



Effective education parameters for trigger remediation in underserved children with asthma: A systematic review

Paula Jo Belice PhD, OTR/L & Ellen A. Becker PhD, RRT-NPS, RPFT, AE-C, FAARC

To cite this article: Paula Jo Belice PhD, OTR/L & Ellen A. Becker PhD, RRT-NPS, RPFT, AE-C, FAARC (2017) Effective education parameters for trigger remediation in underserved children with asthma: A systematic review, Journal of Asthma, 54:2, 186-201, DOI: [10.1080/02770903.2016.1198374](https://doi.org/10.1080/02770903.2016.1198374)

To link to this article: <http://dx.doi.org/10.1080/02770903.2016.1198374>



Accepted author version posted online: 15 Jun 2016.
Published online: 15 Jun 2016.



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



Article views: 128



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 1 View citing articles [↗](#)

EDUCATION

Effective education parameters for trigger remediation in underserved children with asthma: A systematic review

Paula Jo Belice, PhD, OTR/L^a and Ellen A. Becker, PhD, RRT-NPS, RPFT, AE-C, FAARC^b

^aCollege of Health Sciences, Rush University Medical Center, Chicago, IL, USA; ^bDepartment of Cardiopulmonary Sciences, Rush University Medical Center, Chicago, IL, USA

ABSTRACT

Objectives: The prevalence of asthma is highest in minority children living in urban areas. Pediatric asthma research has focused on self-management education and trigger remediation using a multi-trigger, multi-component educational intervention approach. The purpose of this systematic review was to identify common educational parameters of these proposed interventions. The review also sought to identify which clinical outcomes improved with multi-trigger, multi-component educational interventions. **Data Sources:** PubMed, SCOPUS and ProQuest Dissertations were searched between 2000 to 2014 using the following terms: asthma; urban population or poverty area; environmental remediation; health education; allergens or dust mites or cockroaches or mold or mice or rats. **Study Selections:** Studies were included if they met the following criteria: 1) participants were minority children identified as underserved; 2) there was a multi-trigger and multi-component intervention; 3) asthma severity was classified as persistent; and 4) asthma control was classified as not well controlled. **Results:** A total of 531 articles were retrieved of which 17 met the inclusion criteria. The interventions lacked consistency in their explanation. Most studies were vague in reporting pedagogical methods and educational content. Few studies reported a theoretical framework to guide their approach. Over half the studies did not report a learning assessment nor health literacy of the caregiver or the child with asthma. Yet all of the findings demonstrated statistically significant results in some or all of their primary outcomes. **Conclusion:** Overall, the research lacked clarity in the approach to impact asthma outcomes and reduces the opportunity to substantiate the findings through replication.

ARTICLE HISTORY

Received 11 April 2016
Revised 17 May 2016
Accepted 2 June 2016

KEYWORDS

Disparities; home-based interventions; learning principles; pediatrics; remediation; self-management

Introduction

In the United States, 1 in 11 children have asthma. The chronic economic burden of asthma on the U.S. health care system [1–4] and the social strain on children and caregivers is well established [5,6]. Of those with current asthma, 38.4% have uncontrolled asthma [7]. Children with uncontrolled asthma often seek care in the emergency department. In 2009, 1 in 5 children went to an emergency department for asthma-related care. This translates to \$56 billion of healthcare cost for asthma each year [8]. This is especially true for children living in underserved, minority communities. In a recently published report [9], the estimated current prevalence of children 0–17 years with asthma was 8.3%, a decrease from 2012 (9.3%). More specifically, there was a rising prevalence trend for non-Hispanic Black children from 11.4% (2001) to 17% (2009); however, it appears the trend stopped increasing after 2009 [9]. The disparity rate ratio between non-Hispanic Black children and White children

was 1.8 (95% CI: 1.5–2.1) in 2013, down from a high of 2.1 (95% CI: 1.7–2.4) in 2011.

This most recent data may indicate a slowing trend or plateau in disparities between non-Hispanic Black children and non-Hispanic White children. Current disparities appear to be driven more by socioeconomic status than by race. Children living in poverty oftentimes reside in dilapidated housing making them more vulnerable to environmental triggers [9]. Living in impoverished neighborhoods adds complexity to asthma management. Poor housing conditions present many environmental triggers contributing to the health disparity in minority children with asthma [10]. Impoverished communities situated near highways and factories pose additional risk of triggering asthma symptoms [11,12]. To date, health care providers and public health interventions have not been successful addressing asthma control in these minority communities.

Education is recognized as one essential element of asthma self-management resulting in good asthma

control and positive health outcomes [13]. According to the Center for Disease Control and Prevention [8], children are more likely than adults to learn how to manage their asthma. Multiple avenues such as clinic settings, school-based programs and even phone apps have been used to reach children with uncontrolled asthma. However, there is a growing movement to provide education in the home offering the missing link of teaching in context and teaching the child and the caregiver together. Research involving these home-based, multi-trigger, multi-component interventions with children and their families is beginning to show promising results.

Since 2009, four systematic reviews have been published addressing environmental interventions. Two reviews [14,15] focused on the effectiveness of remediation programs. Although the inclusion criteria were different between the two reports, both concluded a multi-trigger, comprehensive approach in the home was most effective for asthma management. A third review [16] sought to describe the composition of asthma interventions as provided by various providers. Based on a review of 50 randomized clinical trials, Clark et al. [16] suggested healthcare utilization and symptom reduction are emerging as the gold standard for asthma interventions. The variability in program components and providers, however, made it difficult to reach a conclusion with regards to standards in program planning. The fourth systematic review centered on the community health worker as a provider of the environmental intervention [17]. Community health workers were determined to be a viable option as a delivery agent of the intervention. The interventions evaluated in this review were based on trigger reduction education and tailoring the program to the individual. Interventions with greater intensity and frequency demonstrated the most positive outcomes. Although theoretical underpinnings existed in the studies reviewed, Postma et al. [17] felt the studies ignored the usefulness of a framework when conducting the interventions.

The results of the systematic reviews lack consensus on the most effective approach to control asthma symptoms, although all agreed education was a necessary key component. The multi-trigger, multi-component interventions included a multitude of educational factors. Clark, Mitchell, and Rand [18] concluded study results that change knowledge and not behavior may be due, in part, to interventions lacking in basic educational principles. A gap in the literature exists examining the design of multi-trigger, multi-component interventions based on common tenets of learning. The scope of this systematic review included analysis of randomized control trials and control trials for the purpose of identifying fundamental effective education parameters for trigger remediation for

underserved children with uncontrolled or very poorly controlled asthma and their caregivers. Specifically, the review sought to identify methods of education, session structure and content, providers of education, facilitators and barriers to learning, and measurements of learning. A second question involved identifying which clinical outcomes improved with trigger remediation education. The population included children 4–18 years old, identified with low SES, living in underserved communities.

The research questions were: 1) What are the common educational parameters for multi-trigger, multi-component interventions for minority children with asthma? and 2) Which clinical outcomes improved with multi-trigger, multi-component educational interventions?

Methods

Literature search

The search for potential articles for inclusion was conducted during the period 2000 to 2014. PubMed, SCOPUS and ProQuest Dissertations were searched using the following terms: asthma; urban population or poverty area; environmental remediation; health education; allergens or dust mites or cockroaches or mold or mice or rats. The limiters placed on the initial search were age (children and adolescents), language (English), peer-reviewed and date (2000–2014). The year 2000 was selected as the cut-off point for publication because the United States experienced a sharp rise in childhood asthma in mid-1990, prompting the expansion of funding resources for asthma research. For the purpose of the literature search it was important to capture the outcomes of this initial influx of investigations. In addition to these databases, Clinicaltrials.gov was scanned using the terms “childhood asthma and environmental triggers” and “childhood asthma and environmental remediation.” Lastly, reference lists from the four previously conducted systematic review studies [14–17] with a focus on asthma and environmental remediation were scanned for articles to include in the review process.

Study selection

After duplicates were removed, the remaining references first underwent a title screening, and if appropriate, an abstract review. References were excluded at the title stage if they indicated the study was qualitative and/or an opinion or editorial paper. The abstract review step determined relevant studies meeting all of the following criteria and those studies were included in the final review: 1) participants were minority children identified as

underserved; 2) the intervention contained an educational component; and 3) trigger remediation was addressed. The full text articles underwent a third examination using a refined set of criteria. The criteria included: 1) interventions must be multi-trigger and multi-component; 2) baseline asthma severity must be classified as persistent; 3) baseline asthma control must be classified as not well controlled or very poorly controlled; and, 4) in the event of multiple publications from a primary study, only the primary results article was reviewed. A second reviewer evaluated all studies included in the final review.

For the purpose of this review, children were considered underserved if the reviewed article: 1) labeled their population as underserved; or 2) described their population as low income, minority, inner city or urban, with poor continuity of health care, reported the emergency department as the primary source of asthma care or received little to no previous asthma education. Trigger remediation refers to the management of allergens and irritants in the home environment, which can cause or exacerbate asthma symptoms [13]. Asthma control refers to the degree to which the manifestations of asthma (symptoms, functional impairments, and risks of untoward events) are minimized and the goals of therapy are met. Not well controlled asthma and very poorly controlled asthma definitions are based on guidelines published by the Expert Panel Report – 3 (EPR-3) [13].

Data collection

One author systematically extracted the following data from each article: 1) study characteristics; 2) research design; 3) participant characteristics; 4) education parameters; and 5) clinical outcomes. The education parameters included method and content of instruction used in the intervention, completion of an environmental assessment as a component of intervention, characteristics of the intervention program (i.e., number of sessions, length of program, providers, cost), components of physical remediation (i.e., HEPA filters, mattress/pillow case covers, mold removal), components of behavioral intervention (i.e., medication instruction, asthma action plan, triggers), measurement of learning, facilitators and barriers to learning and study fidelity. The clinical outcomes recorded included healthcare utilization data, missed school days, use of controller medication, health-related quality-of-life, caregiver quality of life, and health care costs. A second author verified the data and the two coders worked together to gain consensus for the final analysis.

Results

Studies identified through the database search yielded 488 articles in peer-reviewed journals. An additional 57 studies were located through other sources such as reference lists. A total of 531 articles were screened after duplicates were removed. The screening entailed a review of title and abstract, if relevant, and resulted in 84 eligible studies. Sixty-seven articles did not meet the review criteria and were excluded from the final critique. The reasons for articles to be excluded at this stage included non-pediatric population; editorial account; not research-based; study lacked an educational component or an intervention; and qualitative focus. A total of 17 articles comprised this systematic review (see Figure 1).

Study characteristics

An overview of the characteristics for each study reviewed is listed in Table 1. Study designs included pre-post design [19–25], randomized controlled trials (RCT) [26–31], quasi-experimental [32,33], randomized cross-over design [34] and observational [35]. All of the studies except one met the review criteria for the participants to be minority children identified as underserved. The settings for the studies were large, urban areas and included predominately African-American or Hispanic children under the age of 18 years. Sample sizes ranged from 18 to 937 participants, with a median of 115 participants.

Caregiver education and health literacy were two study attributes collected for the purpose of examining their impact on asthma education. The education levels of caregivers varied greatly among the studies but trended more toward caregivers with a high school diploma or equivalent. Four studies showed a higher population of caregivers with less than a high school diploma [28,29,32,33]; 8 studies included predominately caregivers with a high school diploma or equivalent [20,22,24,26,27,30,34,35]; and 4 studies did not report caregiver education [19,23,25,31]. Only one study had a higher percentage of caregivers who were college educated [21]. Health literacy of the caregiver or the child was not addressed in any of the studies.

Primary outcomes measured were categorized into 6 organizing themes for ease of analysis: healthcare utilization, asthma control, medication use, home environment, quality of life, and other. All of the studies except 3 [28,30,34] measured healthcare utilization in various degrees of scope. Most consistent were urgent or unscheduled clinic visits, emergency department visits and hospitalizations. Intensive care unit admissions, inpatient days, and hospital length of stay were other measures included.

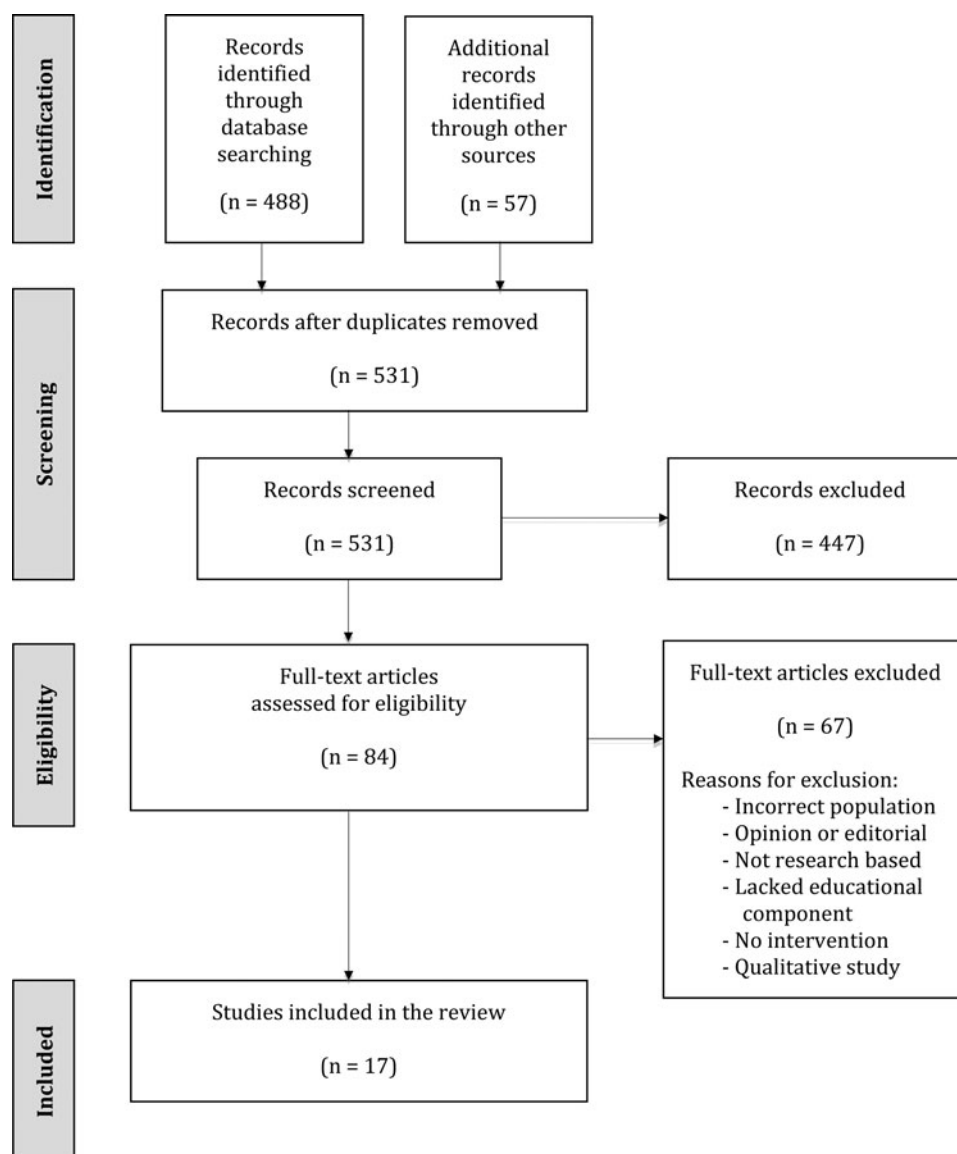


Figure 1. PRISMA flowchart of the search and selection process for the sample of 17 articles included in this review.

Asthma control was cited as a primary outcome in 11 studies. Five studies referenced the EPR-3 Guidelines as criteria to measure asthma control [22,24,32,33,35]. Most of the other studies were conducted prior to the implementation of the EPR-3 Guidelines. Prescription for asthma medication, adherence to medication and rescue inhaler use fell under the medication use category. Quality of life indicators included both child and caregiver assessments. All of the studies reviewed were conducted with some component in the participant's home and included an environmental assessment and/or physical remediation. However, a small number of the studies used changes in the home environment such as trigger reduction and home pollutant exposures as an outcome measure [25,26,28,34]. The last theme for identifying primary outcome measures is other. This included healthcare costs, use of asthma action plans, and pulmonary function.

Education parameters

The primary purpose of the review was to identify effective education parameters for underserved children with asthma and their caregivers. Table 2 details the education intervention characteristics for each study reviewed. An asthma self-management intervention designed within a framework offers a perspective on the approach to the asthma education. Of the 17 studies reviewed, only 4 reported predicated their intervention on theory [21,29–31]. Social Cognitive Theory was used by three of the studies [21,29,31] and one study applied Social Learning Theory [30]. Krieger et al.'s [29] RCT of a community health worker intervention incorporated the Transtheoretical Stages of Change model with Social Cognitive Theory. A combined medical model with a social model gave guidance to a study by Thyne et al. [25]. Authors who did

Table 1. Study characteristics.

Primary Author	Design	Setting	N	Age Range	Race/Ethnicity	Caregiver Education	Caregiver or Child Health Literacy Assessed	Primary Outcomes Measured
Bryesse [32] (2013)	Quasi-Experimental	Seattle - King County, WA	102	3-7	<u>Treatment group:</u> AA 18% Hispanic 47% Vietnamese 21% White 6% Other 9% <u>Historical comparison group:</u> AA 16% Hispanic 46% Vietnamese 12% White 9% Other 17%	<u>Treatment group:</u> < High school 44% High school/GED 21% Some college 35% <u>Historical comparison group:</u> < High school 41% High school/GED 21% Some college 35% College graduate 3%	No	<u>Healthcare Utilization:</u> Urgent clinical care visits <u>Asthma Control:</u> Asthma control; symptom-free days; asthma attacks; days activity-limited; nights with symptoms <u>Medication Use:</u> Days rescue medication used <u>Quality of Life:</u> Caregiver only
Brown [26] (2002)	RCT	Atlanta, GA	95	1-6.99	<u>Control group:</u> AA 89% EuroAm 7% Other 4% <u>Treatment group:</u> AA 90% EuroAm 6% Other 4%	<u>Control group:</u> No high school diploma 26% High school 50% Some college 24% <u>Treatment group:</u> No high school diploma 29% High school 51% Some college 20%	No	<u>Healthcare Utilization:</u> Acute asthma visits <u>Asthma Control:</u> Asthma symptoms; symptom-free days; identification of early signs of asthma <u>Medication Use:</u> Adherence regimen; medications for URI <u>Home Environment:</u> Tobacco in house; mildew in house; cockroaches in house <u>Quality of Life:</u> Caregiver only <u>Other:</u> Level of child participation in administration of asthma medication and symptom prevention and treatment <u>Home Environment:</u> Roach elimination; rodent elimination; smokers; furry pets; bedroom carpet; mattress cover; pillow cover <u>Other:</u> Caregiver knowledge; dust antigen
Bryant-Stephens [34] (2009)	Randomized Cross-Over	Philadelphia, PA	264	2-16	<u>Treatment group - Immediate:</u> Black, non-Hispanic 136 (94%) <u>Treatment group - Delayed:</u> Black, non-Hispanic 112 (93%)	<u>Treatment Group - Immediate:</u> High school 112 (78%) <u>Treatment group - Delayed:</u> High school 97 (81%)	No	



Bryant-Stephens [27] (2008)	RCT - Prospective	West Philadelphia, PA	396	2–16	Control group: AA 124 (100%) Treatment group: AA 145 (99%) Other 1 (1%) Matched Control: AA 115 (100%) Control group: AA 98% Treatment group: AA 100%	Control group: High school diploma 68% Treatment group: High school diploma 76%	No	Healthcare Utilization: Inpatient hospitalizations; emergency department visits; sick visits
Eggleston [28] (2005)	RCT – Parallel Group	Baltimore, MD	100	6–12	Control group: AA 98% Treatment group: AA 100%	Combined Treatment and Control group (mother only): < High school 48% High school 42% One or two years college/tech/voc 10% Not reported	No	Home Environment: Home pollutant exposures of airborne particulates and cockroach allergen levels
Hasan [19] (2003)	Pre-Post	Flint, MI	142	Not reported	AA 79 (54%) White 61 (43%) Other 2 (1%)	Not reported	No	Healthcare Utilization: Critical care days; emergency department visits; inpatient admissions; inpatient days
Krieger [29] (2005)	RCT - Staggered Intervention	Seattle - King County, WA	214	4–12	Caregiver ethnicity: Treatment group - High intensity: non-Hispanic White 12.3% non-Hispanic AA 31.9% Vietnamese 25.4% Other Asian 9.4% Hispanic 17.4% Other 3.6% Treatment group - Low intensity: non-Hispanic White 21.3% non-Hispanic AA 27.9% Vietnamese 22.1% Other Asian 5.2% Hispanic 17.7% Other 5.9%	Treatment group - High intensity: < High school 40.9% High school/GED 25.8% Some college 26.5% College graduate 6.8% Treatment group - Low intensity: < High school 37.6% High school/GED 27.8% Some college 25.6% College graduate 9.0%	No	Healthcare Utilization: Urgent health services Asthma Control: Days with symptoms Quality of Life: Caregiver only

(Continued on next page)



Table 1. (Continued)

Primary Author	Design	Setting	N	Age Range	Race/Ethnicity	Caregiver Education	Caregiver or Child Health Literacy Assessed	Primary Outcomes Measured
Margellos-Anast [20] (2012)	Pre-Post w/historical controls	Chicago, IL	120	2–16	Non-Hispanic Black: 100%	< High school 30.8% High school 38.5% Some college 29.2% Refused 1.5%	No	<u>Healthcare Utilization:</u> Emergency department visits; hospitalizations; hospital days; clinic visits urgent; clinic visits regular; sum of urgent health resource utilization <u>Asthma Control:</u> Daytime symptoms; nighttime symptoms; symptom-free days; activity-limited days <u>Medication Use:</u> Days needing rescue medication <u>Quality of Life:</u> Caregiver asthma-related; pediatric asthma <u>Asthma Control:</u> Maximal # of days with symptoms; days of wheezing; nights with disturbed sleep; child had to slow down or discontinue play
Morgan [30] (2004)	RCT	Multi-site	937	5–11	<u>Control group:</u> Black 41.5% Hispanic 40.0% Other 18.5% <u>Treatment group:</u> Black 37.7% Hispanic 40.3% Other 22.0%	<u>Control group:</u> High school 69.7% <u>Treatment group:</u> High school 69.2%	No	<u>Asthma Control:</u> Maximal # of days with symptoms; days of wheezing; nights with disturbed sleep; child had to slow down or discontinue play
Parker [31] (2008)	RCT	Detroit, MI	298	7–11	<u>Control group:</u> AA 79% Hispanic 10% Caucasian 5% Other 6% <u>Treatment group:</u> AA 83% Hispanic 11% Caucasian 4% Other 3%	Not reported	No	<u>Healthcare Utilization:</u> Needed unscheduled medical care <u>Asthma Control:</u> Symptoms of persistent cough; cough with exercise <u>Medication Use:</u> Has any symptom and not on ICS; has any symptom and not on any controller medication



Primomo [21] (2006)	Pre-Post	Tacoma, WA	60	<1–18	Caregiver's ethnicity: Caucasian 68% AA 19% Samoan 5% Hispanic 3% Native American 3% Chinese 3% Other 2%	< High school 5% High school/equivalent diploma 33% Attended college or earned college degree 62%	No	Healthcare Utilization: Hospitalizations; emergency department visits; unscheduled doctor visits Medication Use: Long-term control medication prescribed; quick-relief medication prescribed Quality of Life: Caregiver only Other: Use of asthma management plan Healthcare Utilization: Emergency department visits; hospitalizations; visits to doctor ^a Asthma Control: CACT score; severe CACT score; ACT score; severe ACT score Medication Use: Use of rescue medications Quality of Life: Missed school days
Shani [22] (2014)	Pre-Post	Not reported	80	2–17	"Most children identified as AA"	< High school 18% High school 44% Some post-high school education 38%	No	Healthcare Utilization: Hospitalizations; intensive care unit days; non-intensive care unit days; hospital length of stay; emergency department visits; doctor office visits Quality of Life: Missed school days
Shelley [23] (2005)	Pre-Post	Not reported	18	Up to 18	AA 3 Hispanic 9 White 5 AA/Hispanic 1	Not reported	No	Healthcare Utilization: Hospitalizations; intensive care unit days; non-intensive care unit days; hospital length of stay; emergency department visits; doctor office visits Quality of Life: Missed school days
Sweet [24] (2013)	Pre-Post	Columbus, OH	115	< 18	AA 56 (71.8%) White 13 (16.7%) Hispanic 4 (5.1%) Other 5 (6.4%)	< High school 27 (24.3%) High school/GED 37 (33.3%) Some college 33 (29.7%) College graduate 12 (10.8%) Post graduate 2 (1.8%)	No	Healthcare Utilization: Emergency department visits; hospitalizations ^a Asthma Control: Symptom days; nighttime awakenings; activity limitation Medication Use: Albuterol use Quality of Life: Missed school days; missed work days (Continued on next page)



Table 1. (Continued)

Primary Author	Design	Setting	N	Age Range	Race/Ethnicity	Caregiver Education	Caregiver or Child Health Literacy Assessed	Primary Outcomes Measured
Takaro [33] (2011)	Quasi-experimental	King County, WA	102	2–17	Caregiver's ethnicity: Control group: White 7.4% Black 17.7% Vietnamese 10.3% Other Asian 11.8% Hispanic 44.1% Other 8.8% Treatment group: White 2.9% Black 29.4% Vietnamese 29.4% Other Asian 14.7% Hispanic 14.7% Other 8.8%	Control group: < High school 37.3% High school/GED 31.3% Some college 25.4% College graduate 6.0% Treatment group: < High school 38.2% High school/GED 35.3% Some college 20.6% College graduate 5.9%	No	Healthcare Utilization: Urgent clinical care ^a Asthma Control: Symptom-free days Quality of Life: Caregiver only Other: FEV ₁
Turcotte [35] (2014)	Observation	Lowell, MA	170	< 15	Black 8 (4.7%) White 21 (12.4%) Asian 26 (15.3%) Hispanic 90 (52.9%) Other 25 (14.7%)	Mother < High school 52 (31%) High School 57 (33.9%) Any college 56 (33.3%) Don't know 3 (1.8%) Father < High school 19 (21.4%) High school 41 (46.1%) Any college 18 (20.2%) Don't know 11 (12.4%)	No	Healthcare Utilization: Emergency department use; doctor visits; hospitalizations ^a Asthma Control: Episodes of wheezing; asthma attacks; difficulty sleeping Medication Use: asthma medication use; average puff rescue medication Other: Health of children and families in 5 domains: child physical health; child social activity; child emotional health; family social activity; family emotional health; high risk asthma group Asthma Control: Days with asthma symptoms; nights with asthma symptoms; days with activity impairment Medication Use: Prescribed controller medication Home Environment: Exposure to tobacco smoke; pets in home; use of bed covers Other: Asthma action plans; FEV ₁
Thyne [25] (2006)	Pre-Post	San Francisco, CA	65	0–12	Latino 28 (43%) AA 28 (43%) Asian/American 7 (11%) White/other 2 (3%)	Not reported	No	

Note. RCT = randomized control trial; AA = African American; EuroAm = European American; GED = general education diploma; ACT = Asthma Control Test; CACT = Childhood Asthma Control Test; FEV₁ = Forced expiratory volume in 1 second.

^abased on EPR-3 guidelines.

Table 2. Education intervention characteristics.

Primary Author	Framework	Provider of Education	Content			Intensity			Measurement of Learning
			Environmental Assessment	Physical Remediation	Behavioral Intervention	# Sessions	Length of sessions	Intervention Duration	
Bryse [32] (2013)	Not Reported	Community Health Worker	Yes	Yes	Yes	Average 5 sessions	Not Reported	Study group: Average 12 months Comparison group: Average 14 months	Not Reported
Brown [26] (2002)	Not Reported	Registered Nurse (RN)	Yes	No	Yes	8 sessions	90 minutes	Average 10 weeks	At the end of each session, RN's used a set of prepared questions, based on educational objectives to assess understanding of material
Bryant-Stephens [34] (2009)	Not Reported	Lay health educator	Yes	Yes	Yes	5 sessions	Not Reported	6 months	16 question multiple choice test given at baseline and end of intervention
Bryant-Stephens [27] (2008)	Not Reported	Home visitor	No	Yes	Yes	5 weekly sessions; then monthly	Not Reported	12 months	Not Reported
Eggleston [28] (2005)	Not Reported	Trained Environmental educator	Yes	Yes	Yes	3 sessions; with telephone follow-up	1 hour	5 months	No formal measurement of learning reported. Conducted quarterly telephone follow-up questionnaires and home evaluations at 6 and 12 months.
Hasan [19] (2003)	Not Reported	Physician, Registered Nurse, Respiratory Therapist, Social Worker	Yes	Yes	Yes	Initial visit and every 3 months	Not Reported	Duration not specified	Not Reported

(Continued on next page)

Table 2. (Continued)

Primary Author	Framework	Provider of Education	Method	Content			Intensity			Measurement of Learning
				Environmental Assessment	Physical Remediation	Behavioral Intervention	# Sessions	Length of sessions	Intervention Duration	
Krieger [29] (2005)	Social Cognitive Theory; Trans-theoretical Stages of Change Model	Community Health Worker	One on one	Yes	Yes	Yes	Average 7 sessions; maximum 9	45 minutes	12 months	No formal measurement reported. Presence of triggers in the home was assessed through interviewer observation and caregiver report.
Margellos-Anast [20] (2012)	Not Reported	Community Health Worker	One on One; The home education sessions were interactive and tailored to family's unique needs.	Yes	No	Yes	Baseline visit; 3–4 sessions	Not Reported	6 months	Caregiver asthma-related knowledge was assessed using a 10-question True/False quiz. Instrument created and not validated. Data collected at baseline; 2 week; 3, 6 and 12 months.
Morgan [30] (2004)	Social Learning Theory	Research assistants	One on one	Yes	Yes	Yes	5 sessions mandatory 2 optional	Not Reported	12 months	No formal measurement reported. Inspection and interview data obtained during home evaluations.
Parker [31] (2008)	Social Cognitive Theory	Community Environmental mental Specialist Asthma outreach worker	One on one; emphasis and order of topics tailored to family's situation One on one in home; phone follow-up	Yes	Yes	Yes	Average 9.24 sessions	Not Reported	12 months	Not Reported
Primomo [21] (2006)	Health Belief Model; Social Cognitive Theory; Models of Community Organizing			Yes	Yes	Yes	Average 2.24 sessions Average 2.6 follow-up phone calls	2.5 hours	Mean = 5 weeks (2–26 weeks)	Not Reported
Shani [22] (2014)	Not reported	Peer educator; Master level health educator	Home visits w/peer educators using one-on-one instructions	Yes	Yes	Yes	4 sessions	Not Reported	6 weeks	No formal measurement reported. The U.S. Environmental Protection Agency Asthma Home Environmental Checklist was used in post-intervention follow-up.

Shelley [23] (2005)	Not Reported	Respiratory Therapist	One on one home visits	Yes	Yes	8 sessions	1–2 hours	8 weeks	Not Reported
	Not Reported	Public Health Nurse with Asthma Education Certification and/or a health educator (nursing student)	Home visits using verbal instruction and demonstration	Yes	Yes	3 sessions; 1–2 follow-up phone calls	Not Reported	Duration not specified	Caregiver trigger-related household activities assessed pre/post on 3 point scale (always, sometimes, never)
Sweet [24] (2013)									Asthma management activities were assessed by asking the caregiver whether their child used a spacer w/their inhaler and whether there was an asthma action plan (yes/no)
									Not Reported
Takaro [33] (2011)	Not Reported	Community Health Worker	Home visits one-on-one; participants also met in the clinic with an asthma nurse	Yes	Yes	1 initial visit; average 4.5 follow-up visits	Not Reported	12 months	Not Reported
Turcotte [35] (2014)	Not Reported	Home Health Assessment Worker; Environmental	Home visits. Project staff met to review assessment data after the initial assessment to individualize the remediation plan.	Yes	Yes	4–9 sessions	Not Reported	Duration not specified	Not Reported
		Assessor							
Thyne [25] (2006)	Medical/Social Team Model	Community Health Worker and clinicians	Clinic visits interspersed with home visits.	No	Yes	4 clinic sessions; 2+ home sessions	Not Reported	Duration not specified	Not Reported

not report a framework were approached for clarification. Viable e-mail addresses could not be located for authors of 2 studies [19,22]. Of the remaining 10, 4 authors responded. Margellos-Anast [20] indicated the Transtheoretical Stages of Change model with Social Cognitive Theory informed their study. Three authors reported not using a theoretical framework [23,24,35].

Providers of asthma education included both health professionals and trained community members. Hasan et al. [19] used a team approach comprised of a physician, registered nurse, respiratory therapist and social worker in both the home and the school setting. Five studies reported using community health workers [20,25,29,32,33]. Additional studies utilized trained lay persons but applied other titles to the positions such as lay health educator, home visitor, asthma outreach worker and peer educator [21,22,27,34]. Three studies identified personnel specific to providing environmental assessment and education [28,31,35].

For inclusion in this review, the education needed to be conducted in the home. Four studies held additional sessions either at a school, clinic or community center. The use of standardized existing curricula was the exception. The majority of studies were nonspecific in describing the method used to provide the educational program stating that sessions were interactive, using verbal instruction and demonstration. Some stated that their methods were individualized to the family's situation [20,31,32,35]. Most interventions included all three major content areas: an initial environmental assessment, physical remediation for triggers, and a behavioral intervention although they were ambiguous on how the sessions were conducted. Components of the physical remediation employed are not reported here. Only 3 studies addressed barriers to learning. Study fidelity was described in the majority of the articles. The number and intervals of intervention sessions and follow-up sessions were widely dispersed. The length of the entire study, however, was typically 12 months.

One important aspect of any educational program is assessment to determine if learning occurred. Over half the studies did not report a learning assessment. Of those remaining, four studies reported using self-created, non-validated instruments [20,24,26,34]. Follow through with environmental recommendations was reported through observation and/or caregiver report.

Clinical outcomes

All of the studies demonstrated statistically significant results in some or all of their primary outcomes. Healthcare utilization, reported as hospitalizations, emergency department visits, unscheduled clinic visits, ICU days,

and urgent clinic visits was included as the primary outcome for 14 studies. The diversity in research design yielded a range of results. Pre-post designed 12-month studies reported a significant decrease in hospitalizations [19,20,23]. Programs three to six months in duration demonstrated decreased emergency department visits [22,24]. Studies with a quasi-experimental design showed reduced healthcare utilization, however found no significance for across group comparison [28,32].

Analysis reflecting within group comparisons between baseline and exit visits was examined for the six randomized controlled trial (RCT) studies reviewed. All the RCTs conducted exit visits at 12 months. Three studies analyzed healthcare utilization by combining data from ED visits, unscheduled clinic visits and/or hospitalizations [29–31]. All reported statistical significance for decreased acute care utilization. When dissecting visit types separately, results were not significant. Brown et al. [26] reported significance for a decline in the number of medical visits for acute asthma, but did not capture other forms of utilization. The remaining two studies were split on results. Bryant-Stephens and Li [27] indicated significance for a decline in hospitalizations, emergency department visits, and unscheduled clinic visits, while Eggleston et al. [28] presented no significance for ED visits and hospitalizations. Each of the 17 studies analyzed demonstrated at least one positive utilization outcome. However, the positive outcomes lacked consistency across all the reports. There were differences in outcome trends when taking into account the length of the study, the use of community health workers, use of physical trigger remediation or a learning framework.

Discussion

The goal of self-management education for children with asthma is to improve the quality of participation in life's activities by reducing the impact of asthma on their daily routines. The EPR-3: Guidelines for the Diagnosis and Management of Asthma [13], identified four components for the effective management of asthma. Two of these, education for a partnership in asthma care and control of environmental factors and co-morbid conditions that affect asthma, provide direction in the design of intervention studies. Both components were inclusive in the studies presented in this systematic review.

A Cochrane review on educational interventions for asthma in children found a general lack of rigor in reporting the methods of intervention studies [36]. One area of reporting weakness is the adoption of a conceptual framework to guide the self-management education. Clark, Mitchell, and Rand [18] advocated a need for asthma research to be grounded in a theoretical frame to assess

behavioral change. Only four of the 17 studies reviewed were explicit in their reporting of a guiding theory [21,29–31]. A conceptual framework sets the premise of beliefs and attitudes and gives an organized direction for the educational intervention. Without this structure, the research lacks clarity in the approach to impact asthma outcomes and reduces the opportunity to substantiate the findings through replication.

Instructional delivery is most often conducted by health care professionals, i.e., nurses, respiratory therapists, or trained lay persons, such as community health workers. In this review of underserved minority children with asthma, the majority of the studies utilized community health workers. Overall, community health workers are found to have a positive impact on asthma self-management outcomes. Their therapeutic role as a social support for the family should not be minimized. However, variability in the level of CHW education and training makes it difficult to compare results with those studies utilizing healthcare professionals. Their role in home-based asthma education needs to be further explored to untangle the impact of their therapeutic processes on the outcomes, their cost-effectiveness and their responsibility as liaisons to healthcare providers [17].

Multi-component interventions were provided in all of the studies reviewed. The educational element was often described as one-on-one instruction with a tailored approach to individual needs. The length of each session was more often not reported and the number of sessions provided was widely dispersed, from as little as two to as many as nine. However, this vast variation in the administration of the education sessions makes it challenging to replicate or generalize results. Reporting an algorithm describing variables that guide specific tailored decisions would provide a flexible, yet replicable intervention.

Interventions designed to impact behavior change are often modified to meet the needs of the individual. Learning theories applied to patient education view the process as active, influenced by the social and physical environment. The teaching approach is often an individual interplay of motivation and control. The application of a learning theory to guide the intervention would give the researcher a valid base to build reliable and effective patient education sessions. Identifying consistent educational components driven by theory that demonstrate positive results would be valuable for subsequent studies.

Formal assessment of learning was deficient in the studies reviewed. The effectiveness of teaching, when reported, was determined through subjective means of observation and self-report. In addition, an account of the barriers and facilitators to learning was not consistently stated. Valid assessments need to be developed and utilized to determine the permanence of learning and both

the positive and negative aspects to the process need to be identified. The omission of these two design components prevents future researchers from developing reasonable and impactful interventions.

The most frequently reported outcome measure in the asthma intervention studies was healthcare utilization, however study authors reported this metric differently. Development of a consistent reporting metric to evaluate utilization would allow for better comparison across future studies. Multi-component interventions even in randomized controlled trials are complex and add to the multitude of variables affecting asthma self-management. Education elements of the interventions are either not standardized or well-described which further obscures the path to a reasonable conclusion. All of these elements make it difficult to discern the source of improved asthma care.

Limitations

Although multiple databases were accessed in the search, the search terms may not have been comprehensive or were insufficient in detail to produce adequate results. A second limitation may be the inclusion of studies conducted prior to the implementation of -EPR-3 guidelines. The revised guidelines introduced a strong emphasis on education. Studies conducted prior to EPR-3 may have showed less attention to education in reporting results.

Conclusion

The multi-component home-base intervention studies reviewed demonstrated mixed clinical outcomes. The effectiveness of the educational components was difficult to ascertain due to exclusion of basic characteristics. The adoption of a learning theory to guide the intervention and valid measures of learning are both essential to sound educational practice. Future studies should adopt pedagogical constructs to develop compelling and effective interventions that follow an appropriate theoretical framework, which would allow for comparisons across studies.

Declaration of interest

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

Funding

This study is part of the *Building Healthy Urban Communities Project* funded by BMO Harris Bank.

References

1. Barnett SB, Nurmagambetov TA. Costs of asthma in the United States: 2002–2007. *J Allergy Clin Immunol* 2011;127(1):145–152.
2. Kamble S, Bharmal M. Incremental direct expenditure of treating asthma in the United States. *J Asthma* 2009;46(1):73–80.
3. Moorman JE, Zahran H, Truman BI, Molla M. Current asthma prevalence - United States, 2006–2008. Centers for Disease Control and Prevention (CDC). *MMWR Surveill Summ* 2011; 60 Suppl:84–86. PubMed PMID: 21430629.
4. Szeffler SJ, Zeiger RS, Haselkorn T, Mink DR, Kamath TV, Fish JE, Chipps BE. Economic burden of impairment in children with severe or difficult-to-treat asthma. *Ann Allergy Asthma Immunol* 2011;107(2):110–119. Epub 2011 Jun 2. PMID: 21802018.
5. Minnesota Department of Health, United States Environmental Protection Agency. (2007). Reducing Environmental Triggers of Asthma in Homes of Minnesota Children (Assistance Agreement No. CH-96541501). Retrieved from: <http://www.health.state.mn.us/asthma/documents/retafullreport0907.pdf> [last accessed 23 March 2016].
6. Moonie SA, Sterling DA, Figgs L, Castro M. Asthma status and severity affects missed school days. *J Sch Health* 2006;76(1):18–24.
7. Zahran HS, Bailey CM, Qin X, Moorman J. Assessing asthma control and associated risk factors among persons with current asthma – findings from the child and adult Asthma Call-back Survey. *J Asthma* 2015;52(3):318–326.
8. Centers for Disease Control and Prevention. Vital Signs: Asthma Prevalence, Disease Characteristics, and Self-Management Education — United States, 2001–2009 *MMWR* 2011;60:547–552.
9. Akinbami LJ, Simon AE, Rossen LM. Changing trends in asthma prevalence among children. *Pediatrics* 2016;137(1):1–7.
10. Holsey CN, Collins P, Zahran HS. Disparities in asthma care, management, and education among children with asthma. *Clin Pulm Med* 2013; 20(4):172–177.
11. Perez L, Lurmann F, Wilson J, Pastor M, Brandt SJ, Künzli N, McConnell R. Near-roadway pollution and childhood asthma: implications for developing “Win-Win” compact urban development and clean vehicle strategies. *Environ Health Perspect* 2012;120(11):1619–1626.
12. Spira-Cohen A, Chen LC, Kendall M, Lall R, Thurston GD. Personal exposures to traffic-related air pollution and acute respiratory health among Bronx schoolchildren with asthma. *Environ Health Perspect* 2011;119(4):559–565.
13. National Asthma Education and Prevention Program. Expert panel report 3: guidelines for the diagnosis and management of asthma. Bethesda, MD: National Institutes of Health; Full Report, 2007:1–440.
14. Crocker DD, Kinyota S, Dummitru GG, Ligon CB, Herman EJ, Ferdinands JM, Hopkins DP, Lawrence BM, Sipe TA. Task force on Community Preventive Services. *Am J Prev Med* 2011;41(2 Suppl 1):S5–32.
15. Townsend K, George M. What is the evidence that environmental remediation programs are effective in urban children with allergic asthma? An integrated review. *J Asthma Allergy Ed* 2011;2:295–304.
16. Clark NM, Griffiths C, Keteyian SR, Partridge MR. Educational and behavioral interventions for asthma: Who achieves which outcomes? A systematic review. *J Asthma Allergy* 2010; 3:187–197.
17. Postma J, Karr C, Kieckhefer G. Community health workers and environmental interventions for children with asthma: a systematic review. *J Asthma* 2009;46:564–576.
18. Clark N, Mitchell H, Rand C. Effectiveness of educational and behavioral asthma interventions. *Pediatrics* 2009;123:S185–192.
19. Hasan R, Zureikat G, Camp J, Duff J, Nolan B. The positive impact of a disease management program on asthma morbidity in inner-city children. *Pediatr Asthma Allergy Immunol* 2003;16(3):147–153.
20. Margellos-Anast H, Gutierrez MA, Whitman S. Improving asthma management among African-American children via a community health worker model: findings from a Chicago-based pilot intervention. *J Asthma* 2012;49(4):380–389.
21. Primomo J, Johnston S, DiBiase F, Nodolf J, Noren L. Evaluation of a community-based outreach worker program for children with asthma. *Public Health Nurs* 2006;23(3):234–241.
22. Shani Z, Scott RG, Schofield LS, Johnson JH, Williams ER, Hampton J, Ramprasad V. Effect of a home intervention program on pediatric asthma in an environmental justice community. *Health Promot Pract* 2015;16(4):291–298.
23. Shelledy D, McCormick S, LeGrand T, Cardenas J, Peters J. The effect of a pediatric asthma management program provided by respiratory therapists on patient outcomes and cost. *Heart Lung* 2005;34(6):423–428.
24. Sweet LL, Polivka BJ, Chaudry RV, Bouton P. The impact of an urban home-based intervention program on asthma outcomes in children. *Public Health Nurs* 2014;31(3):243–252.
25. Thyne S, Rising J, Legion V, Love M. The “Yes We Can” Urban Asthma Partnership: a medical/social model for childhood asthma management. *J Asthma* 2006;43(9):667–673.
26. Brown, JV, Bakeman R, Celano MP, Demi AS, Kobrynski L, Wilson SR. Home-based asthma education of young low-income children and their families. *J Pediatr Psychol* 2002;27(8):677–688.
27. Bryant-Stephens T, Li Y. Outcomes of a home-based environmental remediation for urban children with asthma. *J Natl Med Assoc* 2008;100(3):306–316.
28. Eggleston PA, Butz A, Rand C, Curtin-Brosnan J, Kanchanaraksa S, Swartz L, et al. Home environmental intervention in inner-city asthma: a randomized controlled clinical trial. *Ann Allergy Asthma Immunol* 2005;95(6):518–524.
29. Krieger JW, Takaro TK, Song L, Weaver M. The Seattle-King County Healthy Homes Project: a randomized controlled trial of a community health worker intervention to decrease exposure to indoor asthma triggers. *Am J Public Health* 2005;95(4):652–659.
30. Morgan WJ, Crain EF, Gruchalla RS, O'Connor GT, Kattan M, Evans III R, Stout J, Malindzak G, Smartt E, Plaut M, Walter M, Vaughn B, Mitchell H. Results of a home-based environmental intervention among urban children with asthma. *N Engl J Med* 2004;351(11):1068–1080.
31. Parker EA, Israel, BA, Robins TG, Mentz G, Lin X, Brakefield-Caldwell V, Ramirez E, Edgren K, Salinas

- M, Lewis T. Evaluation of Community Action Against Asthma: a community health worker intervention to improve children's asthma-related health by reducing household environmental triggers for asthma. *Health Educ Behav* 2008;35:376–395.
32. Breysse J, Dixon S, Gregory J, Jacobs DE, Krieger J. Effect of weatherization combined with community health worker in-home education on asthma control. *Am J Public Health* 2014;104(1):e57–64.
33. Takaro TK, Krieger J, Song L, Sharify D, Beaudet N. The Breathe-Easy Home: The impact of asthma-friendly home construction on clinical outcomes and trigger exposure. *Am J Public Health* 2011;101(1):55–62.
34. Bryant-Stephens T, Kurian C, Guo R, Zhao H. Impact of a household environmental intervention delivered by lay health workers on asthma symptom control in urban, disadvantaged children with asthma. *Am J Public Health* 2009;99 Suppl 3:S657–665.
35. 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.
36. Wolf F, Guevara JP, Grum CM, Clark NM, Cates CJ. Educational interventions for asthma in children. *The Cochrane Database of Systematic Reviews* 2002(4); Article No.: CD000326.