



Behavioral interventions to improve asthma outcomes: a systematic review of recent publications

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Purpose of review

Asthma outcomes are influenced by factors at multiple ecological levels: the individual and his/her family, home, medical care, and community. This systematic review describes recently published single-level and multilevel behavioral interventions to improve asthma outcomes.

Recent findings

Of the 23 total title/abstracts reviewed in the original systematic search of PubMed, Ovid, Scopus, PsychINFO, and CINAHL reference review databases, six met inclusion criteria. Five of the studies focused on low-income and/or minority populations. Promising interventions include culturally tailored online asthma self-management programs and family-centered asthma education delivered at the bedside during hospitalization for an acute asthma exacerbation.

Summary

Culturally, tailored online self-management programs offer difficult-to-reach populations asthma support that can be completed at the time and pace most convenient for the individual user. Family-focused asthma education, delivered at the bedside during an acute asthma hospitalization by highly motivated lay volunteers, is an efficacious and low-cost approach to improving pediatric asthma self-management.

Keywords

asthma, education, outcome assessment (health care), schools, self-management

INTRODUCTION

Asthma is one of the most common chronic illnesses, affecting over 24.6 million people in the US and 300 million people worldwide [1–3]. In the US alone, asthma is responsible for over two million emergency department visits [4], 439 000 hospitalizations [5], and 3651 deaths each year [6]. Annual asthma-related indirect (\$5.9 billion) [6] and direct costs (\$50.1 billion) [6] total approximately \$56 billion [2].

Research demonstrates that asthma outcomes are influenced by factors at multiple ecological levels: the individual with asthma and his/her family (e.g., asthma knowledge, self-management skills, family support, and psychosocial factors, including depression), home (e.g., allergen and irritant exposures), medical care (e.g., clinician adherence to national and international asthma guidelines), and community (e.g., school and religious organization programs to promote asthma self-management) [7,8]. National and international guidelines recommend interventions at these various ecological levels to improve asthma outcomes [1,3].

The systematic review aims to identify and assess recently published (i.e., within the past year) behavioral interventions to improve asthma outcomes. Interventions proving efficacy show promise for use in current clinical practice and integration into future multilevel effectiveness studies.

METHODS

Initial search

The systematic review was conducted in accordance with the preferred reporting items for systematic reviews and meta-analyses reference standards

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KEY POINTS

- Difficult-to-reach low-income minority populations may benefit from culturally tailored online asthma self-management programs.
- These programs fit into busy lifestyles in that they allow the individual user to dictate the most convenient time and pace for module completion.
- The acute care setting, such as during a hospitalization for an asthma exacerbation, leverages a unique teachable moment to provide family-focused education to vulnerable children and his/her caregiver.
- This self-management education delivered at the bedside by motivated lay volunteers is an efficacious and low-cost intervention to improve pediatric asthma outcomes.

[9,10]. The following electronic databases were included in the search: PubMed Medline, Ovid Medline, Scopus, PsychINFO, and CINAHL (Table 1). This search included titles and abstracts limited to articles published between 20 December 2015 and 20 December 2016 in the English language, and focusing on humans. To identify behavioral intervention studies for patients with asthma, the terms asthma and intervention were combined with either education, self-management, behavioral, trigger reduction, or technology (Table 1).

Article selection

Two authors (G.S.M. and E.A.) completed title and abstract review. Articles that were not focused on asthma or a behavioral intervention were excluded (Fig. 1). When this information was not clearly evident from title and abstract review, the full article was reviewed. All authors independently verified that all inclusion criteria were met in the remaining articles.

Grouping of intervention studies

Six articles met inclusion and exclusion criteria as described in Table 1 [11¹,12²,13³,14,15⁴,16]. The following data were extracted from each of these six

Table 1. PubMed search strategy

[Asthma (title/abstract)] and [Intervention (title/abstract)] and [Education (title/abstract)] or [Self-management (title/abstract)] or [Behavioral (title/abstract)] or [Trigger reduction (title/abstract)] or [Technology (title/abstract)]

Limited to literature published from 20 December 2015 to 20 December 2016, English Language and humans

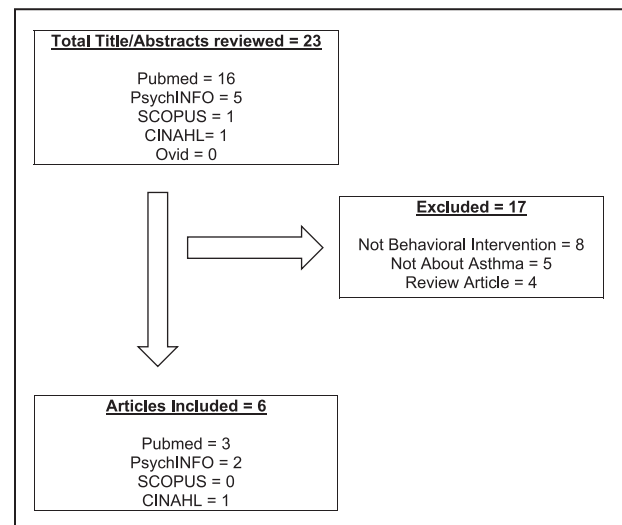


FIGURE 1. Consort diagram. This schematic describes the inclusion and exclusion criteria for articles included in this systematic review.

articles: sample size, population, intervention, control, outcomes/results, timeframe, setting, and intervention level. Each study was evaluated as being single or multilevel. Intervention levels included individual with asthma and his/her family, home, medical care, and community (Table 2). Outcomes were reported as primary or secondary (if specified) and results as positive ($P \leq 0.05$) or negative ($P \geq 0.05$).

RESULTS

Of the six articles included, four were single level, targeting the individual with asthma and his/her family [12²,13³,15⁴,16]. The other two were multi-level: one study targeted the individual with asthma and his/her family and medical care [11¹] and the other targeted the individual with asthma and his/her family and the community [14]. No studies included an intervention at the home level.

Intervention level and results

Individual with asthma and his/her family

Three of the four interventions targeting the individual with asthma and his/her family [13³,15⁴,16] had a positive primary outcome, and the remaining intervention [12²] had a negative primary outcome but positive secondary outcomes. Three of the four studies were conducted in the US, and focused on low-income minority populations, but each targeted a different age group: Rice *et al.* [12²] (range 2–17 years, mean age = 6.9 years, SD = 3.9), Warren

Table 2. Population, intervention, control, outcomes, timeframe, setting

Reference	N, Population	Intervention	Control	Outcome/results	Timeframe	Setting	Intervention Level
Canino <i>et al.</i> [11 ^a]	404, range 5–12 years	CALMA-plus: In addition to the full CALMA intervention, 1) participants' treating physicians were offered NAEPP guideline-based asthma training to enhance their clinical skills to diagnose, manage, and treat asthma in three 1-h interactive seminars; and 2) clinics treating children with asthma were offered a clinic-wide asthma screening program	CALMA: Culturally tailored family management intervention consisting of eight asthma education modules delivered by lay asthma counselors during two home visits and booster telephone calls	Controller medication use (self-reported) ^a : no change Days with asthma symptoms (self-reported) ^a : no change Night with asthma symptoms (self-reported) ^a : no change Asthma control using the pediatric asthma therapy assessment questionnaire (score): No change ^b ED visits (self-reported): no change ^b Hospitalizations (self-reported): no change ^b	18 months	Home; asthma clinic	Individual with asthma and family; medical care
Rice <i>et al.</i> [12 ^{a,b}]	711, range 2–17 years Mean age (SD) = 6.9 years (3.9 years) ^d	Usual care and 30–60 min individualized bedside family-based asthma education session delivered by a trained volunteer lay asthma educator during hospitalization	Usual care (standard medical management and asthma care plan completed by treating physician and nurse according to local asthma clinical practice guideline)	Attendance at posthospitalization asthma clinic visit 7–10 days after discharge ^a : no change ($P = 0.71$) ^c Filling a prescription for oral steroids (self-report): no change ($P = 0.47$) ^c Making any environmental changes (self-report): no change ($P = 0.20$) ^c Use of a controller medication (self-report): improved ($P < 0.01$) ^c Use of a valved-holding chamber (self-report): improved ($P = 0.03$) ^c Possession of asthma action plan (self-report): improved ($P < 0.01$) ^c Parent asthma management self-efficacy questionnaire: improved ($P = 0.02$) ^c Parent report of asthma symptoms and quality of life questionnaire (Peds QL asthma): no change ($P = 0.86$) ^c	1 month	Hospital	Individual with asthma and family
Speck <i>et al.</i> [13 ^{a,b}]	2015 44, range 18–30 years	Breathe Michigan Program: participants completed self-regulatory problem-solving assignments and five educational videos online	No control group	100% found program helpful, 97% would recommend program to others: Demonstrated feasibility ^{a,e,f} Asthma control test: improved ($P < 0.001$) ^e Asthma quality of life questionnaire: improved ($P < 0.001$) ^e	3 months	Technology	Individual with asthma and family

Table 2 (Continued)

Reference	N, Population	Intervention	Control	Outcome/results	Timeframe	Setting	Intervention Level
Suwandkeeree <i>et al.</i> [14]	47, range 6–15 years Mean age (SD) = 10.9 years (2.3 years) ^d	School-based educational intervention for children with asthma, their caregivers, and teachers	No control group	Asthma knowledge (pre/posttest) ^a : improved ($P = 0.02$) ^e Forced expiratory volume in one second: no change ($P = 0.10$) ^e Regular ICS use (self-report): improved ($P < 0.001$) ^e Daytime symptoms (self-report): improved ($P < 0.001$)/($P = 0.03$) ^{e,g} Night time symptoms (self-report): no change ($P = 0.02$)/($P = 0.20$) ^{e,g} Bronchodilator use (self-report): no change ($P = .25$)/($P = .70$) ^{e,g} Emergency room visits (self-report): improved ($P = 0.002$)/($P < 0.001$) ^g School absences (self-report): improved ($P = 0.004$)/($P = 0.03$) ^{e,g}	6 months	School	Individual with asthma and family; community
Warren <i>et al.</i> 2016 [15 ^a]	14, range 13–14 years	Thirty-five 40-min sessions that focused on one teaching students how to use video voice methods to explore their local communities and factors that can impact asthma management; 2) teaching students the basics of health communication and audiovisual production; 3) sharing student-created media and research with the broader public	No control group	Asthma knowledge questionnaire ^a : improved ($P < 0.01$) ^e Pediatric asthma quality of life questionnaire: no change ($P = .17$) ^e Asthma belief survey: improved ($P < 0.05$) ^e Asthma self-care practice instrument: no change ($P = 0.21$) ^e Peak expiratory flow: improved ($P < 0.01$) Sociopolitical control scale for youth: improved ($P = 0.05$) ^e	13 weeks	School	Individual with asthma and family
Yeh <i>et al.</i> 2016 [16]	65, range 6–12 years	Family empowerment program consisting of four counseling sessions with the child and his/her family	Usual care	Parental stress index ^a : improved ($P = 0.0001$) Family environment scale to assess family function: improved ($P = 0.0001$) Family environment scale to assess family function: improved ($P = 0.0001$) Forced expiratory volume in one second: no change (P value not reported)	18 months	Asthma clinic	Individual with asthma and family

ED, emergency department; ICS, inhaled corticosteroids; NAEPP, National Asthma Education and Prevention Program.

^aReported by authors as primary outcome.^b95% confidence intervals do not demonstrate clinically meaningful improvement.^cFor studies using a control group, the P values are for comparison with the control group.^dIf reported by authors, mean and/or median age, and SD included.^eFor studies using no-control group, the P values are for the change from baseline comparison.^fThese outcomes were for feasibility purposes. No P values were reported.^gTwo P values reported because study reported P values for study participants ages 6–11 years and 12–15 years separately.

et al. [15[■]] (range 13–14 years), and Speck *et al.* [13[■]] (range 18–30 years). Yeh *et al.* [16] focused on children ages 6–12 years in Taiwan. The interventions for children under 18 years of age were all directed at both the child and the caregiver [12[■],15[■],16]. Studies featured the following key intervention components: social cognitive theory-based tailored asthma education and self-management training; [12[■],13[■],15[■]] asthma education and family empowerment counseling; [16] and the production and dissemination of video voice asthma education videos [15[■]]. Interventions were delivered across a range of settings, including hospital [12[■]], school and community [15[■]], outpatient clinic [16], and online [13[■]]. Study duration of follow-up varied greatly across studies, ranging from 1 month all the way to 1 year [12[■],13[■],15[■],16].

Positive outcomes included use of a controller medication; [12[■]] spacer use; [12[■]] possession of asthma action plan; [12[■]] parental asthma self-efficacy; [12[■]] finding program helpful and recommending it to others; [13[■]] asthma control; [13[■]] asthma quality of life; [13[■]] asthma knowledge; [15[■]] asthma beliefs; [15[■]] peak expiratory flow; [15[■]] sociopolitical control; [15[■]] parental stress; [16] and family function [16]. The only positive outcome demonstrated using an objective measurement utilized peak flow meters; however, students self-assessed and self-recorded their peak expiratory flow rates [15[■]]. One study had a negative objective primary outcome (attendance at posthospitalization asthma clinic visit 7–10 days after discharge), but positive secondary self-reported (patient self-report or use of validated questionnaire) outcomes [12[■]]. Two studies employed a usual care control group [12[■],16], and three did not include control groups [13[■],14,15[■]].

Individual with asthma and his/her family and medical care

Canino *et al.* [11[■]] conducted a negative study comparing a single-level intervention targeting the child with asthma and his/her primary caregiver [CALMA (an acronym of the Spanish for “Take Control, Empower Yourself and Achieve Management of Asthma), in Spanish, CALMA stands for Controla, Apodérate y Logra el Manejo del Asma] with a multi-level intervention that added a component aimed at medical care (CALMA-plus). This study was executed in Puerto Rico, and included 404 low-income children with asthma ages 5–12 years and their families [11[■]]. All children and their families received a culturally tailored family management intervention known as CALMA that included eight asthma education modules delivered by lay asthma counselors during two home visits and booster

telephone calls. The CALMA-plus group received the CALMA intervention and their treating physicians were offered National Asthma Education and Prevention Program guideline-based asthma training delivered over the course of three 1-h seminars, and the clinics treating children with asthma were offered a clinic-wide asthma screening program. The CALMA-plus intervention was delivered across two settings: the home of the child with asthma, and the clinic [11[■]]. This study utilized a randomized behavioral controlled trial design and had an 18-month follow-up period [11[■]].

Both the primary and secondary outcomes in this study were negative, including controller medication use, daytime symptoms, nighttime symptoms, asthma control, emergency department visits, and hospitalizations. Although some of these outcomes utilized validated questionnaires, most were self-reported and none were assessed using objective measurement [11[■]].

Individual with asthma and his/her family and community

Suwannakeeree *et al.* [14] delivered a school-based asthma education intervention to 47 low-income Thai children with asthma (range=6–15 years, mean age=10.9 years, SD=2.3 years), their caregivers and teachers. The study did not utilize a control group, and had a 6-month follow-up period [14]. The study demonstrated improvements in primary outcome (asthma knowledge), and mixed results on secondary outcomes. Lung function, night time symptoms, and bronchodilator use did not show improvements. However, day time symptoms, emergency department visits, school absences, and regular use of controller medications all improved. The only objectively measured outcome was lung function [14].

DISCUSSION

To improve asthma management and outcomes, national and international asthma guidelines recommend behavioral interventions at the individual and family, home, medical care, and community levels [1,3]. The aim of this systematic review was to assess recently published behavioral intervention studies to discern efficacious approaches at these various levels for potential utilization in future multilevel intervention studies and integration into clinical practice. Four of the six studies demonstrated positive primary outcomes. One study targeted the individual and family and medical care [11[■]], another the individual and family and the community [14], and the remaining four individual and family only [12[■],13[■],15[■],16]. No study was

aimed at the home level. Two studies featured objective measurements of objective outcomes [14,15[■]], only three included a control group [11[■],12[■],16], and three studies had follow-up periods of at least 6 months [11[■],14,16].

Five of the six studies focused on underserved populations [11[■],15[■]]. One study focused on low-income children in Thailand [14], and another on poor children in Puerto Rico [11[■]]. The three US-based studies focused on innercity African-American and Latino preadolescents [12[■]], adolescents [15[■]], and young adults [13[■]]. Thus, although the number of asthma behavioral interventions is low, those that exist focus on the most disadvantaged populations that are in greatest need.

Several promising intervention approaches included unique modalities and settings to deliver the intervention. Although there was no difference in outcomes between treatment and attention-control groups in the study by Canino *et al.* [11[■]] employing a culturally tailored family management intervention delivered by lay asthma educators in participants' homes, both arms demonstrated improvements across multiple asthma outcomes. Yeh *et al.* demonstrated success utilizing a nurse-delivered family empowerment and asthma educational program [16]. Rice *et al.* is the first study to utilize lay asthma health educators in an acute care setting (hospital) [12[■]]. The delivery of family-based asthma education at the bedside during an asthma hospitalization by highly motivated volunteers proved to be a novel, efficacious, and low-cost intervention [12[■]]. Warren *et al.* engaged adolescents in video voice exploration of their communities regarding barriers to asthma management, asthma self-management education; and student led presentations to effect community-wide policy changes to impact asthma outcomes [15[■]]. Suwanakeeree *et al.* [14] engaged children, caregivers, and teachers in a school-based asthma education program. Speck *et al.* [13[■]] took a completely different approach, using a culturally tailored online asthma self-management intervention to improve asthma outcomes for low-income young adult African-Americans.

The systematic review has several limitations. Although a meta-analysis was not executed, the study carefully followed the preferred reporting items for systematic reviews and meta-analyses guidelines for systematic reviews [9,10]. This review also benefits from multidisciplinary expertise, with content experts (an allergist/immunologist and a pediatrician with a clinical focus on asthma) and specialists in behavioral interventions (a behavioral pediatrician and a behavioral psychologist) assessing and analyzing the studies.

CONCLUSION

In conclusion, future research on behavioral interventions to improve asthma control would be strengthened if the designs included robust follow-up periods and rigorous attention control groups. Promising new interventions include culturally tailored online asthma self-management programs, which can be completed at the time and pace most convenient for the individual user. In particular, these new modalities show promise for difficult-to-reach young African-Americans with asthma [13[■]]. Family-centered asthma education, delivered at the bedside during a pediatric asthma hospitalization by highly motivated lay volunteers, is an efficacious and low-cost approach [12[■]].

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G.S.M. serves on the scientific advisory board and owns stock options in Electrocore, LLC; has participated as on scientific advisory boards for Boehringer Ingelheim, GlaxoSmithKline, and Teva; and has served as a consultant for Boehringer Ingelheim, GlaxoSmithKline, Novartis, and Teva.

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Conflicts of interest

There are no conflicts of interest.

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Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

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Special interest: The manuscript describes a culturally tailored family management intervention delivered by lay asthma educators in participants' homes to improve pediatric asthma outcomes among Puerto Rican children.

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Outstanding interest: the first study to utilize lay asthma health educators in an acute care setting (hospital). The delivery of family-focused asthma self-management education at the bedside during an asthma hospitalization by highly motivated volunteers proved to be a novel, efficacious, and low-cost intervention.

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