



Educational and home-environment asthma interventions for children in urban, low-income, minority families

Kristen Welker, Laura Nabors, Myia Lang & Jonathan Bernstein

To cite this article: Kristen Welker, Laura Nabors, Myia Lang & Jonathan Bernstein (2018): Educational and home-environment asthma interventions for children in urban, low-income, minority families, Journal of Asthma, DOI: [10.1080/02770903.2018.1424185](https://doi.org/10.1080/02770903.2018.1424185)

To link to this article: <https://doi.org/10.1080/02770903.2018.1424185>



Published online: 08 Feb 2018.



Submit your article to this journal [↗](#)



Article views: 30



View related articles [↗](#)



View Crossmark data [↗](#)



Educational and home-environment asthma interventions for children in urban, low-income, minority families

Kristen Welker, M.S.^a, Laura Nabors, PhD, ABPP^a, Myia Lang, M.A.^a, and Jonathan Bernstein, MD^b

^aHealth Promotion and Education Program, School of Human Services, University of Cincinnati, Cincinnati, OH, USA; ^bInternal Medicine-Allergy, University of Cincinnati, Cincinnati, OH, USA

ABSTRACT

Objective: This review examined the impact of environmental change and educational interventions targeting young children from minority groups living in urban environments and who were from low-income families. **Data Sources:** A scoping methodology was used to find research across six databases, including CINAHL, ERIC, PsycINFO, PubMed, MEDLINE, and EMBASE. **Study Selection:** 299 studies were identified. Duplicates were removed leaving 159 studies. After reviewing for inclusion and exclusion criteria, 23 manuscripts were identified for this study: 11 featured home-environment change interventions and 12 emphasized education of children. **Results:** Studies were reviewed to determine key interventions and outcomes for children. Both environmental interventions and educational programs had positive outcomes. Interventions did not always impact health outcomes, such as emergency department visits. **Conclusions:** Results indicated many of the environmental change and education interventions improved asthma management and some symptoms. A multipronged approach may be a good method for targeting both education and change in the home and school environment to promote the well-being of young children in urban areas. New research with careful documentation of information about study participants, dose of intervention (i.e., number and duration of sessions, booster sessions) and specific intervention components also will provide guidance for future research.

ARTICLE HISTORY

Received 30 May 2017
Revised 22 December 2017
Accepted 1 January 2018

KEYWORDS

Residence; review; school;
scoping; youth

Introduction

Morbidity and mortality related to asthma are higher in urban, inner-city populations and minority groups from low-income families (1–3). The prevalence of asthma in children is high, and estimated as between nine and ten percent in the United States (US) (4). This chronic medical condition disproportionately affects children from minority groups (5), low-income populations, and children in inner cities (6–8).

Lee et al. reviewed childhood asthma interventions including randomized controlled trials, recent literature reviews (including a Cochrane review), and community and state level efforts to manage childhood asthma (5). In their review, Lee et al. expressed the need for educational interventions addressing asthma management, and cited their importance in reducing the risk for urgent health care encounters, but stated education alone might not be enough to reduce the disparities in asthma management (5). Lee et al. also stressed the critical contribution of changing the home environment coupled with education for parents to promote change in child asthma management. This is in line with Bellin et al.'s recommendations of a multi-pronged approach (9). Lee et al. reported that

child-focused educational interventions often have only a small or modest impact on the number of days a child has symptoms, number of days a child misses of school, or has functional limitations, and that environmental changes in the home can produce greater reductions in allergens in the home, asthma symptoms, and functional limitations (when compared to other intervention types (5)). Despite reductions in home allergens and asthma symptoms, home-based interventions can be costly to implement and challenging to maintain, and there is limited evidence to support these environmental interventions as significantly impacting critical health outcomes such as emergency care visits (5).

Al Aloola et al. recommended that a focused review of educational interventions for children in niche groups or populations, such as those from minority groups or in urban areas, be undertaken (10). The purpose of this review is to extend knowledge and present literature on school-based educational interventions and home-based environmental interventions delivered in urban areas with primarily school-age children from minority groups and low-income families. The literature was reviewed to determine the impact of interventions developed to

improve asthma management and health outcomes for children. Information from these studies may provide guidance to clinicians and researchers working with young children with asthma residing in what often are high risk areas.

Methods

The focus of this review was to identify studies where elementary school-age children (ages five to eleven years), who were in minority groups, residing in low-income families, in urban areas were in the sample. The dates for articles reviewed were from 2000 through 2017. Randomized controlled trials (RCTs) were critical to locate. Although, since it may be difficult to fund or conduct studies in low-income urban areas (11–13), studies that were not RCTs also were considered. A scoping methodology was used to find a broad range of studies in urban areas with children from minority groups, focusing on child education, primarily in the school setting, and environmental change in the home to reduce allergens and asthma triggers (e.g., second hand smoke, mold, dust, pests) (14–16). The scoping methodology is used to create a wide representation of literature in areas where there is a comprehensive array of study designs and research methods (15).

The search strategy involved review of six databases including: CINAHL, ERIC, PsycINFO, PubMed, MEDLINE, and EMBASE. The search was conducted in January through February of 2017. Similar to Al Alooia et al. (10), we used broad search terms to capture a large variety of articles for review. Search terms included the following terms and combination of terms: minority * children * asthma * intervention * school * home. The search terms were identified by the authors based on information provided by previous researchers (5,10).

Two of the authors reviewed and applied the selection criteria to all manuscripts gathered through the search process over four meetings. Discrepancies were resolved by consensus. Inclusion criteria for manuscripts included: (1) asthma interventions for elementary school-age children and/or parents; (2) information about children residing in minority groups, low-income families, and urban areas; (3) interventions including a child-focused education component; or (4) interventions featuring an environmental change in the home. Exclusion criteria included: (1) targeting older youth – ages 12 years and older; (2) not being in urban areas; and (3) not including children from low-income families in the sample. Additionally, manuscripts were excluded if they were: (1) conference abstracts; (2) guidelines for diagnosis, treatment, and care of asthma; (3) focused on assessment of drug efficacy; or (4) focused solely on adherence to medical regimens.

Studies with varying degrees of experimental control were reviewed to provide a wide-ranging base for future research efforts. Studies using randomized controlled trial designs were evaluated using Jadad scores in order to estimate the quality of methods of random assignment, double-blinding, and the flow of patients (17).

Results

Two hundred and ninety-nine studies were identified using search criteria. Figure 1 depicts the results of the literature search, article selection, and inclusion/exclusion criteria.

One hundred and forty of the studies were duplicates and were removed. This left 159 articles and review papers. After reviewing the studies using inclusion and exclusion criteria, there were 23 manuscripts for evaluation. Twelve of these were educational in nature and eleven featured environmental changes in the home.

Educational interventions

Table 1 presents information on educational interventions for children.

These child-focused interventions included education related to asthma management and medication monitoring, avoidance of asthma triggers (e.g., allergens), proper use of inhalers, and recognition of symptoms related to having an asthma attack (18,19; see Table 1). A range of educational techniques were used, such as stories, education in small groups, and games (19,20). Education was delivered by primary care providers, nurses, and trained paraprofessionals (21–23). The delivery of interventions varied, including computer-based education (24,25), face-to-face education (21), and groups (19).

Participants differed in terms of symptoms and symptom severity across studies, but most of the interventions yielded improvements in child health outcomes. Additionally, most reported post-intervention improvements in asthma symptoms (18,20,22–26) and reductions in emergency department (ED) visits and hospitalizations (18,20–23,25–27). These improvements were reported for interventions with relatively fewer educational sessions (18,20–23) and those with higher numbers of educational sessions (24–27). It was noteworthy that many studies did not include critical health assessments, such as use of spirometry to assess peak flow and emergency visits for acute symptoms to examine change in asthma symptoms (see Table 1).

A focal point of many of the available interventions was to improve management and self-care of asthma symptoms (19–20,22–23,28). Child participants in each of these studies were reported to have increases in asthma management skills, although this did not always

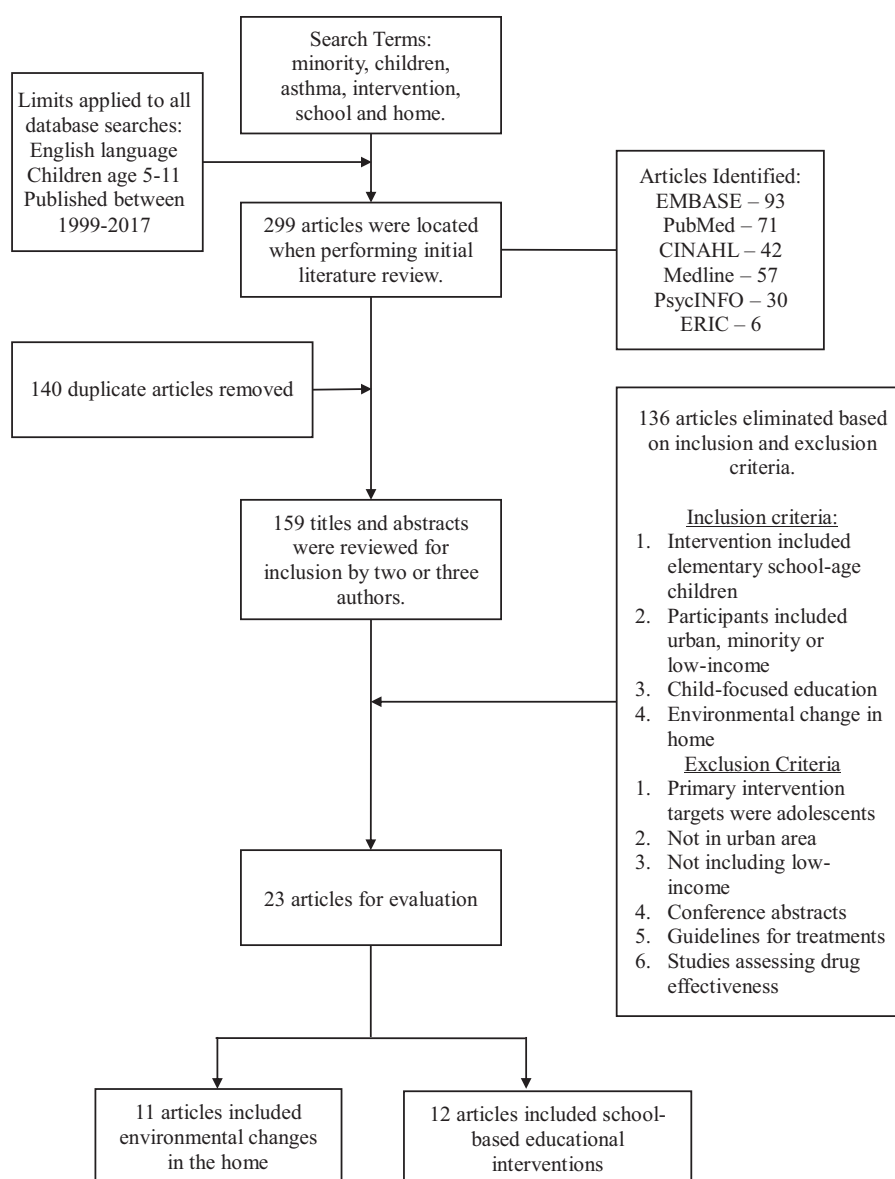


Figure 1. Results of the literature search, article selection, and inclusion/exclusion criteria.

directly relate to improvements in health status. Along with improvements in these critical behaviors, several researchers also assessed self-efficacy for asthma care of the child participants (20,22,23,25,28). Each of these interventions reported gains in child self-efficacy for their asthma management; but only one (25) reported a relationship between self-efficacy and a reduction in asthma related ED visits, and hospitalizations.

Environmental interventions

Table 2 presents information from a review of the environmental change studies.

Environmental interventions included both counseling and in-home efforts. Environmental counseling

was utilized in a majority of the interventions (11–13, 29–33) and included strategies addressing the implications of second-hand smoke exposure (31,33), avoiding indoor allergen sources (31,32), and explaining the importance of pest control and air filters (32). Other interventions provided participants with in-home pest extermination, professional cleaning, repairs and mold removal, air filters, mattress replacements, and allergen-proof bedding (29,30,32,34–36). One intervention focused on a single environmental element (secondhand smoke exposure (33)) while the others had a wider focus. There were reports of improvements in child allergy and asthma symptoms, decreased use of medications, and reduced hospital visits related to exacerbations of asthma symptoms resulting from these in-home interventions (11–13,29–35).

Table 1. Studies presenting interventions focusing on education.

Authors	Design	Jadad Score	Participants	Intervention	Measures	Outcomes
Bryant-Stephens et al. 2015 (26)	Prospective longitudinal cohort study		136 children 2–16 years of age 75 boys 83.6% African American, 13% Latino Live in Mid-Atlantic inner city Children had asthma and one asthma-related hospitalization or two emergency visits the year prior to enrollment.	Children received 5 in-home self-management education sessions by community health workers. Asthma education topics: impact on airways, common asthma triggers and how to avoid them, information on medications and school action plans. Supplies to reduce trigger exposure (e.g., storage bins, hypoallergenic mattress and roach and mouse traps provided to parents). Caseworkers made monthly visits for 12 months to review environmental changes and asthma care plans.	Caregivers recorded child symptoms (e.g., wheezing, coughing) in daily diaries and collected data on health care use. Community health workers conducted bedroom observations to examine trigger reduction.	Symptoms at intake varied based on time of year (winter, summer) when children enrolled. Days with symptoms were reduced from 7 days to 2.5 days a month at 12 months follow-up. Symptom severity improved with a decreased severity score of 29.0 to 7.9 at month 12. 61% of patients with ≥ 2 emergency visits at dropped to 0–1 visits. 81% of patients with hospitalization ≥ 1 visits dropped to 0 visits at 12 months. Asthma triggers in the home were reduced.
Wiecha et al. 2015 (24)	Randomized pilot trial	2	58 children with persistent level asthma ($n = 37$ intervention group) 9–17 years of age (average age = 11.9 years) Over 50% were boys Inner city Boston 54.1% Black, 21.6% White, 10.8% Hispanic, 13.5% other 1.8% total family income under \$15,000	An interactive website to promote adherence to asthma medications, provide a platform for teamwork between caregivers and patients, and to provide care providers with updated information on symptoms and medication use. Website featured: education about asthma care with educational activities (word searches, puzzles). Personalized web pages and discussion boards for participants and care providers.	Asthma symptoms, use of controller medications, counting device on metered dose inhaler, and pill counts. Assessment of patient and provider use of website. Patient knowledge of purpose of controller medications.	After 6 months, wheezing, parent awakening/loss of sleep, adherence to asthma medication regimens, and understanding of the importance of adherence improved significantly. Parental loss of sleep and child awakening improved in the intervention, but not the control group. ED and acute care physician visits did not change between the two groups. Average internet session was 19 minutes. Use of the website decreased over time.
Horn et al. 2014 (21)	Randomized control trial	3	150 parents of asthmatic children 1–12 years of age 57% boys ($n = 86$) ED-based asthma clinic in Washington, DC 89.3% African American, 4.0% Hispanic 43.5% annual income less than \$30,000	Face-to-face education by asthma coaches on effective asthma communication with their child's primary care provider, followed by a single booster call. Education for parents included: planning questions and concerns before visit, seeking information about care plan, and say back recommendations in own words.	Parent perceptions of connectedness to primary care. Parent self-efficacy for communicating with physician. Healthcare utilization (e.g., ED visits, doctor visits where asthma was discussed).	At 2 months, intervention parents were more likely to report higher connectedness, identify a primary care provider as the main source for their child's asthma care, and report less asthma-related ED visits. Parent self-efficacy for communicating with doctors did not change. Reductions in ED visits not present at 6-month follow-up.
Nelson et al. 2011 (27)	Randomized control trial	4	247 parents of children with asthma ($n = 122$ intervention) 2–10 years of age (average age = 7.6 years) 64% boys in the intervention group; 57% boys in the control group 94.2% of parents African American All families received health coverage through Medicaid	An 18-month intervention consisting of coaching about asthma care, outpatient asthma monitoring at clinic visits, and development of a relationship with a primary care provider. Coaches tailored education to parent needs and readiness for each asthma care strategy during telephone contacts. A nurse telephoned parents to answer questions about asthma management and care.	Record review to assess: ED visits, visits to primary care physician for asthma, and hospitalizations for asthma. For physician visits, the development of asthma action plans and controller medications were documented.	More children of intervention group parents had at least one asthma monitoring visit at two-year follow-up. There were no significant differences between groups in the number of ED visits and hospitalizations. Having a controller medication did not impact number of ED visits. Documentation of asthma action plans in records was the same in the two groups. Those with asthma coaches were more likely to have asthma action plans. Coaches were less successful in impacting asthma monitoring visits and least effective in impacting partnerships between doctors and parents.

Robinson et al. 2008 (25)	6-month intervention (no control)	110 children 6–14 years of age 53% boys 80% African American, 22% Hispanic Approximately 37% of families sampled live below the federal poverty line Children had moderate or severe persistent asthma	School-based computer sessions included literacy training, and 30 minutes of asthma education for six months as part of a reading program. There was a refresher course every 4–6 weeks. Access to care from board certified allergists.	Weekly asthma questionnaire to measure asthma symptoms and peak flow. Chart review to assess ED visits. Children reported self-efficacy for asthma care. Literacy assessment (reading level).	Following intervention, asthma-related hospitalizations and ED visits were reduced to 22% and 33%, respectively during the intervention. Improvement in self-efficacy for asthma care was related to reductions in asthma-related ER visits and hospitalizations. Results for asthma symptom change were not reported. Improved reading levels were related to improved self-efficacy and decreased ED recidivism.
DePue et al. 2007 (18)	Single group with pre- and post- assessment	972 children with asthma and their parents Average age = 8.1 years 57% boys, grades K–6 45% Latino 77% of children received health care through Rite Care, the Rhode Island Medicaid program	A 2.5-hour workshop for parents and children at 24 elementary schools in Providence, delivered 4 times over a 3-year period. The interventions were offered in both English and Spanish. Topics covered: the difference between asthmatic and normal airways, understanding what is happening to airways during an asthma attack, understanding how asthma medications work, demonstrating use of inhalers, spacers and peak flow meters; and identifying environmental triggers. Asthma peak flow meters were provided to parents. Additional bi-monthly asthma support groups were held for parents.	Medication use. ED visits. Days in the hospital. School days missed due to asthma.	Use of oral steroids decreased from 35% of the sample at baseline to 12% of the sample. All medication outcomes showed improvements at post-assessment. ED visits decreased from 35% to 4% and hospitalizations decreased from 11% to 2%. School days missed decreased from 48% to 20% of children.
Levy et al., 2006 (7)	Randomized control trial Unit of random- ization was the school.	2 14 schools; 8 in the intervention and 6 receiving usual care 243 students with asthma (115 in intervention school and 128 in control schools) Ages 6–10 years 57%–60% boys across groups Schools had higher than 97% African American children Schools had higher than 85% of children receiving free and reduced cost lunch	For intervention schools, coaches met with children with asthma to coach children on asthma knowledge and management using the Open Airways Program in weekly sessions. Contacts with parents, school personnel, and the child's medical team to improve disease management and eliminate asthma triggers at home and at school. Program implemented by nurses.	School absences. Hospitalizations. ED visits (record reviews). Child knowledge of asthma. management (survey). Telephone surveys for parents.	Students in intervention groups had lower days absent from school and fewer ED, hospitalization and emergent care visits than those in control schools. Students in intervention group showed more knowledge about asthma management pre- to post-intervention; however, students in control did not complete knowledge surveys. Parents in the intervention group showed more knowledge about asthma management pre- to post-intervention; but, there was significant missing data for parent surveys in control schools.

(Continued on next page)

Table 1. (Continued)

Authors	Design	Jadad Score	Participants	Intervention	Measures	Outcomes
Bartholomew et al., 2006 (20)	RCT, with baseline, post-intervention and one-year follow-up assessments.	3	835 children Grades 1-4 (average age = 7.7 years) 435 boys, 400 girls 45% African American, 51% Hispanic, 3% Caucasian Most children lived in families with an annual household income of less than \$20,000, 28% were less than \$9,999	Children played the Watch, Discover, Think, Act interactive computer game based on the NIH's National Asthma Education and Prevention Program's guide for asthma care. Videotaped education of NIH guidelines for asthma care mailed to physicians. Parents received information on asthma care and symptom management and making appointments via videotape. Children with persistent asthma met with a physician and received a one-month supply of medication (enhanced intervention).	ED visits. Symptom change. Dust samples collected at schools. Children's self-efficacy. Knowledge change. Self-management. School performance and attendance.	Symptoms declined in both groups. Hospitalizations increased over time for both groups. Children in the treatment group showed greater increases in knowledge and self-efficacy, and trends for improved asthma self-management. School attendance and performance did not change between groups, except for a small subgroup of children who consulted with an asthma specialist at school, where improvements were evident. There was one environmental change: control classrooms had higher dust after the intervention period. Children in the enhanced intervention had higher academic scores and fewer school absences.
Velsor-Friedrich et al., 2005 (23)	Quasi-experimental pre-test/post-test with control group		52 children ($n = 28$ treatment group) 8-13 years of age 26 boys and 26 girls 100% African American Recruited from four inner-city elementary schools. 38% of the sample had mild, persistent asthma. No report on family income	Open Airways Program was delivered by nurse practitioners in six, 45-minute sessions over to weeks to learn about asthma management (triggers, using medications). There were five follow-up visits with a nurse practitioner, where nurses reinforced information on asthma knowledge.	Asthma diaries assessed peak flow readings, change in asthma symptoms, doctor visits, and medications. School absences. Child asthma knowledge, self-efficacy and self-care abilities.	No differences in symptoms between groups in use of controller medications, peak flow rate, urgent care visits, or school absenteeism. Intervention group showed greater gains in self-care (self-management of asthma) but both groups saw some improvement. The treatment group had greater asthma knowledge and self-efficacy on all assessments.
Horner, 2004 (19)	Pilot intervention with comparison group; Pre-test, Post-test with 6 and 12-month follow-up		60 children with asthma enrolled; 44 completed study (30 boys; 14 girls) with data presented on completers 7-11 years of age (average age = 8.87 years) English or Spanish speaking 41% ($n = 18$) African American, 23% ($n = 10$) Mexican American 46% ($n = 20$) from poor or working-class families	The school-based group had nine sessions addressing asthma physiology and symptoms, asthma triggers, and steps in managing asthma. Short stories, games, posters, and peak flow meters were used to illustrate content. Parents were given an educational booklet addressing asthma triggers and their management, symptoms, medication management, and use of inhalers.	Survey to assess parent management of asthma. Child management examined by child and parent report. School absenteeism. Asthma severity assessed: wheeze frequency, medication used and sleep and exercise frequency.	Parents in intervention group reported significant improvements in asthma management at 12-month post-test. Child self-reported asthma management behaviors were significantly improved at 12-month follow up for children in both groups. Intervention group showed improved home management compared to control. Absenteeism remained similar in both groups. Specific information on symptom change was not provided.

Bruzzese et al. 2001 (28)	One group pretest- posttest No control Pilot study	59 children 4th and 5th grade students No age information provided 54% boys, (n = 32) 46% girls (n = 27) 63% (n = 37) Hispanic, 22% (n = 13) African American 74–100% of students were eligible for free lunch	The Open Airways for Schools (OAS) Program was delivered over 6 weeks by college student mentors, supervised by nurse practitioners. Children and parents learned about asthma management and recognition of triggers, problem-solving related to medication management, and management of asthma at school.	Interviews designed to assess children's learning from the OAS curriculum and knowledge, self-efficacy, asthma management, social support, and well-being. Training in OAS provided to students and nurse practitioners.	Children participating in the program showed significant improvement in knowledge about asthma, feelings of well-being, social support, and self-efficacy for managing asthma, and improved knowledge about self-care. Data on other health outcomes not available.
Bartholomew et al., 2000 (22)	Prospective pre-test, post-test trial with control group receiving usual care	2 133 children with asthma 7–17 years of age (average age = 11.5 years) 60% boys (n = 86) in intervention group; 69.8% boys (n = 44) in control group 49.6% African American, 45.9% Hispanic 57% of participants used Medicaid as their insurance provider, 37% had no insurance coverage Recruited from four inner-city asthma clinic sites	The Watch, Discover, Think and Act program is an interactive adventure game program on CD-ROM delivered at physician's offices and clinics. The program is designed to teach children asthma related skills (e.g., taking medication, and self-regulatory skills like goal setting, self-monitoring, problem identification, solution generation, action and evaluation). The program is tailored to each child's education and asthma management needs.	Interviews with parents and children to determine asthma management practices. Parent questionnaires assessing asthma triggers, symptom severity, asthma medications and child health status and quality of life. Child questionnaires assessing self-management knowledge and self-efficacy for asthma management. Hospitalizations and ED visits due to asthma. Process evaluation questions to assess child use of computer program and their perceptions of the program.	Children in the intervention group under age 12 had fewer hospitalizations at post-test. The intervention was associated with reduced symptoms for children with milder asthma. No differences between groups for ED visits. The parent management interview revealed no differences between groups. Self-efficacy did not differ between groups. Intervention group had higher clinic return rates. Children selected "computer" coaches from their own racial group. 97% of children believed the game to be fun and educational. Children needed help from research assistants to review the program.

Note. ED = emergency department.

Table 2. Studies presenting interventions to change the home environment.

Authors	Study Design	Jadad Score	Participants	Intervention	Measures	Outcomes
Chulada et al. 2012 (11); Sterling & Linville 2015 (12); Thornton et al. 2016 (13)	RCT converted to an intervention study		182 children 4–12 years of age 54% boys (n = 99) 25% less than \$15,000 annual income 67% African American, 7% Hispanic Live in New Orleans Moderate to severe asthma	An asthma counseling intervention that provided case management, education about asthma for parents and children, and guidance for reducing home mold and other allergen levels. Asthma counseling was included.	Parent report of child asthma symptoms, ED visits, hospitalizations, medications, quality of life, child asthma knowledge and management, and home environment. Clinical evaluation of pulmonary function and blood samples to test for allergies. Allergy testing. Air samples of home environment to assess moisture, water damage, pests, tobacco smoke, and mold.	HEAL children often exhibited wheezing and compromised pulmonary function. Improvements in medication-taking, reducing parental worry about medication side effects, and reducing parental concern over having insurance and financial coverage for medical appointments. Indoor mold levels were lower than outdoor levels. About 85% of the children had a place for asthma care. Outcomes measured were not fully reported across the three studies.
McClendon & Babino 2015 (42)**	Records of 50 homes provided for the Green and Healthy Homes Initiative in Atlanta, GA		29 residences where children had asthma Average age = 7.5 years	Green and Healthy Homes Initiative in Atlanta area. Designed to make homes safe and environmentally healthy to improve asthma. Environmental interventions included: " ... concrobium mold control foggers, bathroom vent installation, and gutter/downspout installation (p. 408)."	Medical condition of residents in the home. Residents use of health care. Days missed from work or school due to asthma.	26 residences where children had well-controlled asthma post-intervention, compared to 18 pre-intervention. Emergent care visits decreased from 31 to 2 post-intervention. Authors recommended " ... creating water-tight premises, eliminating cockroaches and dust mites, and eliminating smoking from the home" (p. 409) The average cost of the intervention was "\$2,812" per case or household. (p. 408) Data on days of work and school missed not reported.
Turcotte et al., 2014 (34)	Pre-intervention/post-intervention (with mid-point assessment) with no control group		116 households with 170 children with asthma Average age = 6.08 years 95.9% girls 4.7% Black, 12.4% White, 15.3% Asian, 52.9% Hispanic 84.7% of families <1%–50% area median income	A customized remediation plan over 1–6 home visits – including integrated pest management; commercial cleaning; providing healthy home cleaning equipment and supplies; education; and structural interventions. Education for parents about " ... how to recognize and mitigate asthma triggers and safety hazards" (p. 666)	Asthma survey to assess physical and social-emotional health of child and family, doctor visits, hospitalizations and ED visits. Environment survey to assess exposure to outdoor allergens and asthma triggers. Floor dust in kitchen sampled. Assessment of health care costs.	Home environment management improved post-intervention. Improvements in child physical health and emotional health and activity levels post-intervention. Decreased use of medication. Significant drop in children classified as "high risk," down from 38% to 26%. Decreased hospitalizations and medication use at follow-up. The cost of remediation was \$192 per child. Change in environmental indicators not described.

Streja et al., 2014 (33)	Convenience sample with child-parent dyads randomized to the behavioral intervention or control condition	2	118 children in intervention (124 control) 2–14 years of age (average age = 9 years) 62% boys, 38% girls 60% Latino, 25% African American 44% annual income less than \$10,000, 30% annual income \$10–20,000 At least 1 smoker in the home	Spanish/English video and workbook addressing implications of second-hand smoke exposure for children with asthma. Ideas for improving home climate were presented in materials. Booster or reminder elements such as signs smoking in room was off-limits, magnets, and mugs.	Smoking status of all persons in the home. Parents reported whether smoking occurred inside the home. Urine samples (to assess cotinine) for children. Passive air nicotine monitors.	There were no significant differences between the intervention and control groups, although smoking was reduced in both. Amount of household smoking was 7 hours per week with .5 hours per week of second-hand smoke exposure for the child. Houses with a smoking ban had children with lower nicotine levels. Air nicotine levels were lower in homes where there was no smoking (65% of households had smoking bans at the second follow-up).
Bernstein et al., 2006 (35)	Randomly assigned groups in a crossover trial with double-blinded placebo control	4	19 children from 17 homes with central ventilation 5–17 years of age (average age = 9.6 years) 68% boys 53% African American Children had asthma with sensitivity to mold	CREON2000 Photonic Air Disinfection System installed in homes to remove dust from the air.	Morning and evening peak flow rates, asthma symptoms, medications, quality of life. Changes in temperature, relative humidity, and dew point. Indoor mold and bacteria counts. Air samples. Dust analysis.	With CREON2000 in home, children experienced reduced levels of some asthma symptoms (e.g., shortness of breath and chest tightness). Other asthma symptoms did not change. Quality of life ratings did not change. Peak flow improved in intervention group. Use of medications decreased post-intervention. A trend for reduction in indoor mold and bacteria levels for intervention group. Carpet dust analysis revealed no differences between groups.
Levy et al., 2006 (29)	Pre-test/Post-test assessment with no control group		50 children with asthma from 41 households in 3 walk-up family public house facilities in Boston 4–17 years of age Information on child sex not provided. 70% Hispanic, 28% African American	Asthma education intervention/case management from a community health nurse. Four environmental interventions: visual inspection and trap placement, sealing cracks and small holes; one-time intensive cleaning; in-home education about pest reduction, provided in three modules; and mattress replacement for the child with asthma.	Child ratings of quality of life and asthma symptoms. Skin testing for allergies. Caregivers reported smoking in home, child asthma symptoms, hospitalizations, and management.	Significant reduction in respiratory symptoms. Clinically significant improvement in asthma-related quality of life. Specifically, lower wheezing, more involvement in play, less night-time awakening. Significant increase in prevalence of use of peak-flow meters (from 29% to 93%). Exposure to cockroach allergens, dust mites and cat allergens in bed reduced. No significant changes in hospitalizations. Reducing cat allergens in bed related to improved respiratory symptoms.
Eggleston et al., 2005 (32)	Randomized controlled trial Control group received the intervention at the end of the study period	3	100 families with children randomized to intervention or control group 6–12 years of age (average age = 8.4 years) 54% girls 98% African American (100% in the control group) 33% annual income <\$10,000, 42% between \$10,000 and \$20,000 annual income Children had physician-diagnosed asthma and current asthma symptoms Participants were graduates of a school-based asthma education program in Baltimore public schools	Families were given room-sized high-efficiency particulate air filters for the child's bedroom. Allergen-proof mattress and pillow coverings were fitted to each child's bed. Any home with pest infestation was given free professional extermination. Educational interventions aimed at behavior change (e.g., explain the use of pest control and air filters) took place over three in-home visits. Educators gave information about avoiding tobacco smoke and indoor allergen sources. In the intervention group, 42 families received cockroach extermination, and 35 received mouse extermination.	Parent and child report of asthma symptoms. Parent report health care visits and medication use. Home environmental evaluation to determine water damage, infestation, bedding condition, and household dust. Air pollution samples from child's bedroom. Children's skin tested for allergens.	During the trial and at six-month follow-up, the proportion of children with allergy/asthma symptoms increased in the control group and decreased in the intervention group. There were no significant differences in the number of hospital/clinic visits for acute asthma and hospitalizations between groups, although there were reductions in both groups. Mattress and pillow covers were found to be in place in 78% of intervention homes at 3 months, 53% of homes at 6 months, 39% at 9 months and 27% at one year. Air filters were in place in 96% of homes at 6 months. Exposures to cockroach allergen and airborne particulate matter reduced in intervention group.

(Continued on next page)

Table 2. (Continued)

Authors	Study Design	Jadad Score	Participants	Intervention	Measures	Outcomes
Morgan et al., 2004 (30)	Randomized controlled trial	3	937 children with atopic asthma (intervention group $n = 469$) 5–11 years of age (average age = 7.7 years) 63% boys in intervention; 62% boys in control group 40.3% Hispanic, 37.7% African American 59.8% of treatment group families had an annual income of under \$15,000	Five mandatory and two optional home visits over the 12-month intervention. Intervention teams taught caregivers the role of allergens and irritants and provided an environmental intervention plan. The child's box spring, mattress, and pillows were covered with an allergen-impermeable cover. Families were given a vacuum with a HEPA air filter, and a HEPA air filter was placed in the child's room if he/she was exposed to passive smoking, sensitized to cat or dog allergens, or sensitized to mold. Professional pest control services were provided for families of children sensitized to cockroach allergens.	Questionnaires assessing asthma symptoms and the home environment. Skin testing for allergens. Inspection of dust in the child's bedroom (vacuumed dust samples from bed and floor).	The intervention group had fewer days with asthma symptoms for every two-week period during the one-year intervention and at the one-year post-intervention period. Intervention group saw greater decreases in Der fl allergens in the bed and on the bedroom floor, in D pteronyssinus in the bed, and cockroach allergen on the bedroom floor. Reductions of cockroach and Der fl allergens were correlated with reduced complications from asthma. The control group families were only evaluated at 6-month intervals.
Wilson et al., 2001 (31)	Randomized controlled trial	2	77 parents (44 intervention group) 3–12 years of age 50% boys 44% Hispanic, 38% African American Children were exposed to smoking Families were Medicaid eligible	Nurses provided three counseling sessions with caregivers on personalized strategies featuring role modeling, contingency contracting, and practicing reducing smoke exposure for children. Information included education about asthma management, education on the relationship between smoke exposure and elimination of smoking in the home and other environments that would be frequented by the child on child asthma.	Parent report of child asthma symptoms, medicines, physical activity, and home environment (e.g. smoking in the home). Bronchodilator to examine child pulmonary function. Urine creatinine for children. Health care utilizations and ED visits.	Primary smoker was the mother in 61% of the intervention group families and 42% of control families at baseline. Emergency care visits for asthma decreased in the intervention group and increased slightly for the control group. Lower cotinine in intervention group, when not adjusted for baseline differences between groups. Lower acute care visits for intervention group. Fewer parents smoking in the home in the intervention group. No differences between groups for child asthma control or cotinine levels. There was no significant change in symptom-free days or lung function for children in the intervention group.

Notes. *HEAL procedures were adopted at federally qualified health centers in the United States. **Lacks information about children in the homes.

Specific to the environment, findings indicated there were reductions in allergens in homes (30), increased numbers of air filters in homes (32), and reductions in second-hand smoke in the home (29,31,33). The interventions utilizing a more intensive intervention (e.g., providing professional cleaning/pest removal or equipment for families to improve the home environment) reported improvements in the home environment and child asthma symptoms (29,30,32,34–36). Interventions focused on encouraging parents and family to reduce second-hand smoke exposure in the home reported reductions in in-home smoking, but this did not directly relate to improved asthma symptoms for the child (29,31,33).

Most of the environmental interventions included a relatively short educational component. The education provided to children was not always clearly explained in the manuscripts. These educational components averaged about three sessions, and education was often provided to parents by nurses (29, 32; see Table 2). The exception to this was the Head-Off Environmental Asthma in Louisiana (HEAL) study, where case management and home-based counseling were more frequent (up to 25 sessions); however, counselors were addressing trauma related to a natural disaster, which increased needs for visits (13). After studying the process of care for HEAL, Thornton et al. reported that evidence-based interventions to educate and assist children and families work well in low-income, urban settings when strategies are user-friendly, culturally considerate, and realistic (13).

Jadad scores

For those interventions where it was possible, Jadad scores were computed to assess the quality of the trial. There were six educational (7,20–22,24,33) and five environmental (30–33,35) interventions that utilized randomized controlled trial designs. The environmental interventions had an average score of 2.8 (range 2–4) and the educational interventions had an average score of 2.67 (range 2–4). Many of the trials did not have blinding incorporated in to their study design, which weakened their score (e.g., 20–22, 24, 30, 31, 33).

Discussion

Findings of this study showed many of the environmental change and educational interventions produced gains in either management or control of asthma symptoms, as well as improvements in the environment with respect to air quality, mold, pests and other environmental triggers. The majority of studies discussed prevention of multiple asthma triggers in order to deliver comprehensive

interventions to address multiple causes of asthma for children.

Educational interventions often produced gains in child and parent abilities to manage asthma symptoms, adhere to medical regimens, use inhalers, and recognize asthma symptoms (e.g., 24). Tool kits and programs that work for young children are available (e.g., Open Airways for Schools intervention by the American Lung Association (23,28,37), National Cooperative Inner City Asthma Study (NCICAS) (38)). These tool kits may be an effective way for future researchers to approach asthma interventions in this population. The use of tool kits may be beneficial in encouraging behavior change and not simply gains in knowledge. This is critical as increased knowledge does not always translate directly into improved behavior.

Many of the home-environment interventions provided families in low-income, urban areas with resources (e.g., air filters) to help their child's asthma that may not have otherwise been available. Various interventions provided in-home cleaning, and pest and mold removal, along with professional equipment to help remove allergens from the air, carpets and bedding. The cost of services and equipment may be too high for families with low household incomes. Interestingly, Turcotte et al. (34) were able to provide pest management, commercial cleaning, and cleaning equipment for intervention families at a cost of just \$192 per child, and they discovered significant reductions in hospitalizations and medication use.

Environmental change can be challenging to implement, and adherence to environmental modifications can be low (27). For environmental interventions to be effective, parents may need to understand the potential health benefits of these interventions and the importance of maintaining changes in the home (36). Moreover, it may be difficult to estimate how many children and parents will actually participate in the intervention, which was an issue for the HEAL project (12) and the Inner-City Asthma Intervention (38). Researchers will need to better understand why participants who are in the original pool of participants decline to participate in research trials (e.g., 32), in order to develop treatments that work for all children. Consequently, there is a need for outreach efforts to educate about the value of the project and the development of referral sources to ensure that children and their parents enroll in projects (38).

It is important to ensure that educational interventions in both school and home environments are intensive enough (i.e., the dose of treatment is sufficient) to produce change in health behaviors. Dosage, or the number and intensity of educational and environmental interventions, varied widely, and finding the optimal dose of education sessions and optimal length, number, and type of environmental interventions has yet to be determined.

Many of these studies were relatively short in duration, and it is possible these interventions may have been more effective in eliciting changes in child health status with an increased study duration.

The interventions reviewed included many components. As such, it is difficult to determine which components of interventions were more successful in improving asthma management and symptoms. Understanding what components of interventions are most effective remains a goal for future studies. Bellin et al. recommended a multipronged approach, consisting of self-management education for children and parents, and environmental control interventions to improve asthma management for inner-city youth (9). Combined school- and home-based educational and environmental change interventions fit the description of a multipronged approach and may produce long-term changes in knowledge and behaviors for children and parents and critical changes in the home environment. This combined approach may lead to long-term improvements in health outcomes for families in low-income urban areas (23,39,40). Schools are suggested as a hub for child education and outreach to the homes to engage parents, because this venue provides access to the majority of children and parents in urban areas.

Interventions need to be delivered in a flexible manner (11,33) and should be tailored to children's educational and asthma management needs (11,20). This may make it difficult to assess fidelity of implementation of manualized interventions, which often are a cornerstone of randomized clinical trials. Given the transient nature of urban, low-income populations, it will remain critical to use a broad lens and review studies with an eye toward applicability of the methods and designs of studies to learn what helps which children. Thus, review papers that include information on randomized controlled trials and other types of research designs may provide valuable information for clinical practice guidelines (41). Moreover, the studies implementing a randomized controlled trial design did not always yield improvement in asthma health outcomes (e.g., 21, 33) and studies where these designs were not possible (e.g., 11–13) provided information that may be widely used.

While many of the educational and environmental studies reviewed showed positive outcomes (e.g., 11–13, 18, 20, 22–26, 29–35), it is challenging to argue that the literature reviewed provides clear information to determine the effectiveness of educational and home change interventions. Clear information on income status and age were not consistently available across studies and the behavioral and health outcomes measured across studies were inconsistent. Many studies did not clearly report asthma severity and control. For example,

most researchers did not assess use of controller medications and peak flow (e.g., 20, 21, 28, 33, 36). Additionally, asthma-related visits to primary care physicians were under-reported. With these inconsistencies in outcomes measured and reporting, it is difficult to pinpoint the most effective intervention design for improving asthma symptoms and child health outcomes.

Conclusions

Our review found initial evidence for the impact of educational and home-based interventions. However, some of the educational techniques did not produce change in ED visits and primarily impacted knowledge and self-efficacy for asthma management. More research is needed to determine the conditions under which the different educational and home environment change programs are effective in reducing asthma symptoms, lost school days, and emergent care visits. In future studies, it will be important to control the time of year when children are enrolled, because asthma symptoms may change in different seasons (26). System-level factors related to health care access, quality of health and quality of life, as well as costs of health prevention and education efforts are another area for continued research (42,43). This study concentrated on urban areas, but other areas, such as mining towns, areas near power plants, and low-income rural areas are targets for future research. Improving environmental quality, education, and reducing cost and access barriers to quality health care will provide further gains in eliminating health disparities to improve asthma management for children residing in urban areas who are from low-income, minority households.

Several areas for future research were discovered. For instance, analyzing data for minority youth in large scale studies may yield new knowledge. Re-analyzing data from large-scale studies to determine outcomes for niche populations may be a relatively less expensive way to examine outcomes for special groups. Information from existing educational programs and home- and school-based environmental change programs that are offered in an integrated format, with booster sessions available over longer periods of time, may be effective in improving asthma outcomes over time (9,21). Although there was some limited information about sustainability of positive health outcomes, more systematic estimation of outcome sustainability in longitudinal studies is needed.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Gruchalla RS, Pongracic J, Plaut M, Evans R, Vissness CM, Walter M, Crain EF, Kattan M, Morgan WJ, Steinbach S, et al. Inner City Asthma Study: relationships among sensitivity, allergen exposure, and asthma morbidity. *J Allergy Clin Immunol* 2005;115(3):478–485. doi:10.1016/j.jaci.2004.12.006.
2. Kopel LS, Phipatanakul W, Gaffin JM. Social disadvantage and asthma control in children. *Pediatr Respir Rev* 2014;15:256–263. doi:10.1016/j.prrv.2014.04.017.
3. Akinbami LJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States. US Dept of Health and Human Services, Centers for Disease Control and Prevention, 2005–2009. *Natl Health Stat Reports* 2011;32:1–14.
4. Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, Liu X. Trends in asthma prevalence, health care use, and mortality in the United States, 2001–2010. NCHS Data Brief, No. 94. Hyattsville, MD: National Center for Health Statistics; 2012.
5. Lee H, McCullough C, Heider F, Hanlon C, Kniffin T. MDRC Working Paper: The effectiveness of interventions to address childhood asthma: a scan of literature and current approaches. New York (NY): MDRC Publications; 2016.
6. Oraka E, Iqbal S, Flanders WD, Brinker K, Garbe P. Racial and ethnic disparities in current asthma and emergency department visits: findings from the National Health Interview Survey, 2001–2010. *J Asthma* 2013;50:488–496. doi:10.3109/02770903.2013.790417.
7. Levy M, Heffner B, Stewart T, Beeman G. The efficacy of case management in an urban school district in reducing school absences and hospitalizations for asthma. *J Sch Health* 2006;76(6):320–324. <https://doi.org/10.1111/j.1746-1561.2006.00120.x>.
8. Bloom B, Cohen RA, Freeman G. Summary health statistics for US children: National Health Interview Survey, 2008. *Vital Health Stat* 10 2009;(244):1–81.
9. Bellin MH, Newsome A, Land C, Kub J, Mudd SS, Bollinger ME, Butz AM. Asthma home management in the inner-city: what can the children teach us? *J Pediatr Health Care* 2017;31(3):362–371. doi:10.1016/j.pedhc.2016.11.002.
10. Al Aolola NA, Naik-Panvelkar P, Nissen L, Saini B. Asthma interventions in primary schools - a review. *J Asthma* 2014;51(8):779–798. doi:10.3109/02770903.2014.914534.
11. Chulada PC, Kennedy S, Mvula MM, Jaffee K, Wildfire J, Thornton E, Cohn RD, Grimsley LF, Mitchell H, El-Dahr J, et al. The Head-off Environmental Asthma in Louisiana (HEAL) Study - methods and study population. *Environ Health Perspect* 2012;120(11):1592–1599. doi:10.1289/ehp.1104239.
12. Sterling Y, Linville LJ. A qualitative study of case management of children with asthma. *Prof Case Manag* 2015;20(1):30–39. doi:10.1097/NCM.0000000000000068.
13. Thornton E, Kennedy S, Hayes-Watson C, Krous RZ, Mitchell H, Cohn RD. Adapting and implementing an evidence-based asthma counseling intervention for resource-poor populations. *J Asthma* 2016;53(8):825–834. doi:10.3109/02770903.2016.1155219.
14. Ahmad E, Grimes DE. The effects of self-management education for school-age children on asthma morbidity: a systematic review. *J Sch Nurs* 2011;27(4):282–292. doi:10.1177/1059840511403003.
15. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res and Methodol* 2005;8(1):19–32. doi:10.1080/13645570320000119616.
16. Clark NM, Shah S, Dodge JA, Thomas LJ, Andridge RR, Little RJ. An evaluation of asthma interventions for preteen students. *J Sch Health* 2010;80:80–87. doi:10.1111/j.1746-1561.2009.00469.x.
17. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJM, Gavaghan DJ, McQuay HJ. Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 2006;17(1):1–12. doi:10.1016/0197-2456(95)00134-4.
18. DePue JD, McQuaid EL, Koinis-Mitchell D, Camillo C, Alario A, Klein RB. Providence school asthma partnership: school-based asthma program for inner-city families. *J Asthma* 2007;44(6):449–453. doi:10.1080/02770900701421955.
19. Horner SD. Effect of education on school-age children's and parents' asthma management. *J Spec Pediatr Nurs* 2004;9(3):95–102. doi:10.1111/j.1547-5069.2004.00095.x.
20. Bartholomew LK, Sockrider MM, Abramson SL, Swank PR, Czyzewski DI, Tortolero SR, Markham CM, Fernandez ME, Shegog R, Tyrrell S. Partners in school asthma management: evaluation of a self-management program for children with asthma. *J Sch Health* 2006;76(6):283–290. doi:10.1111/j.1746-1561.2006.00113.x.
21. Horn IB, Mitchell SJ, Gillespie CW, Burke KM, Godoy L, Teach SJ. Randomized trial of a health communication intervention for parents of children with asthma. *J Asthma* 2014;51(9):989–995. doi:10.3109/02770903.2014.930881.
22. Bartholomew LK, Gold RS, Parcel GS, Czyzewski DI, Sockrider MM, Fernandez M, Shegog R, Swank P. Watch, Discover, Think, and Act: evaluation of computer-assisted instruction to improve asthma self-management in inner-city children. *Patient Educ Couns* 2000;39(2):269–280. doi:10.1016/S0738-3991(99)00046-4.
23. Velsor-Friedrich B, Pigott T, Srof B. A practitioner-based asthma intervention program with African-American inner-city school children. *J Pediatr Health Care* 2005;19(3):163–171. doi:10.1016/j.pedhc.2004.12.002.
24. Wiecha JM, Adams WG, Rybin D, Rizzodepaoli M, Keller J, Clay JM. Evaluation of a web-based asthma self-management system: a randomised controlled pilot trial. *BMC Pulm Med* 2015;15:17–27. doi:10.1186/s12890-015-0007-1.
25. Robinson LD Jr, Calmes DP, Bazargan M. The impact of literacy enhancement on asthma-related outcomes among underserved children. *J Natl Med Assoc* 2008;100(8):892–896. doi:10.1016/S0027-9684(15)31401-2.
26. Bryant-Stephens T, West C, Klein G. Impact of a multi-trigger intervention on seasonal patterns of asthma symptoms in inner city children. *J Asthma* 2015;52(6):565–570. doi:10.3109/02770903.2014.991968.
27. Nelson KA, Highstein GR, Garbutt J, Trinkaus K, Fisher EB, Smith SR, Strunk RC. A randomized controlled trial of parental asthma coaching to improve outcomes among urban minority children. *Arch Pediatr Adolesc Med* 2011;165(6):520–526. doi:10.1001/archpediatrics.2011.57.
28. Bruzzese J-M, Markman LB, Appel D, Webber M. An evaluation of Open Airways for Schools: using college

- students as instructors. *J Asthma* 2001;38(4):337–342. doi:[10.1081/JAS-100000261](https://doi.org/10.1081/JAS-100000261).
29. Levy JI, Brugge D, Peters JL, Clougherty JE, Sadler SS. A community-based participatory research study of multifaceted in-home environmental interventions for pediatric asthmatics in public housing. *Soc Sci Med* 2006;63(8):2191–2203. doi:[10.1016/j.socscimed.2006.05.006](https://doi.org/10.1016/j.socscimed.2006.05.006).
 30. Morgan WJ, Crain EF, Gruchalla RS, O'Connor GT, Kattan M, Evans R, Stout J, Malindzak G, Smartt E, Plaut M, et al. Results of a home-based environmental intervention among urban children with asthma. *N Engl J Med* 2004;351(11):1068–1080. doi:[10.1056/NEJMoa032097](https://doi.org/10.1056/NEJMoa032097).
 31. Wilson SR, Yamada EG, Sudhakar R, Roberto L, Manino D, Mejia C, Huss N. A controlled trial of an environmental tobacco smoke reduction intervention in low-income children with asthma. *Chest* 2001;120(5):1709–1722. doi:[10.1378/chest.120.5.1709](https://doi.org/10.1378/chest.120.5.1709).
 32. Eggleston PA, Butz A, Rand C, Curtin-Brosnan J, Kanchanaraks S, Swartz L, Breysee P, Buckley T, Diette G, Merriman B, et al. Home environmental intervention in inner-city asthma: a randomized controlled clinical trial. *Ann Allergy Asthma Immunol* 2005;95(6):518–524. doi:[10.1016/S1081-1206\(10\)61012-5](https://doi.org/10.1016/S1081-1206(10)61012-5).
 33. Streja L, Crespi CM, Bastani R, Wong GC, Jones CA, Bernert JT, Tashkin D, Hammond SK, Berman BA. Can a minimal intervention reduce second-hand smoke exposure among children with asthma from low income minority families: results of a randomized trial? *J Immigr Minor Health* 2014;16:256–264. doi:[10.1007/s10903-012-9713-4](https://doi.org/10.1007/s10903-012-9713-4).
 34. Turcotte DA, Alker H, Chaves E, Gore R, Woskie S. Healthy homes: in-home environmental asthma intervention in a diverse urban community. *Am J Public Health* 2014;104(4):665–671. doi:[10.2105/AJPH.2013.301695](https://doi.org/10.2105/AJPH.2013.301695).
 35. Bernstein JA, Bobbit RC, Levin L, Floyd R, Crandall MS, Shalwitz RA. Health effects of ultraviolet irradiation in asthmatic children's homes. *J Asthma* 2006;43(4):255–262. doi:[10.1080/02770900600616887](https://doi.org/10.1080/02770900600616887).
 36. Brandt DM, Levin L, Matsui E, Phipatanakul W, Smith AM, Bernstein JA. Allergists' attitudes toward environmental control: insights into its current application in clinical practice. *J Allergy Clin Immunol* 2008;121(4):1053–1054. doi:[10.1016/j.jaci.2007.11.025](https://doi.org/10.1016/j.jaci.2007.11.025).
 37. Horner SD. Using the Open Airways Curriculum to improve self-care for third grade children with asthma. *J Sch Health* 1998;68:329–337. doi:[10.1016/S1081-1206\(10\)60784-3](https://doi.org/10.1016/S1081-1206(10)60784-3).
 38. Love AS, Spiegel J. The Inner-City Asthma Intervention tool kit: best practices and lessons learned. *Ann Allergy Asthma Immunol* 2006;97(Suppl 1):S36–S39. [https://doi.org/10.1016/S1081-1206\(10\)60784-3](https://doi.org/10.1016/S1081-1206(10)60784-3).
 39. Fisher EB, Stunk RC, Sussman LK, Sykes RK, Walker MS. Community organization to reduce the need for acute care for asthma among African American children in low-income neighborhoods: the neighborhood asthma coalition. *Pediatrics* 2004;114(1):116–123. <https://doi.org/10.1542/peds.114.1.116>.
 40. Woods ER, Bhaumik U, Sommer SJ, Ziniel SI, Kessler AJ, Chan E, Wilkinson RB, Sesma MN, Burack AB, Klements EM, et al. Community asthma initiative: evaluation of a quality improvement program for comprehensive asthma care. *Pediatrics* 2012;129(3):465–472. doi:[10.1542/peds.2010-3472](https://doi.org/10.1542/peds.2010-3472).
 41. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews and meta-Analyses: the PRISMA statement. *PLoS Med* 2009;6(7):e1000097. doi:[10.1371/journal.pmed.1000097](https://doi.org/10.1371/journal.pmed.1000097).
 42. McClendon E, Babino J. Evaluating in-home intervention strategies to mitigate disparate respiratory illness rates in disadvantaged urban pediatric populations. *Int J Child Adolesc Health* 2015;8(4):405–411.
 43. Rubin IL, Geller RJ, Nodvin J, Marcus M, Howett M, Merrick J. Break the cycle of environmental health disparities in vulnerable children: special issue on health disparities in children. *Rev Environ Health* 2011;26(3):135–137. doi:[10.1515/RAVEH.2011.019](https://doi.org/10.1515/RAVEH.2011.019).