Based on McNemar's test to test the hypothesis that the percentage of people within each group who answered yes to a question was different at the baseline vs the exit visit.
[b]Based on a logistic model to test that the log-odds of yes answers in the study group were different from those in the comparison group, controlling for the baseline response for each variable.
[c]The trigger score was 0 to 6, depending on the number of triggers identified.

however, the improvements observed for the BEH group, although greater than those for the historical-education-only group, were not significantly greater. The improvements observed in our current study were generally greater than those observed in the BEH study. For example, the asthma control improvement of the study group versus comparison group was approximately 20% in the current study and 5% in the BEH study. Caregivers' quality of life improved by 0.7 units in the study group over that of the comparison group in the current study, compared with 0.2 units in the BEH study. Improvements in asthma trigger scores, however, were greater in the BEH study than in the current study (score reduction of 0.69 vs 0.5). More research is needed to determine why asthma outcome improvements observed for weatherizing existing homes were greater than those observed for constructing new, asthma-friendly homes.

The types of structural interventions and costs varied considerably depending on the type of dwelling in which the study child resided. Roughly one third of enrolled homes (32%) were apartments in multifamily buildings; the remaining 68% were duplex or single-family dwellings. Additional interventions that supplemented the more routine weatherization repairs, such as carpet replacement and bathroom fan installation, were generally performed both in apartments and in duplexes and single-family dwellings. However, the housing authority could perform only limited weatherization interventions in single apartments of multifamily buildings because they were not treating the whole building. In a routine weatherization program, the housing authority would treat an entire multifamily building if 50% or more of the residents were eligible in terms of income. However, because this study began with enrollment of asthmatic children instead of enrollment of homes needing weatherization, the housing authority could treat only the study child's apartment. The median weatherization cost for duplexes and single-family dwellings ($4181) was nearly twice as high as that for apartments ($2243), whereas median costs for the additional interventions were similar (apartment = $3005; duplex or single-family dwelling = $3103). The small sample size prevented evaluation of the impact of variable intervention intensity on asthma outcomes.

Study group caregivers did not have substantially greater improvements in cleaning activities than the comparison group (data not shown), suggesting that the observed reduction in asthma triggers was more likely related to weatherization improvements and less to caregivers' education and actions. The weatherization improvements may have also yielded the reductions in dust mite allergen levels and reduced moisture and water damage in study group homes.

We observed only a modest decline in visible evidence of rodents and a small increase in visible evidence of cockroaches. Integrated pest management was not a formal part of the weatherization-plus-health interventions. CHWs did emphasize the behavioral components of integrated pest management, including proper food material storage and disposal. CHWs also performed a one-time cleaning training session in homes with visible cockroach problems. The study findings, including the lack of significant improvements in Mus m1 allergen levels, suggest that education and one-time cleaning alone is insufficient to reduce pest-related asthma triggers.

Strengths and Limitations

Study strengths included a high retention rate, the availability of a comparison group, and inclusion of vulnerable populations. Because the work was done in real-world settings, it is probably generalizable to other weatherization programs.

This study also has limitations. Blinding of the study team was not possible. A randomized controlled design was infeasible because the way homes are processed through the weatherization program precludes randomization. The robust findings of this observational study, however, support the conclusion that a package of weatherization-plus-health interventions and education yield greater improvements in asthma control. As with all intervention studies, the placebo effect may account for some of the findings; however, such placebo effects may be considered a useful intervention, yielding health benefits. The small study size and duration did not permit a formal economic analysis, but the greater decline in urgent health care use in the study group, although not significant, suggests that the intervention has the potential to generate health cost savings. If structural interventions are durable, longer-term follow-up might reveal greater health improvements. Because of the small sample size, we could not control for multiple comparisons. It would also be beneficial to study the impact of weatherization alone on child health outcomes. In general, weatherization programs are limited in the types of repairs they can make compared with a more holistic approach that has both weatherization and healthy homes funding.

Conclusions

A comprehensive program combining an intensive CHW in-home education program with structural weatherization-plus-health interventions substantially improved asthma control and caregivers' quality of life and significantly reduced the presence of home asthma triggers. These improvements were significantly greater than those observed in households that received asthma education visits alone. Improved coordination among weatherization and public health programs may result in greater improvements in both the home and the health of children with asthma. ■

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Contributors

J. Breysse, a subgrantee project manager, aided in the overall study design and implementation, oversaw evaluation data collection and analysis, and was the primary author of the article. S. Dixon, the study biostatistician, was responsible for data management and statistical analysis. J. Gregory, the primary grantee project manager, aided in the overall study design and implementation and recruitment of homes, determined the weatherization work to be done and oversaw and documented that work, and collected allergen samples. M. Philby, a subgrantee program manager, oversaw the enrollment of residents, managed the community health worker visits, oversaw health and visual assessment data collection, and managed the health and visual assessment data. D. E. Jacobs, the subgrantee principal investigator, aided in overall study design and contributing to the data interpretation. J. Krieger, a subgrantee co-principal investigator, aided in the study design, data analysis, and interpretation of study findings, and oversaw the provision of comparison group data.

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Note. The authors are solely responsible for the accuracy of the statements and interpretations contained in this publication. Such interpretations do not necessarily reflect the views of the US government.

Human Participant Protection

The University of Washington's human subjects review committee approved this study prior to any data collection.

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