Asthma Control: Home-based Multi-trigger, Multicomponent Environmental Interventions

Summary Evidence Tables -- Economic Review

Lead Author, Year Study Design Economic Method	**Study Location Sample Size Population Characteristics Time Horizon**	**Intervention Description**	**Environmental Remediation Education Focus Home Visitor Number of Home Visits**	**Select Effectiveness Outcomes[1]**	**Program Costs[2]**	**Direct Medical Costs Averted Productivity Losses Averted**	**Full Economic Summary Measure**
Barton, 2007 RCT of houses Cost analysis	Torquay, England 119 total, 49 received intervention (1 dropped out), and 69 served as the control (most received the intervention the following year). The city is a popular resort, but the income of the residents is unequal with some in poverty, and the residents of the neighborhood have the highest out of hours visiting rate by family doctors in the town. Homes were improved over a seven month time period. The time between the completion of the intervention and collection of health data was variable, but it was usually 6-9 month.	The intervention consisted of home improvements to bring the houses up to current standards and included re-roofing, full central heating, rewiring, ventilation systems, double glazed doors, cavity wall and roof insulation.	Major environmental remediation -- Nurse 1 home visit	--	Per household: $14,858 Total: $728,042 No list of costs provided—limited cost information	-- --	N/A

[1] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[2] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[3]	Program Costs[4]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Somerville, 2000 Before-and-after Cost analysis	Cornwall, UK 87 households with baseline survey, an intervention, and children with asthma less than 16 years old; 59 households with 72 children with asthma followed up Households with an asthmatic child ages 0-15 living in damp council housing were identified through information on file within the housing departments, health visitors, asthma liaison nurses and pediatricians. Most children lived in semi-detached housing, with pets, smokers, and two or more adults. The intervention length was not explicitly stated. The reviewers assume it varied since the intervention was major remediation of the home. The mean follow-up time period was 11.7 months and the range was 3-22 months.	Each of the 59 homes received a new form of heating, either gas central heating, electric storage heaters, solid fuel central heating, or oil-fired central heating. Home visits were carried out by local housing officers, who assessed the housing conditions and also administered a respiratory system and school days lost questionnaire with the child and/or parent. Post-intervention measures were compared to the baseline; however, there was large variation in the time between questionnaires.	Major environmental remediation --- Local Housing Officer 2 home visits	Reduction in school days lost due to asthma*	Per household: $6,424 Total: $558,888 (Reviewers computed, assuming 87 households received the intervention) No list of costs provided—limited cost information	-- --	N/A

[3] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[4] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[5]	Program Costs[6]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Kercsmar, 2006 RTC (modified: there were 6 children re-assigned against random-ization) Cost-analysis	Cuyahoga county, Ohio 62 children were randomized (29 to the intervention group and 33 to the control group) Children between 2 and 17 years of age at the time of recruitment, had physician-diagnosed asthma for at least 3 months before enrollment, English speaking, and had at least 2 ED visits or at least 1 hospitalization in the preceding 12 months The intervention was conducted within the first 4-5 months of the study and participants were followed for 12 months.	All participants were evaluated by a pediatric pulmonologist, given an asthma action plan and given in depth instruction on the use of their medical treatment plan and use of medication and equipment. The intervention group received environmental remediation directed at reducing water infiltration, removal of water-damaged materials, alterations of heating/ventilation/air conditioning, lead hazard control, and environmental cleaning. Dust sampling of the home occurred at baseline, and at 6 months and 12 months after randomization. The families in the control group received home cleaning information and were offered remediation at the end of the study.	Major environmental remediation Self-management 5 home visits Sanitarian	Decrease in ED/inpatient visits* (6 month to 12 months follow-up) Increase in symptom free days; decrease in acute care visits	Per household: $3,796 Total: $110,084 (computed, per household cost multiplied by 29, the number of people in the intervention group). Costs included: the text reports the program cost as the "mean cost of remediation per household" and may not include clinic visits, lab costs, and labor; no list of costs provided—limited cost information	-- --	N/A

[5] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[6] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[7]	Program Costs[8]	Direct Medical Costs Averted Monetized Productivity Losses Averted	Full Economic Summary Measure
Eggleston, 2005 RCT of households Cost analysis	Baltimore, Maryland 100 children randomized, 3 dropped out (group not specified) and 97 completed the study The intervention was conducted for 1 year	Each family in the treatment group was given a room sized HEPA filter for the child's bedroom (the on switch was locked and it had a computer device), allergen-proof mattress and pillow encasings and plastic food containers. Families with cockroach and mouse infestation were professionally treated and mouse entry holes were closed. An environmental educator visited the home three times and called once.	Moderate environmental remediation Environmental education Environmental educator, exterminator 3 home visits	--	Per child: $554 Total: $27,700 (computed, based on the assumption of 50 participants in the treatment group) Costs included: mattress and pillow encasings, room HEPA filter, pest control visits, and educator visits; the cost per component was not provided – partially complete cost information	-- --	N/A

[7] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[8] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[9]	Program Costs[10]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Primomo, 2006 Before-and-after Cost-analysis	Tacoma-Pierce County, Washington 197 families received services; 105 consented to participate in the evaluation study and 60 completed follow-up surveys. The respondents were typically the child's parent (98%), female (95%) and had attended college or had a college degree (62%). One third (34%) reported an annual income of less than $20,000 and half (49%) were Caucasian. Program was conducted 2001-2003; follow-up was approximately 1 month after baseline but varied.	The asthma outreach worker conducted home visits, which included environmental assessment and asthma education. Families were supplied with allergen proof pillow and mattress covers, doormats, spacers and facemasks, and peak flow meters. Additionally letters were sent to the health care providers outlining home visit findings and recommendations for environmental changes in the home. mean visits (2.24); mean follow-up calls (2.6); mean length of service (5 weeks)	Minor environmental remediation Self-management and environmental education Outreach worker 2 home visits	Decrease in hospitalizations*; decrease in the prescribed use of quick-release medications* Decrease in ER visits; increase in unscheduled physician visits; increase in long-term control medicines	Program cost per family: $231 Total cost of program: (Reviewers computed, per family cost multiplied by 197--those who received the intervention): $45,507 Costs included: overhead, travel, supplies, and labor; cost per component provided—satisfactory cost information	-- --	N/A

[9] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[10] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[11]	Program Costs[12]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Lin, 2004 Before-and-after Cost-analysis	8 counties in New York Not explicitly stated The program sought: households with minorities, children under 14, residents with less than high school education or with an annual income of less than $16,452. Intervention length is not explicitly stated; 12 months follow-up time	Program interventions include providing education, various environmental controls (mattress and pillow covers, furnace filters, rodent baits, cleaning equipment, and vacuums) and referrals to other agencies related to the goals of the Healthy Neighborhoods Program. Visitors provided education regarding asthma management, community services, and reducing asthma triggers. Home visits also included activities related to fire, CO, lead, falls risk assessment and reduction.	Moderate environmental remediation Self-management and environmental education Outreach worker 2 to 3 home visits	Decreased rate of hospitalizations (hospital admissions and ER visits)*	The study reports total encumbrances for the total Healthy Neighborhoods Program (HPN) and the authors ascribe roughly 50% of costs to asthma related activities. The total cost of the program for 4 years: $3,128,653 (Reviewers computed from table 6, this is 50% of total program costs based on the above assumption) Average cost per visit was $96 in 1997, $102 in 1998, $69 in 1999, and $103 in 2000.	Authors report a cost savings in 2000, but the data and the analysis used to reach that conclusion are not clear. --	N/A

[11] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[12] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[13]	Program Costs[14]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Outman, 2007 Before-and-after Cost-benefit analysis	Greater Minneapolis-St. Paul Metropolitan area 64 children at baseline and 20 at the 12 month follow-up Children less than 19 years with a physician-diagnosed of persistent asthma, under a physician care and on daily preventive medications 12 months	A certified Asthma Educator/respiratory therapist taught the families about environmental triggers of asthma. The following environmental remediation products and services were provided as needed: mattress and pillow encasements, HEPA filters for gas forced air furnace, HEPA room air cleaners, HEPA vacuum cleaners and bags, dehumidifiers, and integrated pest management. Families were also educated on reducing environmental asthma triggers.	Moderate environmental remediation Environmental education Certified asthma educator/ respiratory therapist 3 home visits	Reduction in unscheduled visits*; number of times oral prednisone was used*; school days lost* Increase in ER visits and decrease in hospital visits	Per enrollee: $497 Total: $31,808 (Reviewers computed, assumed 64 received the intervention) Costs included: initial home assessment, remediation products, and product delivery (not sure if this includes the cost of follow-up visits and phone calls); cost per component provided—satisfactory cost information	Direct medical costs averted per enrollee: $2,637 Direct medical costs averted included: hospitalizations and unscheduled visits Source of dollar estimates: charges per claim and Medicare cost-to-charge ratios	Benefit-Cost Ratio: 5.3

[13] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[14] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[15]	Program Costs[16]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Jowers, 2000 Before-and-after Cost-benefit analysis	Western Pennsylvania 317 at the 6-month follow-up and 62 at the 12-month follow-up. All participants in the program were members of a single Medicaid managed care plan. People with an asthma related hospitalization or ER visit during the preceding 12 months were invited to participate; 61% female and 53% 15 years old or younger Intervention time period not explicit; follow-up at 6 and 12 months.	The program consisted of provider education and patient education, including an asthma action plan, management of medication, devices, and triggers. Patients received 2 home visits by nurses regarding asthma management, trigger assessment and education for remediation/abatement. Patients received between 4 (moderate asthma) and 6 (severe asthma) proactive phone calls by care management nurses and were encouraged to contact nurses when they were symptomatic.	Minor environmental remediation Self-management Nurse 2 home visits	At 12 months: Reduction in ER visits*, hospital days*; unscheduled doctor visits*; oral steroid use*; decreased adult, caretaker, and child missed days* Decrease in ICU admissions	Per child: $377 Total program costs: $119,509 (computed, using per patient program cost table 2 multiplied by 317, the number of participants at 6 months) No list of costs provided—limited cost information	Direct medical costs averted per child: $2,181 per child at 12 month follow-up Direct medical costs averted included: ER visits, hospital days, ICU admissions, and doctor visits. Source of dollar estimates: billing quotes from a survey of Denver hospitals and allergists' offices multiplied by .75 Productivity loss averted per child: $772 Source of wage estimates: Bureau of Labor Statistics	Benefit-cost ratio: 7.8

[15] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[16] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[17]	Program Costs[18]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Shelledy, 2005 Before-and-after Cost benefit analysis	Little Rock, AR There were 18 children in the study The children were identified to have high use of ED and hospital for at least 2 consecutive years; 12 male, 9 Hispanic, 11 covered on Medicaid and 2 without insurance, ages 3-18 Intervention length appeared to be 8 weeks. Participants were followed for 12 months.	The intervention consisted of weekly home visits by the respiratory therapist. Topics covered in the visits included: identification and education about triggers and their control (Only week 1 and Week 3); correct use of meds; monitoring symptoms with equipment; develop and follow care plan; correct use of peak-flow meters and nebulizers; administration of medicines; outreach and discuss with school nurse as needed; reports to physician. The educational materials were developed by NHLBI	Minor environmental remediation Self-management and environmental education Respiratory therapist 8 home visits	Decreases in hospitalizations*; ICU days*; non-ICU hospital days*; hospital length of stay*; ED visits*; doctor's office visits*; school days missed*	Per child: $721 (Reviewers computed; per visit cost multiplied by 8) Total program cost: $12,978 (Reviewers computed; per child program cost multiplied by 18) Costs included: respiratory therapist visits; cost per component is not provided—partially complete cost information.	Direct medical costs averted per child: $10,093 Direct medical costs averted included: hospitalizations, ICU days, non-ICU hospital days, hospital length of stay, ED visits, doctor's office visits Source of dollar estimates: facility fees provided by the business office of the hospital --	Benefit-cost ratio: 14.0

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[18] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[19]	Program Costs[20]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Krieger, 2005 RCT with low and high intensity arms Cost-effectiveness analysis	King County, WA High intensity group had 110 households and low intensity had 104. Households with an asthmatic child 4-12 years age; all households were below 200% of the Federal poverty line; White (21%), Black (28%), Vietnamese (22%), Hispanic (18%) 1 year intervention and 6 months follow-up	Home visits were conducted by community health workers. Low intensity group received: one home visit, remediation action plan, bedding covers and cases, and limited education. The high intensity group received: an initial home visit plus 4-8 additional visits, environmental assessment and action plan, education on asthma control, smoking cessation, trigger abatement/ control, and resources to reduce exposure (door mats, vacuum cleaners, roach/ rodent bait and assistance, and cleaning kits).	Moderate Environmental education Community health workers 5-9 home visits	High-intensity group compared to low-intensity group: reduced urgent health services*(hospital admissions, ER visits, and unscheduled clinic visits) Decrease in symptom free days Reviewers computation of incremental change in SFDs: SFD per 2 weeks at base minus at exit for high intensity was 4.7 SFD per 2 weeks at base minus at exit for low intensity was 3.9. Incremental increase in SFD due to high intensity per year is [(4.7-3.9)*26] = 20.8 SFDs per year	Marginal program cost of the high intensity arm in comparison to the low intensity arm per child per year: $1,316 (total program cost was not reported) Costs included: Personnel costs including salary and benefits, supplies, rent, travel, office expenses, and other indirect charges; cost per component was not provided—partially complete information	Direct medical costs averted per child per year: Range $124-$147 (Reviewers computation: the estimated decrease in 2-month costs between the base line and exit ranged from $258.66 to $429.81 per child, and within the low intensity group, they ranged from $238.07 to $405.36; the difference is $20.59 to $24.45 every 2 months or $124 to $147 annualized) Direct medical costs averted included: hospitalizations, ER visits, and unscheduled clinic visits. Sources of dollar estimates: Sullivan et al. 2002, Stroupe et al. 1999, and Lozano et al. 1997 for low estimate and Washington State Medicaid Program and Weiss et al. 2000 for high estimates --	Incremental-cost effectiveness ratio: $56 to $57 per SFD

[19] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[20] All costs are in 2007 dollars

Lead Author, Year Study Design Economic Method	Study Location Sample Size Population Characteristics Time Horizon	Intervention Description	Environmental Remediation Education Focus Home Visitor Number of Home Visits	Select Effectiveness Outcomes[21]	Program Costs[22]	Direct Medical Costs Averted Productivity Losses Averted	Full Economic Summary Measure
Kattan, 2005[23] RCT with block randomization Cost-effectiveness analysis	7 cities: Boston, Bronx, Chicago, Dallas, New York, Seattle and Tucson 937 children were randomized (469 to the intervention group); 800 children had complete data for 2 years, 408 in the treatment group and 392 in the control group Children with asthma who had at least one hospitalization or 2 unscheduled visits 6 months prior to enrollment 1 year for the intervention, 1 year follow-up	Environmental counselors completed median of 5 home visits over 12 months and phone interviews were collected every two months to collect data on asthma symptoms and medication use over the past two weeks. Environmental counselors implemented remediation of exposure to dust mites, passive smoking, cockroaches, pets, rodents, and mold. The modules delivered were tailored to the environmental risk and allergen skin test sensitivity to each child. All homes in the treatment group were given dust mite remediation strategies and were provided with impermeable mattress and pillow covers. It is unclear how many visits the control group received.	Moderate environmental remediation Environmental education Environmental counselor (high school graduates) 5 to 7 home visits	Reduced number of unscheduled visits*; beta-2 agonist inhalers used per year*; increase (37.8) in symptom free days over two years* Decrease in the number of scheduled medical visits; ER visits, inpatient hospital days; anti-inflammatory medication; increase in cromolyn inhalers	Per child: $1,720 Total cost: $806,680 (Reviewers computed, assuming 469 received the intervention) Costs included: skin tests, remediation products, salary, travel, and pest management; the study provides costs per component – satisfactory cost information Note: both costs and cost averted were discounted at 3% the second year.	Medical costs averted per child for 2 years: $555 Direct medical costs averted included: scheduled medical visits, unscheduled clinic visits, ER visits, impatient hospital day, medication Source of dollar estimates: Medicaid reimbursement survey, Sullivan et al. 2002, HCUP, The Medical Letter, Drug Topics Red Book	$30.82 per SFD

[21] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[22] All costs are in 2007 dollars
[23] Morgan, 2004 also reports program cost of this intervention. Since Kattan 2005 provides more economic information, only the economic estimates from that paper are included in the review.

Lead Author, Year Study Design Economic Method	**Study Location Sample Size Population Characteristics Time Horizon**	**Intervention Description**	**Environmental Remediation Education Focus Home Visitor Number of Home Visits**	**Select Effectiveness Outcomes[24]**	**Program Costs[25]**	**Direct Medical Costs Averted Productivity Losses Averted**	**Full Economic Summary Measure**
Sullivan, 2002 RCT Cost-effectiveness analysis	8 inner-city urban areas (specific locations not provided) 1,033 children were randomized (515 to the intervention group and 518 to the control group); 961 were followed in the second year English and Spanish speaking children ages 5-11 with a doctor-diagnosis of asthma meeting specific severity criteria 1 year of intervention, and 1 year of follow-up	Interventions were individually tailored and conducted by Asthma counselors (Master's level social workers). ACs trained families through 2 adult education sessions, 2 child education sessions and individual meeting with their counselor covering coordinated care, self-management and environmental education. Primary care physicians were sent a blank asthma action plan, a spacer, a peak flow meter, and NHLBI asthma treatment guidelines. Each family given pillow and mattress covers and encouraged to reduce exposure to triggers. Children with a positive skin test response to cockroaches received 2 home visits by exterminators. Additional contacts with ACs continued in person every 2 months and spoke on the telephone on the alternate months for the first year of the study.	Minor environmental remediation Self-management and environmental education Exterminator 0 or 2	Increased (26.6) symptom free days over two years* Decrease in unscheduled visits; ED visits; non-ICU hospital days; inpatient physician visits per hospital stay; no difference in ICU hospital days; increase in scheduled medical visits	Per child over the 2-year period: $458 Costs included: personnel and training, extermination visits, skin tests, asthma control devices, and other expenses; the study included cost per component—satisfactory cost information	Medical care costs averted per child over the 2-year period: $147 Direct medical costs averted included: scheduled and unscheduled visits; ED visits; ICU and non-ICU hospital days; inpatient physician visits per hospital stay Source of dollar estimates: Medicaid reimbursement rates --	ICER = $12 per SFD

[24] Priority outcomes in this review: health care utilization and medication, productivity measures, and symptom free days (* denotes statistical significance)
[25] All costs are in 2007 dollars.

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Page last reviewed: March 11, 2010
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