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Outcomes of the Montana Asthma Home Visiting Program: A home-based asthma education program

Jessie C. Fernandes, MPH, William W. Biskupiak, BA, Sarah M Brokaw, MPH, Dorota Carpenedo, MPH, Katie M Loveland, MPH, MSW, Sonja Tysk, MS, and Shea Vogl, BA

Montana Department of Public Health and Human Services, Helena, MT, USA

ABSTRACT

Objective: Asthma is a common disease in children. Home-based, multi-trigger, multi-component interventions with an environmental focus have been shown to be effective to address asthma in children. The objective of this study was to assess the outcomes and feasibility of implementing a specific asthma home visiting (HV) program in a rural area. **Methods:** Children aged 0–17 years with uncontrolled asthma were enrolled in an asthma HV program that included six contacts over a 12-month period delivered by a registered nurse specifically trained in asthma education and trigger removal in eleven counties in the rural state of Montana. Between June 2010 and December 2016, data on asthma symptoms and asthma self-management skills were collected at baseline and throughout the program. In June 2017, they were analyzed to assess changes in asthma control and quality of life over time among participants completing all six contacts. **Results:** Since June 2010, 152 of 338 enrolled children completed all six contacts outlined in the program (45%). Participants who completed the program reported significant improvements in asthma control test scores, self-management skills, and self-efficacy related to asthma management. These results improved the longer participants remained in the program. **Conclusions:** These findings suggest that it is feasible to implement a 12-month HV program using local public health resources in a rural area as outcomes improved over this time period.

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Introduction

Asthma is a common childhood chronic disease affecting approximately 6.3 million children (0–17 years) in the United States (1). In 2015, 6.3% of children in Montana had current asthma (2). Of the nearly 14,000 children with asthma in Montana, an estimated 36% live with uncontrolled asthma (3). Uncontrolled asthma is associated with activity limitation, urgent care or emergency department (ED) visits, self-reported fair or poor health status, and financial burden (4,5).

The 2007 Expert Panel Report 3 (EPR-3) Guidelines for Treating Asthma emphasize providing education on pathophysiology, medication use, signs and symptoms of asthma, triggers, and skills that include how to use an asthma action plan (AAP), reviewing inhaler technique, and using a valved holding chamber with a metered dose inhaler (6). By providing effective treatment and self-management education, children with asthma can live full and active lives, free of troublesome asthma symptoms. The Community Guide for Preventive Medicine synthesized all available evidence for asthma home visiting (HV) and recommended the use of home-based, multi-trigger,

multi-component interventions with an environmental focus to address asthma in children and states that these interventions are of economic value (7,8).

Several HV programs have reported significant improvements in participant's asthma symptoms, environmental controls, number of missed school and work days, and medication use (9–11). However, the majority of these studies and programs have been conducted in large urban areas with different geography, climate, and demographics than Montana. Montana is the fourth largest and the third least densely populated state in the nation (12,13). A higher proportion of Montanans are non-Hispanic white (86.5%) or American Indian/Alaska Native (6.6%) compared to the United States (61.6% and 1.2%, respectively). Montanans also have a lower median household income than the United States (\$47,169, and \$53,889, respectively). The state's sparse population, high elevation, and colder climate mean that children with asthma in Montana are exposed to different asthma triggers and face different challenges in accessing health-care, and that the logistics for asthma HV nurses in this program vary from those described in previous studies.

CONTACT Jessie C. Fernandes ✉ jfernandes@mt.gov Montana Department of Public Health and Human Services, 1400 Broadway, Cogswell C314B, Helena, MT 59601, USA.

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Other previously described programs are also made up of various combinations of number of visits, length of participation, and amount or type of supplies received.

In 2010, the Montana Asthma Control Program (MACP) developed a home-based asthma program modeled after guideline recommendations. The Montana Asthma Home Visiting Program (MAP) is designed to address asthma triggers in the home, provide asthma self-management education (ASME), and coordinate asthma care in the school, childcare, and the clinical setting. The program includes six contacts by a registered nurse with a family to address the uncontrolled asthma of the child or children in the home. This study describes the implementation of a HV program in a rural area and the outcomes achieved among MAP participants.

Methods

In March 2010, the first MAP site was funded via a competitive application. Three more MAP sites were funded in the spring of 2014 and an additional three in the fall of 2014. Two final sites were funded in the fall of 2015. Five sites are located in more urban areas, with a 2015 population between 65,000 and 114,000 people. The remaining six sites serve counties with less than 35,000 people. An estimated 62% of children with asthma in Montana have access to MAP in their area. Each site received approximately \$32,000 to pay for program costs, including a portion of a registered nurse salary. All MAP HV nurses attended a training organized by the MACP and led by topic experts that covered program logistics, how to conduct a home environmental assessment, asthma pathophysiology, asthma medications, inhaler technique, and data collection and reporting. MAP HV nurses also attended the Association of Asthma Educators' National Asthma Educator Certification and Re-certification Review Course as sponsored by the MACP. The MACP provided ongoing technical assistance to intervention sites and MAP HV nurses throughout the delivery of the program through monthly conference calls, meetings, and ongoing training opportunities.

Institutional Review Board approval was not required by the Montana Department of Public Health and Human Services because previous research established the safety and efficacy of the lifestyle intervention and only de-identified data were used for analyses. All participants signed a consent form and a release of information prior to participating in the MAP.

To be eligible, participants had to have a diagnosis of asthma; be between 0 and 17 years of age; have uncontrolled asthma as defined by having an asthma control test (ACT) score less than 20 or having had an ED visit for

asthma in the last year; and live within the funded jurisdiction. Families participating in MAP received six contacts from the same HV nurse over the course of a year. To address home asthma triggers, families were given a home environmental assessment using the Environmental Protection Agency's (EPA) home environmental checklist, mattress, and pillow covers for the child's bed, and a high-efficiency particulate absorption (HEPA) filter if they had a pet or a tobacco smoker in the home. They also were given a workbook to track progress and take notes along with comprehensive education on asthma triggers and medications. A description of each contact is outlined in [Table 1](#). Completion of the program was defined as participation in all six contacts with the MAP HV nurse.

MAP HV nurses collected data at regularly scheduled intervals on asthma knowledge, symptoms, inhaler technique, ACT scores, school and work days missed due to asthma, and services provided. Asthma knowledge was measured using an 11-question survey developed by the MACP. The survey addresses common ASME topics, including knowledge of basic pathophysiology, asthma symptoms, asthma medications, and triggers. The survey questions were tested among participants, and minor changes were made to wording to ensure appropriate reading level. A score of 91% or greater (correctly answering at least 10 out of 11 questions) was considered good asthma knowledge for the purpose of this paper. Participants also reported asthma daytime and nighttime symptoms, activity limitations, and short-acting beta-agonist (SABA) use based on recall from the last month. The ACT was administered and scored according to recommendations previously described ([14](#)). An ACT score of less than 20 was considered uncontrolled asthma. Children aged 4–11 years completed the childhood ACT and children 12 years and older completed the adult ACT. Children aged less than four years were not eligible to complete an ACT. MAP nurses used InCheck Dials™ to assess inhaler technique ([15](#)). With exception to the ACT, responses were based on parent recall or nurse observation. Metric descriptions are provided in the supplemental table.

Statistical analysis

De-identified participant data were submitted to the MACP from each site quarterly through a secure web-site/FTP site, and data files were combined into an aggregate data set for analysis. Data collected between June 2010 and December 2016 were analyzed in December 2017 using SAS version 9.4 (SAS Institute, Inc., Cary, NC). Descriptive statistics were used to calculate frequencies and averages of knowledge, symptoms, missed school days, and self-efficacy. Chi-square test was used to compare categorical group differences and

Table 1. Description of Montana Asthma Home Visiting Program.

Visit	Month	Type of contact	Visit outline
1	Baseline	Home visit	Baseline data collection, educate on asthma pathophysiology, asthma triggers, medication, devices and technique, AAP, perform home environmental asthma triggers assessment, set home environmental change goal
2	1	Home visit	Review home environmental asthma trigger assessment and discuss if goal was met, review inhaler technique, review importance of AAP
3	3	Phone call or home visit	Home visit if environmental change has not been made, SABA use still high, a HEPA purifier was provided in second visit, or child does not have an AAP. Otherwise, phone call to address any questions family may have
4	6	Home visit	Re-measure child's symptoms and asthma knowledge, provide review of the curriculum from Visit 1, review child's AAP
5	9	Phone call or home visit	Home visit if the ACT given at Visit 4 was <20 , if SABA use still high, or if there was no updated AAP at Visit 4. Otherwise, phone call to address any questions or concerns
6	12	Home visit	Re-measure child's symptoms and asthma knowledge, review inhaler technique, review asthma curriculum from previous visits, address final questions, administer exit survey

Note. SABA, short-acting beta-agonist; HEPA, high-efficiency particulate absorption; ACT, asthma control test.

McNemar's test was used to compare baseline and completion frequencies. Paired t-tests were used to compare individual baseline and completion frequencies for ordinal and interval variables. Multiple logistic regressions were used to adjust program outcomes for potential covariates. The analysis model included categorical predictors for age (0–3 years (reference), 4–11 years, 12–17 years), sex (male (reference), female), race (white (reference), other), and insurance type (private (reference), Medicaid, unknown). A *p*-value of less than 0.05 was considered statistically significant.

Results

The MAP sites have enrolled a total of 428 children as of December 2016. Of the 338 children that have had the opportunity to complete the program, 152 (45%) completed the six contacts outlined in the MAP. One hundred eighty six participants did not complete all six contacts (mean number of visits completed was 3.9 [*SD* = 2.0]) and 90 were currently active participants. Fifty-five percent of the participants who completed the program were boys and 55% were between the ages of 4 and 11 years (Table 2). Children who did not finish the MAP were more frequently of races other than white and had Montana Medicaid for health insurance. There were no differences in those who completed the program compared to those who did not by sex, age, knowledge of asthma, ACT score, inhaler technique, having an AAP, activity limitations, days with asthma symptoms in the last month, having an unscheduled office visit or ED visit in the last six months, missing at least one school day in the last six months, parent missing at least one day of work in the last six months, or using SABA medication everyday of the last 30 days (Table 2).

MAP participants who completed the program had improved asthma outcomes. The percent of participants experiencing symptoms every day in the last month, using a SABA medication every day in the last month,

and restricting their activities due to asthma decreased significantly (Table 3). Nearly all participants eligible to take the ACT had well-controlled asthma at the end of the 12 months. Participants reported missing fewer days of school due to asthma while participating in the program and visited the ED less frequently than before after entering the program. Nearly all participants had good inhaler technique and an AAP upon completing the program. Improvements in asthma control and knowledge increased with the number of sessions attended. Measurements taken of those who completed the program at 6 months demonstrated improvements, which continue to improve by the end of 12 months (Table 3). Adjusted models indicated that program outcomes were not associated with age group, sex, race, or insurance type except in four instances: participants insured through Medicaid were more likely to have reduced number of days with asthma symptoms than those with private insurance (adjusted odds ratio (AOR) 2.56 (95% confidence interval (CI) 1.04–6.30)), participants aged 4–11 years were more likely to have reduced activity limitation than those in the 0–3 years or 12–17 years age groups (AOR 2.41 95% CI 1.06–5.47), participants insured through Medicaid were more likely to have a decreased number of SABA days in the last 30 days than those with private insurance (AOR 2.35 95% CI 1.07–5.15), and participants aged 12–17 years were more likely to have a decreased number of missed work days by the parent than those in the 0–3 years or 4–11 years age groups (AOR 0.11 95% CI 0.02–0.61). Paired results also indicated significant improvements in perceived severity, asthma knowledge test (AKT) score, and ACT score and reductions in number of symptom days, use of SABA, ED visits, and missed school and work days from baseline to completion (Table 4).

Participants also reported an increase in self-efficacy in managing asthma. Participants reported knowing more about asthma, asthma medications, and asthma triggers at the end of the program (Table 5).

Table 2. Comparison of MAP participants who did and did not complete the program, 2016.

	Did not complete N = 276 % (n)	Completed N = 152 % (n)	p-value ^a
Boys	65 (180)	55 (84)	0.05
Age			
0–3 years	32 (88)	30 (45)	0.79
4–11 years	52 (143)	55 (84)	
12–17 years	16 (45)	15 (23)	
Race			
White	74 (204)	85 (129)	0.01
Other race	26 (72)	15 (23)	
Hispanic (any race)	7 (20)	6 (9)	0.69
Insurance Type			
Private	42 (100)	61 (81)	0.0005
Medicaid	58 (139)	39 (52)	
Does not have good inhaler technique	78 (175)	71 (87)	0.12
Has an AAP	66 (181)	67 (102)	0.83
Some/extreme activity limitation	67 (186)	74 (113)	0.15
Think they know about asthma			
Fair amount, quite a bit, a lot	61 (167)	63 (95)	0.76
ACT score	Mean (n)	Mean (n)	p-value ^b
AKT score	17.9 (194)	17.7 (106)	0.99
Days with asthma symptoms in last month	8.0 (253)	8.3 (147)	0.50
Unscheduled office visit or ED visit for asthma in the last six months	10.6 (273)	11.4 (151)	0.64
Missed days of school in the last six months	1.6 (276)	2.0 (152)	0.58
Missed days of work due to child's asthma in the last six months	5.2 (193)	4.7 (107)	0.85
Days used SABA in the last 30 days	2.2 (218)	2.7 (117)	0.40
	9.2 (271)	8.7 (152)	0.52

Notes. ACT, asthma control test; AKT, asthma knowledge test; AAP, asthma action plan.

^aChi square, ^bWilcoxon Rank Sum Test.

Discussion

These findings suggest that it is feasible to implement an asthma HV program using local public health resources in a rural state. Participants achieved notable improvement in self-efficacy and asthma symptoms, with almost all participants exhibiting well-controlled asthma upon completion of the program. Among participants, the number of missed school days and ED visits decreased significantly. Parents also reported missing fewer days of work due to their child's asthma. Outcomes continued to improve over the 12 months of the program and were not all achieved within the first few months.

Asthma is a disease that requires specific self-management skills, and data suggest that people living in rural areas have more difficulty obtaining health care and may receive inferior care for their asthma than people in more urban areas (16). The MAP curriculum/program emphasizes the importance of receiving regular medical care and evaluation, which in some cases meant that families had to travel long distances to receive specialized asthma care. Furthermore, guidelines recommend ASME as a key component of effective asthma management. However, self-reported receipt of ASME is low in the United States and Montana, including participants of

Table 3. Comparison of participant outcomes who completed MAP at baseline, 6 month, and 12 month, 2011–2016.

	Percent			p-value ^a (Baseline vs 12 month)
	Baseline (n/N) ^b	6 month (n/N)	12 month (n/N)	
Severe or very severe self-reported asthma	26.3 (40/152)	Not measured	13.8 (21/152)	0.01
AKT ^c score of 9 or less (equivalent to < 91%)	73.2 (104/142)	31.0 (45/145)	25.4 (36/142)	<0.0001
ACT ^d score 19 or less (uncontrolled asthma)	67.9 (74/109)	35.1 (39/111)	11.9 (13/109)	<0.0001
Does not have good inhaler technique	70.1 (82/117)	58.4 (45/77)	6.0 (7/117)	<0.0001
Does not have an AAP	67.1 (102/152)	19.7 (30/152)	10.5 (16/152)	<0.0001
Had symptoms every day of the last 30 days	17.9 (27/151)	3.3 (5/152)	3.3 (5/151)	<0.0001
Some/extreme activity limitation in the last month	74.3 (113/152)	52.6 (80/152)	34.9 (53/152)	<0.0001
Used SABA every day of the last 30 days	14.5 (22/152)	4.6 (7/152)	1.3 (2/152)	<0.0001
Missed at least one school day due to asthma in the last six months	62.1 (64/103)	30.7 (39/127)	33.0 (34/103)	<0.0001
Had an unscheduled office visit or ED visit for asthma in the last six months	61.8 (94/152)	19.0 (28/147)	22.4 (34/152)	<0.0001
Parents missed at least one day of work due to child's asthma in the last six months	48.2 (54/112)	14.8 (20/135)	12.5 (14/112)	<0.0001

Notes. AKT, asthma knowledge test; ACT, asthma control test; AAP, asthma action plan; SABA; short-acting beta-agonist; ED, emergency department.

^aMcNemar's test, ^bDenominators may differ due to missing data, ^cTotal points possible = 11, ^dTotal points possible = 25 (12+) or 27 (4–11 years).

Table 4. Paired results of baseline and 12 month outcomes of MAP participants, 2011–2016.

	Mean change	T Value	p-value ^a
Perceived severity (scale of 1 to 5)	0.6	5.69	<0.0001
Asthma knowledge test score	2.4	3.73	0.0003
Asthma control test score	4.8	11.0	<0.0001
Symptom days in the last 30 days	– 7.8	– 8.82	<0.0001
Days used SABA in the last 30 days	– 5.5	– 6.11	<0.0001
Missed days of school in the last six months	– 3.3	– 4.22	<0.0001
Unscheduled office visit or ED visit for asthma in the last six months	– 1.7	– 7.28	<0.0001
Missed days of work due to child's asthma in the last six months	– 2.4	– 5.26	<0.0001

Notes. SABA, short-acting beta-agonist; ED, emergency department.

^aPaired t-test.

the MAP (17,3). The MAP is a public health intervention that can bridge the gap between receiving specialized asthma care and the convenience of receiving asthma education in the home. HV nurses can coordinate with health care providers, pass on asthma-related information, and empower families to seek specialized care while addressing key asthma triggers and education in the home that may not be identified or addressed in a medical office.

Exposure to personal asthma triggers can dramatically affect the ability to achieve asthma control and often specific education on asthma triggers and trigger control strategies are not discussed during primary care visits (18,19). While participating in MAP, families received a home assessment of asthma triggers and information on managing their triggers, including in other environments where the child spends significant time (e.g., school, childcare, or other homes). Families set goals for addressing asthma triggers in their home and were given specific education on asthma triggers common to Montana, resulting in a large increase in knowledge. Nearly all families felt that they knew more about asthma triggers at the end of the program.

Other HV programs have demonstrated similar success in urban areas. In Connecticut, the AIRS HV program demonstrated a decrease in missed school days and rescue inhaler use, as well as an increase in participants with well-controlled asthma (10). The Healthy Homes University in Lansing, Michigan, reported a decrease in

missed school or daycare days, less activity limitation, and fewer asthma symptoms after participation in the HV program (11). The Inner City Asthma Study conducted in seven large urban areas also reported similar reductions in asthma symptoms and health care usage to the MAP (12). Despite the low population density of Montana, HV nurses were able to enroll and travel to the homes of children in the surrounding jurisdiction within the MAP budget and achieve similar outcomes as programs in larger urban areas.

Completion rates for HV programs vary widely. Studies have explained the factors that families experience that limit the ability to engage and complete a program include, but are not limited to, scheduling difficulties, educational attainment, mother's age, living environment, readiness to change, and compatibility with the HV nurse (20–22). While HV nurses delivering the MAP did offer flexible schedules, there are no limits on who can participate in MAP other than the child having uncontrolled asthma. Therefore, most of the factors mentioned above are not controlled for in participation. There were no differences in any asthma outcome categories among those who complete MAP and those who did not suggesting that factors other than those related to the disease influence attrition. Future research will examine specific reasons for attrition from MAP, especially any reasons related to non-white and low-income populations.

Table 5. Participant-reported self-efficacy and receipt of self-management education, 2011–2016.

	Percent		p-value ^a
	Baseline (n/N)	12 months (n/N)	
Self-reported fair amount, quite a bit, or a lot known about asthma	62.5 (95/152)	99.3 (151/152)	<0.0001
Self-reported fair amount, quite a bit, or a lot known about asthma medications	50.7 (77/152)	98.0 (149/152)	<0.0001
Self-reported fair amount, quite a bit, or a lot known about asthma triggers	61.2 (93/152)	98.0 (149/152)	<0.0001
Self-reported that they are confident or very confident that they can handle an asthma attack	58.6 (89/152)	92.8 (141/152)	<0.0001

Note. ^aMcNemar's test.

There are several limitations to this study. First, most outcome data were self-reported and may introduce recall bias. However, the recall time periods were of relatively short duration. Second, a control or comparison group was not used and only pre-and post-data were used in analysis. However, this type of intervention had previously been shown to be effective. Finally, data were not analyzed using intent-to-treat and only included participants completing the six contact visits.

Conclusions/key findings

The study provides an example of a successful asthma HV curriculum and format. While asthma education provided early on in the program is beneficial, long-term participation (12 months) enhances the outcomes and demonstrates the need for ongoing, reinforced asthma education for children with uncontrolled asthma and their families. This information has implications for the promotion of HV as a reimbursed service from insurance companies as the service has been shown to have a positive return on investment (8). This program also emphasizes the need for the collaboration between healthcare and public health services. In the era of team-based care, HV services can provide valuable insight to a healthcare provider who does not see the home environment or may not have adequate time to spend on ASME.

Declaration of interest

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

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