Original Research

Asthma Smarts Education: Increased Disease Knowledge and Reduced School Nurse Visits

Erin Lee, MS (Corresponding Author)
Fight Asthma Milwaukee (FAM) Allies, Board Member
Medical College of Wisconsin, Clinical Research Coordinator

Mitchell Grayson, MD
Nationwide Children's Hospital – The Ohio State University School of Medicine
The Abigail Wexner Research Institute at Nationwide Children's Hospital

Mahua Dasgupta, MS
Department of Pediatrics
Medical College of Wisconsin

Daniel Klaver, MPH
Fight Asthma Milwaukee (FAM) Allies

Brett Fuller, MA.Ed
Curriculum Specialist: Health and Physical Education
Milwaukee Public Schools

Joshua Steinberg, MD
Division of Allergy and Clinical Immunology
Medical College of Wisconsin

John Meurer, MD, MBA
Professor and Director, Institute for Health and Equity
Medical College of Wisconsin

Partial funding sources:
Centers for Disease Control cooperative agreement number 1U59EH000503-01 (09/01/2009 - 08/31/2014)
Centers for Disease Control, National Center for Chronic Disease Prevention and Health Promotion cooperative agreement number 1U87DP001196-01 (03/01/2008 – 02/28/2013)

Submitted 30 November 2020, revised 17 May 2021, accepted 25 August 2021

ABSTRACT:

Background: Worldwide, asthma is one of the most prevalent chronic diseases. Lack of asthma knowledge can lead to exacerbations, emergency room visits, absenteeism, and decreased quality of life. Asthma prevalence in Milwaukee Public Schools (MPS) is often 20% or higher, and among children ages 5-17, asthma is a leading cause of missed school days. A community collaboration created an asthma education program tailored to MPS needs.

Objective: The purpose of this study was to evaluate the efficacy of brief, school-based asthma education for students with asthma in grades 3-5.

Methods: A prospective cohort study of students with asthma in 3rd-5th grades was developed to assess asthma knowledge improvements via survey (n=2,066) before and after implementing three 30-minute Asthma Smarts lessons delivered one week apart. Additionally, MPS data was analyzed to explore impact on asthma related school nursing visits (n=110).

Results: Improvement upon post-testing was shown for all questions in each implementation year with highly significant results (all $p<0.0001$). Students that participated in Asthma Smarts made fewer asthma related visits to the school nurse with a significant difference in the mean number of visits pre and post program ($p<0.001$).

Conclusion: This project demonstrates potential for mutually beneficial partnerships addressing gaps in school-based nursing services, and successful support for students with asthma.

KEYWORDS: Medicine, Nursing, Community health partnerships, Lung Diseases, Asthma, Great Lakes Region

INTRODUCTION

Asthma is a leading chronic disease in children[1], and in the United States, 6.2 million (8.3%) under age 18 have asthma[2]. One out of 13 Wisconsin children has asthma, and this burden disproportionately impacts urban school children[3]. In Milwaukee, significant asthma disparities exist as a factor of income, race, and ethnicity, accounting for much of the risk associated with asthma morbidity[4]. Uncontrolled asthma often results in school absenteeism, restriction from school activities, emergency room (ER) visits, and hospitalizations[5]. Among children ages 5-17 years, asthma is a leading cause of missed school days, accounting for 13.8 million missed days in 2013[2], and asthma prevalence in Milwaukee Public Schools (MPS) is often 20% or higher[6]. From 2008-2013, the annual economic cost of asthma was more than $81.9 billion, including $50.3 billion in medical costs, $29 billion due to asthma related mortality and $3 billion in losses from missed work and school[7].

Published guidelines suggested students with asthma can best manage their disease upon receiving education on asthma basics and management as well as recognizing and responding to emergencies[1]. Recent studies demonstrated that school-based asthma educational interventions, improve asthma management knowledge, skills and school performance, as well as decrease ER visits, hospitalizations, unscheduled doctor visits, and school and work absenteeism[8,9]. Team-based programs integrating schools, clinicians, and families have been shown to increase asthma knowledge and self-efficacy[10]. Delivery of programming by clinicians has also shown reductions in symptoms, activity limitations and healthcare utilization[11].

School-based asthma education programs for elementary aged participants such as Open Airways for Schools, Iggy and the Inhalers, and Fight Asthma Now (FAN) for youth[12,13,14] have shown benefit. Interventions differed in length, number of sessions, instruction content, type of instructor and instructor training. A 2014 review of 23 elementary school asthma interventions showed positive clinical and academic outcomes despite heterogeneity[15]. Our project seeks to showcase that community collaborations can offer asthma education solutions that demonstrate knowledge gains among learners in a cost-effective manner. Uniquely, the project is a coalition initiative, not investigator-run or school-sponsored, that mobilizes teaching staff through innovative partnerships.

Asthma is an equity challenge requiring community wide efforts to better serve diverse and vulnerable populations. Principles of Community Based Participatory Research (CBPR), particularly (1) building on community strengths, (2) facilitating equitable partnerships, and (3) balancing research and action toward mutual benefit were employed as vehicles for establishing trust and increasing project relevance to participating communities[16,17]. Our multi-organizational collaboration developed a study whose purpose was to evaluate the efficacy of brief, school-based asthma education for students with asthma in grades 3-5 taught by healthcare professional students and community-based instructors.

Fight Asthma Milwaukee (FAM) Allies began in 1994 under fiscal agency of the American Lung Association of Wisconsin as a volunteer-based surveillance project to define Milwaukee's asthma epidemic and create solutions for the disproportionate burden of disease on low-income and diverse residents (Figure 1). Initial members were healthcare professionals from hospitals,

health departments, and clinics, as well as parents of children with asthma. Fiscal agency transferred to Aurora HealthCare in 1996 and membership expanded, adding social service agencies and healthcare business representatives. In 1999, fiscal agency was transferred to Children's Hospital of WI (CHW) and by 2010 about 300 coalition members represented 80 Milwaukee county organizations and families, adding members such as government, higher education, schools, community nonprofits, childcare, and Boys and Girls Clubs. Members volunteered in 5 different working committees addressing community needs, and in 2015 delivered "413 educational sessions…to 3,688 people"[18] in Milwaukee. When fiscal agency ended in 2015, FAM Allies secured a non-profit 501c3 status retroactive to July 2014, and select programming continues to this day.

METHODS

In 2008, the FAM Allies education committee members, including school nurses and curriculum specialists from MPS, allergy nurses from the Medical College of Wisconsin (MCW), health educators from Milwaukee Area Health Education Center (Mil AHEC), biostatisticians from Children's Research Institute (CRI) and nursing instructors from Alverno College, Concordia University, Marquette University, Milwaukee School of Engineering, the University of Wisconsin, and Wisconsin Lutheran College, focused asthma in elementary schools. Members met monthly to create a new curriculum called "Asthma Smarts" (Table 1) because existing programming for elementary aged students was difficult for MPS to schedule and for community-based instructors to teach.

The "Asthma Smarts" program was tailored to MPS's needs as discussed with MPS representatives during planning meetings– specifically a targeted and time-limited intervention that would not depend entirely upon school nurse involvement or require them to be instructors. Curriculum content emerged through collaboration of coalition asthma expertise with MPS curriculum specialists, resulting in education consistent with National Institutes of Health National Asthma Education and Prevention Program (NAEPP) guidelines as well as with MPS learning targets in reading, math, science, and health[19]. While specific concepts addressed in asthma education meeting NAEPP guidelines is similar across programs, "Asthma Smarts" included activities, worksheets, and games co-created with MPS committee members to best serve teaching interests of the school system.

"Asthma Smarts" instructors included FAM Allies members that were community health workers, community-based educators from local nonprofit organizations, AmeriCorps volunteers, and health education interns. Additionally, nursing and medical school partners connected their students with the project to facilitate real-world practice with community health skill sets. Collectively, these students taught the largest number of "Asthma Smarts" classes of all instructor groups.

Committee members outlined program implementation roles. School nurses agreed to obtain permissions from principals and classroom teachers, identify participants with asthma, and schedule with instructors. Nursing instructors scheduled training for their students and coordinated data submission to FAM Allies during debrief sessions with student instructors. FAM Allies staff provided instructor training, maintained the school interest list, assigned instructors to schools, and managed data.

With a completed curriculum and roles delineated, pilot outreach to schools took place from 2009-2011, using a survey of five binary questions. Elementary school students struggled to understand the questions, so reading level was lowered, and the updated survey implemented through 2014. The education committee then decided to change the questions in favor of a multiple-choice tool that would allow improved evaluation of learning. The final survey was adopted from 2014-2019 (Appendix A), and allowed the team to measure outcomes, specifically changes in knowledge related to asthma content.

Study Design

A prospective cohort study of students with asthma in 3rd-5th grades was developed to assess asthma knowledge improvements via survey before and after implementing three 30-minute "Asthma Smarts" lessons. MPS did not wish to withhold educational resources for a control cohort, nor were there resources to track a comparator cohort. Additionally, school nursing visits were analyzed to explore changes in asthma related nursing visits among students that participated in "Asthma Smarts". The CHW Institutional Review Board approved this study.

Participants

All elementary schools in the City of Milwaukee were invited to host the program. Each year, there were at least 100 elementary schools open in the school district (Table 2). School nurses identified students with asthma for "Asthma Smarts" participation and then submitted requests for programming to FAM Allies. Participants were identified through any combination of:

- Reviewing parent completed health forms for asthma diagnosis
- Searching electronic student records for students with an asthma diagnosis
- Identifying students who made frequent visits to the nursing office for asthma
- Identifying students taking daily asthma controller medicines

Nurses sent passive parental opt-out forms home with identified students at least one week before the first "Asthma Smarts" class. Parents that returned the forms were declining permission for participation and those students did not attend the "Asthma Smarts" lessons. Schools did not disclose to FAM Allies whether a child's participation was declined by the families.

Procedures

FAM Allies trained member volunteers as well as nursing and medical students to serve as "Asthma Smarts" instructors supporting school nurses who were unable to deliver the programming themselves. A two-hour, in-person orientation provided an overview of implementation steps and assessed demonstration technique for spacers and peak flow meters. Video directions and examples allowed trainee review of teaching technique independently at any time. Additionally, nursing instructors incorporated practice teaching into classroom time prior to delivery in elementary schools.

FAM Allies staff maintained a waiting list of schools interested in hosting "Asthma Smarts". As instructors were trained, they were connected to their school nurse via an email containing contact information and logistics. The timing of lessons was negotiated between the instructor and school nurse to accommodate each other's schedules. School nurses coordinated the lesson room and worked with classroom teachers to release participants at the scheduled time.

Instructors arrived at the school, signed-in at the office, and reported to the school nurse just prior to teaching. Supplies, stored in the nursing office, would be collected and instructors would prepare the teaching space while students were released from classes. "Asthma Smarts" education was delivered to a maximum of 10 students at a time in three, 30-minute lessons scheduled at least one week apart. This format afforded timing flexibility and minimized or eliminated missed classroom time.

Before lesson one and at the end of lesson three, the knowledge survey was implemented. All survey questions and answers were read out-loud to the participants by instructors and students

recorded their answers on paper. Instructors coded, paired, and returned pre and post answers to FAM Allies during a debrief session. FAM Allies then compiled and shared the data with bio-statisticians for analysis.

Statistics

The survey instrument was developed by a multidisciplinary team and was pilot tested from 2010-14, but not validated. The final set of questions (Appendix A) was implemented during 4 full school years (2014-15, 2015-16, 2016-17, 2017-18). McNemar's Test (paired) was used for pre-test vs. post-test survey analysis, and comparisons between participants with complete and incomplete data were assessed.

"Asthma Smarts" attendance and asthma related school nurse visits were maintained by school nurses in MPS electronic student files. To describe possible links to programming, MPS provided deidentified data on asthma related school nurse visits that occurred from 2008-2013. Visits were aggregated to determine the number of visits per student per month. Using Stata″ (version 15.1) statistical software, the mean number of asthma visits per student per month both before and after programming was compared using a paired t-test. While pre and post program school nurse visits were paired, these students could not be matched to their pre and post "Asthma Smarts" surveys.

RESULTS

"Asthma Smarts" Improved Asthma Knowledge

Between 2010-2018, FAM Allies provided the "Asthma Smarts" curriculum (Table 1) to 3,669 students. From 2014-2018, 132 elementary schools hosted the program, and pre and post survey responses were analyzed for 2,066 students from 77 different schools (Table 2). Each year, about 42% of schools were new in that they had not hosted the previous school year (Table 2). Improvement upon post-testing was shown for all questions in all years (Table 3) with highly significant results (all $p \leq 0.0001$).

The question on identifying triggers (Table 3, question 3) showed the largest percentage increase from pre to post in the percentage of correct answers, followed by the question on when to use controller medicines (Table 3, question 1). These questions also showed the highest percentage of incorrect pre-test answers by students. While the percentage increase for these questions pre to post was high, the percentage of correct post-test answers was lower than post-test answers for all other questions.

Knowledge on when to use both controller and quick relief medicines (Table 3, questions 1 and 2) was evident upon post testing for each question ($p<0.0001$). During pre-testing, more students answered the quick relief question correctly than answered the controller question correctly; however, significant knowledge gains were demonstrated upon post testing for both types of medications.

Students demonstrated learning on the correct use of a spacer and cough as an asthma symptom (Table 3, questions 5 and 6) with significant knowledge increases upon post testing ($p<0.0001$). The percentage of correct pre-test answers for these questions was high (55% and 66% correct), and the percentage of correct post-test answers for the cough question was higher than for all other questions (85% correct).

Seventy percent of students answered the smoking question (Table 3, question 4) correctly upon pre-testing. Despite this baseline knowledge, the increase in correct answers upon post testing was significant ($p \leq 0.0001$).

Incomplete or missing data accounted for more than 10% of participation. The available responses were compared (Table 4). More pre data was missing (7.5% - 22.9%) than post (0.9% - 3.7%). All comparisons for each year were made at a $p<0.005$, to adjust for multiple testing, and no significant differences were found.

"Asthma Smarts" Decreased School Nurse Visits

Asthma related school nurse visits from 2008-2013 were queried from an MPS database and analyzed. The query showed that in 70 elementary schools "Asthma Smarts" attendance and asthma related school nurse visits were tracked in the database, and these records were analyzed. Students (n=110) that participated in "Asthma Smarts" made fewer asthma related visits to the school nurse (Table 5). The mean number of asthma related nursing visits per student per month before "Asthma Smarts" participation was 2.55 and after was 1.91. The difference in means (0.64) was statistically significant ($p<0.001$).

DISCUSSION

The benefit of school-based asthma education programs for elementary aged participants has been shown even when interventions differed in length, content, type of instructor and instructor training. Our project showcased community collaborations as a pathway to successful asthma education solutions through CBPR.

Major findings

This research demonstrates the efficacy of a brief, school-based asthma education program to significantly improve asthma knowledge and decrease asthma related visits to the school nurse.

Knowledge results suggest that clinicians and asthma educators could focus more education on trigger identification and controller medication use. Students demonstrated increases in correct answers when asked to identify triggers as well as when to use controller medicine (Table 3, question 3 and 1). However, they also showed the highest percentage of incorrect pre-test answers in these areas, suggesting lower baseline understanding. Additionally, student percentages of correct post-test answers for these questions were lower than for all other questions, indicating opportunity for enhanced learning in these areas. Prioritizing trigger and controller medication learning concepts into asthma education is therefore recommended.

When comparing baseline understanding of quick relief and controller medication use, students more often answered pre-test questions on quick relief medications correctly versus pre-test controller questions . This suggests that students better understood the use of quick relief medications than that of controllers. For this reason, it is recommended that educators, including in

clinic settings, increase or enhance messaging to patients on controllers. However, significant knowledge gains were demonstrated upon post testing for both types of medications.

Students demonstrated consistent learning and significant knowledge increases upon post testing on health impacts of smoking, the correct use of a spacer, and cough as an asthma symptom, (Table 3, questions 5, 6, and 4) even when pre-test answers suggested high baseline understanding. When considering the smoking question specifically, high baseline understanding may reflect existing health curricula in place at schools; however, vaping was not included in "Asthma Smarts" education and may be a consideration for future programming.

Even though students demonstrated baseline knowledge on many learning concepts, significant knowledge gains were possible with additional education. Annual asthma education in schools for students with asthma may support management understanding and reinforce healthy behaviors.

Challenges and Lessons Learned

Recruiting elementary schools benefitted from an in-house champion, often the school nurse, and required more lead time than expected. School nurses worked with administrators for permission to host "Asthma Smarts" programming, and with individual classroom teachers to coordinate favorable times to release students from class. An interest list of elementary schools was recruited a semester in advance of programming to accommodate approval processes.

The process of training healthcare professional students as instructors was initially challenging, but evolved into an important partnership, albeit resource and time intensive. Each university hosted its own orientation every semester that outlined a case for addressing asthma in Milwaukee elementary schools and provided statistical results from "Asthma Smarts" education implemented the prior year. This was motivating for students and professors. In-person demonstration of teaching techniques as well as hands-on practice and teach back to the FAM Allies instructor were essential, but effectiveness increased when recorded videos were also made available. In-person debrief sessions provided feedback that was more useful than written or emailed responses. Students whose professors provided extra in-class practice time showed confidence and provided more constructive feedback upon debriefing.

Limitations

External funding for "Asthma Smarts" provided limited support for one position during the pilot years of programming. Partnership entities provided in-kind staff time to accomplish training, coordination and data analysis. While this in-kind support was extraordinary, limitations were created. First, resources to implement a cross-over follow up study with a control group were unavailable. Additionally, schools could not adjust how absenteeism was recorded, asthma control for participants could not be measured, the team could not link varied data sources to specific students, and students could not be tracked to measure retained knowledge.

Assessment of asthma control through attendance records was considered, but not implemented. Attendance within MPS schools was recorded as excused or unexcused; data on health status related to absences was not collected. The education committee discussed with MPS members

challenges to changing the attendance system, and whether pilot testing new approaches was feasible. Ultimately, changing the attendance reporting system was outside the scope of this project.

Broader assessment of education affecting asthma control was attempted through pediatric Asthma Control Tests (ACTs)[20,21], but not implemented past the pilot phase. Pediatric ACTs in the 4-11-year age range required parental input for validated responses, but consistency in returning paperwork was low. Team members and school volunteers made phone calls and sent written reminders home, yielding little increase in parental response. Due to limited resources, staff coverage to administer or collect Pediatric ACT scores was not feasible. However, community groups that can develop relationships with parent coordinators or parent teams within the schools may be able to accomplish this task.

A data set from 2008-2013 on asthma related visits to the school nurse was secured for the project, however additional queries were not available. MPS introduced a new system of digital record keeping, and during the transition data entry for "Asthma Smarts" was not prioritized or required. Furthermore, asthma related funding to MPS had finalized and the work to query data was too expensive to offer in-kind. Ultimately, only a limited subset of MPS data on asthma related visits to the school nurse could be queried, and subsequently, matching those nursing visit records to individual "Asthma Smarts" participants was not allowed by the Family Educational Rights and Privacy Act (FERPA)[22].

Measuring longer term impacts of the education presented challenges. To test retained knowledge in subsequent school years, past participants would need to be identified and located, especially if there was a move to a different school. Tracking participants would require securing and maintaining patient identifiable information. Additionally, available staff or volunteers would need to revisit each school to implement surveys. The team determined that there were not enough resources to track students. However, testing retained knowledge was of interest to community partners and would be prioritized pending opportunities for funding.

Future Research

Potential future research included measuring asthma control resulting from education via ACT tests, as well as measuring changes in absenteeism and retained knowledge. These quantitative approaches could be enhanced by qualitative interviews with elementary school students, discussing changes in self-efficacy related to management behaviors taught in the program, as well as home-based influences on their asthma self-management. Interviews or focus groups with school nurses and classroom teachers could capture, from the school perspective, program benefits or recommended improvements.

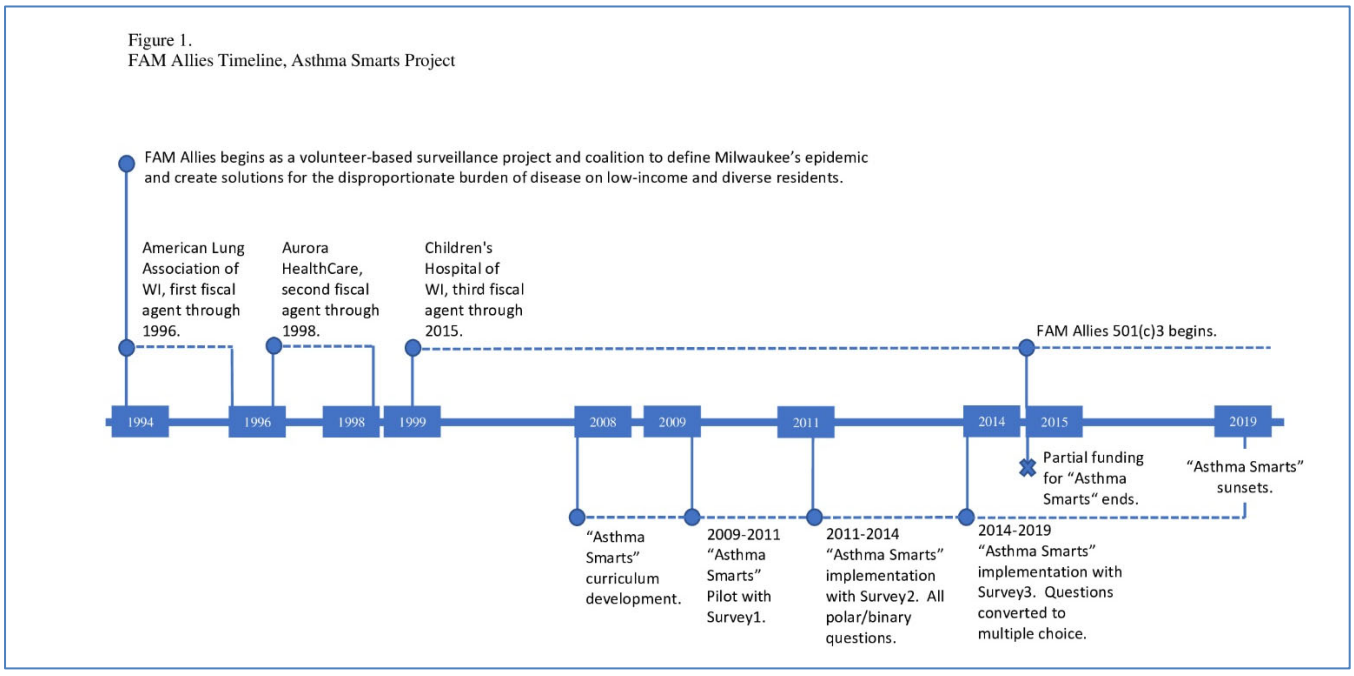
Instructor groups could be compared to measure any differences in effectiveness shown by the test scores of their students. Additional areas for future inquiry relate to insights gleaned from "Asthma Smarts" instructors as learners themselves. How does asthma understanding change among participating medical and nursing instructors? Does their involvement in teaching "Asthma Smarts" translate to better instruction on asthma in their future clinical settings? What

are the benefits to exposing healthcare professional students to meaningful work with community-based organizations?

Sustainability

Partnerships allowed the "Asthma Smarts" program to continue four years after partial funding was exhausted (2015-2019) (Figure 1). This was only attainable through cooperation among volunteers and in-kind staff time, travel reimbursement, space and equipment use as well as photocopying. Additionally, a greater number of elementary school students were able to participate because nursing and medical school partners involved their students as volunteer instructors.

Figure 1. FAM Allies Timeline, Asthma Smarts Project



Currently, FAM Allies would require significant funding to re-open the "Asthma Smarts" program even if partners offered the same level of in-kind support. Continuous and sufficient funding is an ongoing challenge, especially for small community-based groups. In general, funding is obtained by partners, and only a small component is provided to the community group – and this is usually for outreach but not personnel. The community-based groups often don't have the staff and time to write competitive funding applications. Philanthropy is another option, but for similar reasons, small community-based groups are often at a disadvantage in this arena, as well. While CBPR is a welcome concept that can harness and amplify community voice, commitment to equitable financial engagement of community groups might lift more of them into sustainability.

Community Considerations

Community-wide efforts can make a difference in serving diverse and vulnerable populations. Principles of CBPR, allowed FAM Allies to incorporate community needs into asthma education for elementary schools and demonstrate student learning. The team was successful because it built partnerships from diverse perspectives and structured action around community strengths. Importantly, the interest in generating research was balanced by the need for flexibility in serving community interests.

Program results were presented at annual community meetings hosted by FAM Allies and were compiled into posters displayed at community and organizational resource fairs throughout the

year. To generate continued participation from elementary schools and university partners, results were also routinely shared with two main stakeholder groups, (1) school nurses and (2) healthcare professional students and professors. MPS school nurses conferenced at the beginning of each school year, and at this conference FAM Allies provided an "Asthma Smarts" overview, statistical results from outreach during the previous school year, as well as directions on how to host the program. Often, school nurses would provide positive testimonials. This combination of information inspired participation from different schools each year. Additionally, "Asthma Smarts" statistical results from the previous school year were incorporated into the orientation sessions scheduled each semester at each nursing and medical school, providing tangible value to continued partnership.

Communities and schools could replicate this programming affordably. The format offers flexibility in scheduling, as three, 30-minute sessions could be offered during lunch or after school. Alternately, sessions scheduled during class time could be rotated so that students don't miss the same class repeatedly. Additional flexibility over time allows schools to determine their own yearly hosting schedule. For example, several schools provided "Asthma Smarts" every year, to eligible third graders, while others hosted every third year for all students in 3-5th grades.

Options for recruitment of effective instructors includes local nonprofit organizations that employ community-based educators, community health worker alliances, AmeriCorps, and universities with nursing and medical student programs. Delivery does not require a classroom, computer or special equipment as teaching manuals and student handouts are all printable.

In communities where nursing and medical students can be engaged as instructors, this curriculum offers meaningful practice with community health skill sets. Contributing as instructors may reinforce student's asthma knowledge base, and build confidence with asthma management content. Facilitating a better understanding of asthma recommendations could yield future benefits in clinical settings such as improved alignment with guidelines. Ensuring asthma teaching competency among future healthcare providers was an unexpected benefit that could be evaluated in future research.

Nationally, asthma management in schools remains challenging. Despite research limitations, the success of this project demonstrates potential for mutually beneficial partnerships addressing gaps in school-based nursing services, and succesful support for students with asthma.

Acknowledgements

Individuals: Lee Ann Corning, retired Asthma Grant Manager and Teacher with Milwaukee Public Schools and Kristin Kappleman, Research, Policy and Data Manager at Milwaukee Public Schools, Suzanne Letellier, MEd, Director of Community Health Programs at Milwaukee Area Health Education Center, Raymond Hoffman, PhD and Pippa Simpson, PhD at Medical College of Wisconsin and FAM Allies volunteers.

Institutions: Milwaukee Public Schools principals, school nurses and teachers; medical students with the Medical College of Wisconsin Urban and Community Pathway and the University of Wisconsin-Madison School of Medicine and Public Health Primary Care Clerkship; and nursing

students from University of Wisconsin-Milwaukee, Marquette University, Milwaukee School of Engineering, Wisconsin Lutheran College, Alverno College, and Concordia University.

REFERENCES

1. National Heart, Lung and Blood Institute. Strategies for Addressing Asthma in Schools; 2017. Available at: https://www.cdc.gov/asthma/pdfs/strategies_for_addressing_asthma_in_schools_508.pdf Accessed May 2019.

2. Zahran HS, Bailey CM, Damon SA, Garbe PL, Breysse PN. Vital Signs: Asthma in Children - United States, 2001-2016. MMWR Morb Mortal Wkly Rep. 2018;67(5):149-55. Epub 2018/02/09. doi: 10.15585/mmwr.mm6705e1. PubMed PMID: 29420459; PubMed Central PMCID: PMCPMC5812476.

3. Wisconsin Department of Health Services, Division of Public Health, Wisconsin Asthma Program. Asthma in Wisconsin 2017. https://www.dhs.wisconsin.gov/publications/p02412.pdf. Accessed February 2020.

4. Wisconsin Department of Health Services. Health Disparities in Wisconsin Hospitaliztions for Asthma. 2017. https://www.dhs.wisconsin.gov/publications/p01727.pdf .

5. Francisco B, Rood T, Nevel R, Foreman P, Homan S. Teaming Up for Asthma Control: EPR-3 Compliant School Program in Missouri Is Effective and Cost-Efficient. Prev Chronic Dis. 2017;14:E40. Epub 2017/05/25. doi: 10.5888/pcd14.170003. PubMed PMID: 28541869; PubMed Central PMCID: PMCPMC5457908.

6. Milwaukee Public Schools. Unpublished data query. 2011.

7. Nurmagambetov T, Kuwahara R, Garbe P. The Economic Burden of Asthma in the United States, 2008-2013. Ann Am Thorac Soc. 2018;15(3):348-56. doi: 10.1513/AnnalsATS.201703-259OC. PubMed PMID: 29323930.

8. Isik E, Fredland NM, Freysteinson WM. School and Community-based Nurse-led Asthma Interventions for School-aged Children and Their Parents: A Systematic Literature Review. J Pediatr Nurs. 2019;44:107-14. Epub 2018/11/21. doi: 10.1016/j.pedn.2018.11.007. PubMed PMID: 30683275

9. Cicutto L, Gleason M, Szefler SJ. Establishing school-centered asthma programs. J Allergy Clin Immunol. 2014;134(6):1223-30. doi: 10.1016/j.jaci.2014.10.004. PubMed PMID: 25482867.

10. Kakumanu S, Lemanske RF. Asthma in Schools: How School-Based Partnerships Improve Pediatric Asthma Care. Immunol Allergy Clin North Am. 2019;39(2):271-81. doi: 10.1016/j.iac.2018.12.011. PubMed PMID: 30954176.

11. Magzamen S, Patel B, Davis A, Edelstein J, Tager IB. Kickin' Asthma: school-based asthma education in an urban community. J Sch Health. 2008;78(12):655-65. doi: 10.1111/j.1746-1561.2008.00362.x. PubMed PMID: 19000242.

12. Bruzzese JM, Markman LB, Appel D, Webber M. An evaluation of Open Airways for

Schools: using college students as instructors. J Asthma. 2001;38(4):337-42. doi: 10.1081/jas-100000261. PubMed PMID: 11456387.

13. Mickel CF, Shanovich KK, Evans MD, Jackson DJ. Evaluation of a School-Based Asthma Education Protocol. J Sch Nurs. 2017;33(3):189-97. Epub 2016/07/22. doi: 10.1177/1059840516659912. PubMed PMID: 27450449.

14. Mosnaim GS, Li H, Damitz M, Sharp LK, Li Z, Talati A, et al. Evaluation of the Fight Asthma Now (FAN) program to improve asthma knowledge in urban youth and teenagers. Ann Allergy Asthma Immunol. 2011;107(4):310-6. doi: 10.1016/j.anai.2011.07.008. PubMed PMID: 21962090.

15. Al Aloola NA, Naik-Panvelkar P, Nissen L, Saini B. Asthma interventions in primary schools--a review. J Asthma. 2014;51(8):779-98. Epub 2014/05/19. doi: 10.3109/02770903.2014.914534. PubMed PMID: 24730772.

16. Burke JG, Hess S, Hoffmann K, Guizzetti L, Loy E, Gielen A, Bailey M, Walnoha A, Barbee G, Yonas M. Translating community-based participatory research principles into practice. Prog Community Health Partnersh. 2013 Summer;7(2):115-22. doi: 10.1353/cpr.2013.0025. PMID: 23793242; PMCID: PMC4138529.

17. Bordeaux BC, Wiley C, Tandon SD, Horowitz CR, Brown PB, Bass EB. Guidelines for writing manuscripts about community-based participatory research for peer-reviewed journals. Prog Community Health Partnersh. 2007 Fall;1(3):281-8. doi: 10.1353/cpr.2007.0018. PMID: 20208291; PMCID: PMC4304664.

18. Fight Asthma Milwaukee Allies, Inc. (2015). Annual Report 2015. https://d4cfb386-744f-4989-b1c88408c79f9be3.filesusr.com/ugd/6a7705_7843a6b50ee4449a81f03be62e06f4f9.pdf

19. Program NAEaP. Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma-Summary Report 2007. J Allergy Clin Immunol. 2007;120(5 Suppl):S94-138. doi: 10.1016/j.jaci.2007.09.043. PubMed PMID: 17983880.

20. Schatz M, Sorkness CA, Li JT, Marcus P, Murray JJ, Nathan RA, et al. Asthma Control Test: Reliability, validity, and responsiveness in patients not previously followed by asthma specialists. Journal of allergy and clinical immunology. 2006;117(3):549-56. doi: 10.1016/j.jaci.2006.01.011.

21. Liu AH, Zeiger R, Sorkness C, Mahr T, Ostrom N, Burgess S, et al. Development and cross-sectional validation of the Childhood Asthma Control Test. Journal of allergy and clinical immunology. 2007;119(4):817-25. doi: 10.1016/j.jaci.2006.12.662.

22. US Department of Education. Family Education Rights and Privacy Act (FERPA); 2018. http://www2.ed.gov/policy/gen/guid/fpco/ferpa/index.html Accessed February 2020.

Table 1. "Asthma Smarts" Curriculum Overview

Lesson	Topic	Activity
1		
	Pre Test	
	Respiratory System	Fill in the blanks, identify the parts worksheet
	What is Asthma?	Discussion of airway images
	Asthma Symptoms	Circle your symptoms worksheet
		Stoplight card game
	Asthma Decision Making	Asthma Tracker worksheet 1
2		
	Controller Medicines	Name your controller – controller poster reference
	Quick Relief Medicine	Name your reliever – reliever poster reference
	Asthma Care Plans	Medications Card Game
	Why Use a Spacer?	Discussion of deposition images
	How to Use a Spacer	Students take turns demonstrating spacer use. Gift spacers to students that do not already have them.
	Asthma Decision Making	Asthma Tracker worksheet 2
3		
	How to Use Peak Flow Meters	Students all use the peak flow meters, generating 3 numbers each. Discussion: why the numbers are different.
	Peak Flow Meters, Graphing	Guided discussion on a completed peak flow meter graph.
	Asthma Triggers	Matching worksheet to identify triggers. Students identify their own triggers.
		Memory card game: trigger cards are matched to a method of control.
	Asthma Decision Making	Asthma Tracker worksheet 3
	Post Test	
	Certificates	

**The "Asthma Smarts" Facilitator Guide is available upon request to the corresponding author. Appropriate recognition to FAM Allies requested before use.

Table 2. Elementary Schools Hosting "Asthma Smarts"

	2014-2015	2015-2016	2016-2017	2017-2018	Total
Total Number of Elementary Schools in Milwaukee	**104**	**101**	**111**	**113**	
Total Number of Schools Hosting "Asthma Smarts"	**35**	**37**	**32**	**28**	**132**
Total Number of New Schools Hosting "Asthma Smarts" (did not host in the previous year)	**14**	**17**	**13**	**11**	**55**
Percentage of New Schools (over the previous year)	**40%**	**46%**	**41%**	**39%**	**42%**

Table 3: "Asthma Smarts" Pre and Post Tests 2014-2018

	Questions	2014-2018 Data (4 years pooled together) % Correct			
		N	**Pre**	**Post**	**p-value***
Q1	When are controller medicines used?	1690	32%	54%	**<0.0001**
Q2	When someone is having asthma symptoms they should:	1699	64%	79%	**<0.0001**
Q3	Which is not an asthma trigger	1682	28%	55%	**<0.0001**
Q4	Which is true (smoking)	1688	70%	80%	**<0.0001**
Q5	Which picture shows how to use a spacer	1663	55%	79%	**<0.0001**
Q6	Cough is an early symptom of asthma	1696	66%	85%	**<0.0001**

* McNemar's Exact Test (paired)

Table 4. Missing Data Percentages Within Each School Year

Year	N	Complete Test Data	Post Test missing	Pre Test Missing	Both Pre and Post Test Missing
2014-15	568	466 (82.0%)	61 (10.7%)	21 (3.7%)	20 (3.5%)
2015-16	611	549 (89.9%)	46 (7.5%)	15 (2.4%)	1 (0.2%)
2016-17	555	451 (81.3%)	84 (15.1%)	5 (0.9%)	15 (2.7%)
2017-18	332	249 (75.0%)	76 (22.9%)	7 (2.1%)	0 (0.0%)

Table 5. Asthma Related Visits to the School Nurse before and after "Asthma Smarts" (2008-2013)

	Before Asthma Smarts			After Asthma Smarts			p-value*
N=110	Mean number of asthma visits per student per month	Standard deviation	Difference	Mean number of asthma visits per student per month	Standard deviation	Difference	
School Nurse Visits	2.55	2.36	0.64	1.91	1.7	1.92	<0.001

*paired t-test

Appendix A
Survey Questions, 2014-2018

Circle the correct answer:

1. What is your age:
   a. 0 – 10 years
   b. 11 - 20 years

---

2. Has a doctor or nurse ever told you that you have asthma?
   a. Yes b. No

---

3. Controller medicines are used:
   a. Only during an asthma attack
   b. Everyday even when the person doesn't have any symptoms
   c. Only after quick relief medicines don't work
   d. To prevent smoking

---

4. When someone is having asthma symptoms, they should:
   a. Drink a glass of water
   b. Go exercise
   c. Take a quick relief medicine
   d. Stop taking a controller medicine

---

5. Which is NOT an asthma trigger:
   a. Dust mites
   b. Cockroaches
   c. Bed bugs
   d. Mold

---

6. Which is true:
   a. Smoke does not make asthma worse
   b. If you can smell smoke, it can hurt your lungs
   c. Cigarette smoke is only bad for the person smoking

---

7. Which picture shows the correct way to take asthma medicines?
   a. 
   b. 

---

8. Cough is an early symptom of asthma.
   a. TRUE b. FALSE
