

SCHOOL-BASED ASTHMA PROGRAMS: A LITERATURE ANALYSIS

by

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ABSTRACT

Asthma is a respiratory disease that impairs the quality of life of children across the United States. A higher percentage of children than adults have been diagnosed with asthma, and minority and low socioeconomic populations are disproportionately affected by the disease. Although medications and techniques are available to control asthma, many children continue to experience asthma symptoms. Uncontrolled asthma has a lasting and irreversible effect on the child's respiratory system. Asthma exacerbations lead to unplanned medical care including hospitalizations and increased health care costs. Asthma is the number one chronic disease reason for absenteeism among children in the United States.

School-based health programs provide the connection between a student and his or her family, the school nurse, and the child's health care provider. By offering a health program at school, barriers to asthma care can be reduced.

A literature search was completed to seek the most effective school-based asthma programs. The search results were analyzed for their effectiveness in producing improved individual asthma outcomes. A rubric, adapted from the CDC's Guide to the Continuum of Evidence on Effectiveness, was used to identify each program's level of effectiveness. The results were analyzed for the components of successful for school-based asthma program. The school-based asthma programs showed that programs that included supervised medication administration produced the highest effect rating.

Public Health Statement:

I provided additional recommendations, informed by the literature analysis, on the key components to a school-based asthma program and how to design the most effective study design. In order to effectively reduce asthma health outcomes among children and produce reliable results, programs should be a randomized control and longitudinal design, be rooted in a formal theory such as the Social Cognitive Theory, have independent replications, high implementation guidance, and be able to show external and ecological validity through implementation with multiple different populations in a “real-world” setting.

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PREFACE

I would like to thank all members of my thesis committee for their support and guidance in constructing this thesis. Dr. Jessica Burke, Dr. Todd Bear, and Melanie Vignovich have provided invaluable advice and support during the process of developing my thesis. Additionally, I would like to thank Barbara Folb who helped me with the literature search. Lastly, I would like to thank my husband for all of his love and support during the process of writing this thesis and throughout the entire Master's program.

1.0 INTRODUCTION

Asthma is a respiratory disease with high morbidity that impairs the quality of life of children across the United States. More children experience asthma than adults, and minority and low socioeconomic populations are disproportionately affected by the disease.¹ Although medications and techniques are available to control asthma, many children continue to experience uncontrolled asthma. Uncontrolled asthma has a lasting effect on the individuals' respiratory system. Asthma exacerbations lead to unplanned medical care including hospitalizations and increased health care costs. The level of disparity that exists among asthmatic patients calls for inclusive programming that addresses the needs of all children, especially minorities and those of lower socioeconomic status.

The aim of this thesis is to determine the aspects of school-based asthma programs that have led to improved asthma health outcomes for children. In order to determine the most effective approaches in reducing asthma-related health outcomes, I completed a literature review of school-based asthma programs that included children, ages five to seventeen.

School is a setting of high level of interaction between the school personnel and students. Additionally, the school nurse serves as a link between a health care provider, the student, and the family for chronic disease. I analyzed the results of the literature search for program effectiveness. I assessed the following aspects of each study: sample size, sample selection, study design, theoretical basis, level of internal validity, appropriateness of the statistical test used, type of

evidence, level of independent replication, level of implementation guidance, and external and ecological validity.

As a conclusion for the literature analysis, I provide suggestions for key components and aspects to consider when implementing future school-based asthma programs.

2.0 BACKGROUND

2.1 ASTHMA

2.1.1 Epidemiology

Asthma, a chronic respiratory disease, is a significant public health issue among children in the United States. In 2015, 8.4% of children and 7.6% of adults were diagnosed with asthma according to the National Health Interview Survey.¹ Boys (9.9%) are more commonly diagnosed with asthma than girls (6.9%).¹

Racial and ethnic minorities are more likely to develop chronic disease including asthma, and individuals of lower socioeconomic backgrounds are more likely to experience significant breathing problems.² In the United States, asthma affects Puerto Rican children and Black Non-Hispanic children more than any other races.¹ Compared to White Non-Hispanic children, Black Non-Hispanic individuals have a higher asthma hospitalization rate (29.9% vs. 8.7%) and asthma mortality rate (23.9% vs. 8.4%).¹ Black Non-Hispanic asthmatic children are four times more likely to go to the emergency department than White Non-Hispanic asthmatic children.³ Additionally, in the United States, individuals below 100% of the poverty level experience a higher asthma prevalence (11.1%) compared to individuals at every other bracket above the poverty level.¹

Not only is asthma prevalent in the United States, it is costly. In 2015, 219 American children died because of asthma,¹ and about half of asthmatic children had at least one “asthma attack,” or asthma exacerbation, in 2016.⁴ Children experiencing an asthma exacerbation often

utilize urgent or unplanned care which leads to an increase in health care cost. In 2014, over 13,000 asthma emergency care visits occurred, which made it the fourth leading reason for emergency room visits of all chronic diseases in 2014.⁵ During the period of 1985 to 1994, parents of asthmatic children spent an average of \$1,042 for annual direct asthma medical expenses.⁶ Although this is not representative of today's costs, it is the most recently available information. In 2007, \$56 billion dollars were spent in total costs, direct and indirect costs, for individuals suffering with asthma.⁷ Direct costs for asthma, which include emergency room visits, hospital admissions, medications, outpatient visits, and outpatient testing related to asthma accounted for \$50.1 billion in 2007.⁷ Indirect costs, which consist of missed days of work or school, disability associated with asthma, and early mortality, accounted for \$5.9 billion in 2007.⁷ For children, the indirect costs associated with asthma are often higher than those of adults; not only are the children missing school but parents are also missing work which results in loss of productivity for both children and parents.⁸

Asthma impacts a child's educational experience. Poor sleep due to asthma nighttime awakenings impacts the child's ability to stay awake and focused during school. Asthma symptoms can also decrease a child's interest in interacting with their peers and poor perception of school. Asthmatics feel ostracized or "different" because of their asthma.⁹ Asthma is the most frequent reason, among chronic disease, for absenteeism.¹⁰ An estimated 13.8 million school days were missed in 2013.¹¹ Absenteeism leads to a reduced level of education attainment.^{12,13}

2.1.2 Asthma Physiology

Asthma is a multifactorial chronic respiratory disease, defined by airway inflammation, a partially obstructed airway, and exacerbations.¹⁴ This inflammation stimulates many different types of cells involved in the individual's immune system including mast cells, eosinophils, T-lymphocytes, macrophages, neutrophils and epithelial cells.¹⁴ It also causes constriction of the asthmatic's smooth muscle lining of the airway, edema of the airway, and increased mucus production causing a blocked airway. This results in the asthma patients experiencing symptoms such as: chest tightness, wheezing, coughing, or breathlessness. It is also important to note that asthma is a reversible airway disease, meaning that after bronchoconstriction, the smooth muscle will loosen, opening the airway again, either spontaneously or with help from a bronchodilator medication.¹⁴ The asthmatic should feel his or her airway opening up again, a few minutes after taking this medication.

The inflammation that causes the airway to tighten is initiated as a response to a stimulus, or an "asthma trigger." For instance, allergens, exercise, respiratory infections, tobacco, outdoor air pollution, cold air, irritants, or aspirin can cause bronchoconstriction. Each asthmatic experiences different symptoms and severity of symptoms when his or her asthma is provoked. One asthmatic may cough when exposed to animal dander and not experience any other symptoms; whereas, a different asthmatic may not respond to animal dander at all but wheeze when exercising.

Unfortunately, some asthmatics do not recognize what breathing "normally" is supposed to feel like because they have grown accustomed to asthma symptoms. This perception was captured in Bruzesse's study that included interviews with undiagnosed asthmatic high school students.¹⁵ Students reported that they did not realize that the breathing issues they were

experiencing should be concerning. Additionally, parents of some of these students were not aware that their child was experiencing symptoms and thus did not seek medical help for it.¹⁵

Asthma exacerbations have a profound effect on a child's airway recovery. Although definitions vary, an asthma exacerbation is an acute increase of a patient's asthma symptoms with a decrease in expiratory lung function, as assessed by spirometry.¹⁴ The definition of an asthma exacerbation varies because patients have subjective definitions of when their asthma is worse. Clinical trials have a standard definition, but the outcomes included in that definition varies: spirometry values, rescue medication use, recent emergency room visit, dose of a systemic corticosteroids.¹⁶ Many times, the definition varies depending on how the clinical trial is designed and which population is targeted. An asthma exacerbation can happen for any asthmatic in any disease severity. Asthmatics who experience multiple asthma exacerbations have an increased risk for worse and more frequent asthma exacerbations.¹⁴ Reoccurring inflammation leads to only partial, as opposed to full, airway recovery, which means that, over time, the individual's airway is less able to respond as quickly or as well to the medication or spontaneous opening of the airway. This airway remodeling makes it easier for an individual to have bronchoconstriction to a stimulus and can be irreversible.¹⁴ Reducing the number of asthma exacerbations will lead to long-term asthma improvements for those patients.

2.1.3 Asthma Treatment

Treatment for asthmatics varies according to the severity of the disease. The more severe or uncontrolled an asthmatic's disease is, the more complex of their treatment plan. Treatment plans for asthmatics include multiple medications, each with unique formulations, differing dosing regimens, and intended treatment use. As the patient's control improves or worsens, his or her

treatment plan will change, and this constant changing of medication creates confusion among children and their parents.

The Guidelines for Diagnosis and Management of Asthma (EPR-3) were formed by a panel of asthma experts brought together by the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) under the commission of the National Asthma Education and Prevention Program (NAEPP) in 2007.¹⁴ The panel performed an extensive literature review to find evidence-based research to inform the EPR-3. The EPR-3 is upheld today as the best practice for asthma diagnosis and disease management but are intended to assist health care providers (HCP) in their decision-making. It identifies and discusses four aspects to asthma care: pharmacological treatment, assessment and reduction of triggers that impact asthma severity, monitoring the disease, and patient education.¹⁴

When determining a course of treatment, a HCP is directed to take into consideration the patient's disease severity and control. A patient's severity can be either intermittent or persistent, and persistent asthmatics are further diagnosed as either mild, moderate, or severe.¹⁴ The distinction between the severity classifications is made according to the patient's symptoms, history of asthma exacerbations, quality of life, and lung function. The following symptoms are taken into consideration: frequency of daytime asthma symptoms in the past two to four weeks, number of nighttime awakenings due to asthma in the past month, frequency of use of a short-acting bronchodilator, the level of limitation that asthma imposes on the patient's life, and the patient's lung function. The frequency of asthma exacerbations, and a patient's risk for experiencing an exacerbation is also considered when determining the severity of their asthma.¹⁴

In EPR-3, asthma control is classified at one of three levels: well controlled, not well controlled, or very poorly controlled.¹⁴ When determining a patient's level of asthma control, a

HCP is directed to take into consideration the same aspects as listed previously for determining severity. An individual's level of control is used to determine the patient's risk of developing worsening lung function or worsening symptoms.¹⁴ It is recommended that a HCP start by prescribing the least amount of medication that is necessary to treat a patient's symptoms and then "step-up" the dose if the patient's disease state worsens or becomes uncontrolled. With a known classification of asthma, a HCP can better determine when to change a patient's medication dose or medication is necessary.

The first step, for intermittent asthmatics, consists of prescribing a short-acting bronchodilator (i.e. Albuterol, Levalbuterol), often referred to as a "rescue inhaler." This medication's intended use is for a quick response to an acute onset of asthma symptoms due to its ability to alleviate airway obstruction within a few minutes.¹⁴ Additionally, a short-acting bronchodilator can be used preventatively. For example, an individual may use take the medication before exposure to a known trigger. If an individual experiences symptoms worse than those of a mild asthmatic, as classified by the EPR-3 the next "step" of therapy would be prescribed.¹⁴

Additional asthma medications, prescribed for persistent asthmatics, are prescribed to be taken at least once a day but the dosing regimen depends on the patient's age, asthma severity, and level of asthma control.¹⁴ Maintaining asthma control through pharmacological methods reduces asthma symptoms so sleep is not lost, daily activities are not affected, lung function is high, and asthma exacerbations are prevented. To promote adherence to a prescribed dose, a HCP is guided to assess the patient's ability to take these as prescribed. A HCP may suggest a specific regimen if he or she believes adherence would best be achieved with once daily dosing over twice daily dosing or otherwise. These additional asthma medications, often called "controller medications" could be: Inhaled Corticosteroids, Leukotriene Antagonists, Long-Acting Beta-Agonists, Cromolyn,

Nedocromil, or Theophylline.¹⁴ Controlling the patient's airway inflammation during an asthma exacerbation may require a temporary increase in daily medications or the addition of a systemic corticosteroid (i.e. Prednisone, Prednisolone).¹⁷

Each controller medication has a different dosing regimen or different formulation, and thus different instructions to administer the medication. This makes it difficult for a patient to remember when and how to take the medication. For instance, one inhaler corticosteroid, such as Flovent, can be prescribed as either a metered-dose inhaler which is administered like a short-acting bronchodilator or a dry-powdered inhaler. Each formulation looks different and requires a unique process to correctly take the medication. The EPR-3 suggests that patient education represents a vital point in successful control of asthma, and this education should be focused on proper administration of medications, understanding the purpose and intended use of the different medications, and self-monitoring of the disease.¹⁴ This coincides with EPR-3's aspects to asthma care: assessment and reduction of triggers, pharmacological treatment, monitoring the disease, and patient education.

2.2 SCHOOL-BASED HEALTH PROGRAMS

Asthma control improves through pharmacological treatment, assessment and reduction of triggers, coordinated care to manage the disease, and patient education. Interventions to improve asthma control take place in multiple locations to reach asthmatics: primary care physician offices, asthma specialist offices, community centers, patient's homes, or schools. School-based programs can vary at their level of implementation: the school-wide policy level, the school-community level including school administrators, teachers, staff, and all students; the school-interpersonal

relationship level; or the individual level. By offering a health program at school, barriers to asthma care can be reduced. School-based programs can provide care to which low-income or minority groups often do not have access.^{18,19}

School-based health programs have great access to the students: 1,000 hours during the school year, 5 days of the week, and approximately 180 days a year.²⁰ The education setting where children spend a large proportion of concentrated time is a perfect location to implement a program to improve their health because it's a place where healthy habits can be formed.¹⁸ Next, the teachers and school staff are authority figures in the eyes of children and create an environment conducive to learning. Most asthma exacerbations occur during the school year so school staff are likely to witness these symptoms during the school day.¹⁸ Additionally, asthma exacerbations can impact the learning environment for asthmatic students and others. The teacher's time can be taken away from educating to help an asthmatic child control his or her breathing. Chronic absenteeism, which is often the case for asthmatics, can also affect a teacher's ability to keep asthmatic children at the same education level as the other children.

A vital component to any health program in the school, the school nurse has a wealth of knowledge about the children's health. The nurse collects each student's medical history from parents at the beginning of the school year and maintains a health record during the school year. The school nurse has frequent contact with students and is the only qualified school personnel to help children with both acute and chronic illness. The nurse has the health education required to execute health-focused duties, the connection with the parent to make recommendations, and the professional relationship to communicate with a student's HCP.

School nurses from St. Paul, Minnesota, and Reykjavik, Iceland, participated in focus groups in order to create an international school-based care model for asthma.²¹ Nurses in both

locations identified their role in 4 aspects: identification of children with asthma, maintaining focus on the children at the highest risk for an asthma exacerbation, prioritization of all students' health needs within the school system while providing care for acute and chronic illness, and planning for the students' future health needs. Asthma care coordination through the school nurse requires the nurse to manage the student's asthma symptoms through treatment with a rescue inhaler and assessing when an acute episode requires more treatment, managing the student's asthma symptoms through coordinated care with the parents and HCP, and educating students and school staff on the disease and treatment of asthma.²¹ Although this extensive asthma care coordination does not occur at all schools, the focus groups agreed that all of these aspects are crucial and should be considered when creating an asthma-care coordination plan in the schools.

3.0 METHODS

I completed a literature review from January to February of 2018 to assess the evidence and existing research publications addressing school-based asthma programs. The literature review, conducted through PubMed, contained the following terms, “Asthma,” “School,” “Health Promotion,” and “Child.” In order to narrow the search, I set filters on the results to include only primary research studies (not systematic reviews) and children only (five to seventeen years old). I chose this age range because it includes school-aged children, enrolled in Kindergarten through twelfth grade. A summary of the literature search components is provided in Appendix A.

A “school-based program,” defined for the purposes of this search, is a program that is implemented within the school, involves members of the school staff, and enrolls the children registered in that school. Although other “school-based programs” seek change at the school system level, this search focused on programs with a primary implementation on the individual or interpersonal level in the school community.

I reviewed the search results, 1630 abstracts, and applied inclusion and exclusion criteria to narrow the results. Inclusion criteria included: programs or interventions that were completed in a United States school setting at an individual or interpersonal level with an asthmatic student who was at Kindergarten grade level or older, studies seeking improvements in outcomes directly correlating to those in EPR-3 for control and severity (e.g. symptom frequency, nighttime awakenings, short-acting bronchodilator inhaler use, limitation due to asthma, frequency of asthma

exacerbations), and publication in the past 15 years. The literature search exclusion criteria included: studies identifying outcomes of determining factors or triggers (e.g. programs with the objective to reduce air pollution exposure or other triggers), health education and health promotion programs conducted fully or partially outside of the United States, and programs involving daycares or preschool children.

After I applied the inclusion and exclusion criteria to the initial result of 1630 abstracts, 46 abstracts remained. Limitations exist in this methodology. First, some abstracts and articles were not available due to limited University of Pittsburgh access and length of time after publication. Additionally, multiple articles were submitted on behalf of one program. Feasibility or pilot studies, along with their larger program, resulted in the search. Programs represented by multiple articles were evaluated for effectiveness under the umbrella of one program entry, not by each individual publication.

Twenty programs from these 46 abstracts were evaluated for their strength in evidence. During this evaluation, notes were taken in a spreadsheet according to the rubric provided in Table 1. This rubric, adapted from the Center for Disease Control (CDC)'s Guide to the Continuum of Evidence on Effectiveness,²² identifies 6 factors to determine evidence strength. The guide was initially created through the National Center for Injury Prevention and Control to determine and understand the evidence that is presented in research and programs. I used this rubric to assess school-based asthma programs instead of its initial purpose of assessing violence prevention programs. This adaption is another limitation to the methodology because the Continuum was not intended to be used for these purposes. I scored each aspect according to the suggestions in the guide associated with the rubric.²²

Table 1. Rubric for Determining Effectiveness

	Effect	Internal Validity	Type of Evidence/ Research Design	Independent Replication	Implementation Guidance	External and ecological validity
1	Practice constitutes risk of harm	Any design with results indicating negative effect	Any design with results indicating a negative effect	Possible program replication with/without evaluation replication	Unsupported: Comprehensive/partial	Harmful: Possible applied studies-similar/different settings
2	Ineffective	Unsupportive: True or quasi experimental design	Unsupported: randomized control trials or quasi experimental design	Program replication with evaluation replication	Unsupported: Comprehensive	Unsupported: Applied studies- same/different settings
3	Effect is undetermined	No research; No sound theory	Anecdotal/Needs Assessment	Partial program replication without evaluation replication	None	Not real-world informed
4	Expected preventive effect	Sound theory only	Exploratory Study	Program replication with evaluation replication not by the independent investigators	Partial	Somewhat real-world informed
5	Some evidence of effectiveness	Non-experimental design	Single Group Design	Program replication with evaluation replication by independent investigators	Comprehensive	Real-world informed
6	Found to be effective	Supported: Quasi-experimental design	Supported: Quasi Experimental Design			Supported: Applied studies-similar settings (2+)
7		Supported: true experimental design	Supported: Randomized control trials and meta-analysis/systematic review			Supported: Applied studies-different settings (2+)
0				No Replication		

I judged the studies based upon sample size, sample selection, theoretical basis, experimental design, evaluation assessments used, number of data points per participant, appropriateness of the statistical test used, effect rating, level of internal validity, type of evidence, level of independent replication, level of implementation guidance, and level of external and ecological validity. Sample size, sample selection, theory name, experimental design, evaluation assessments, number of data points, and statistical test identification were added to the CDC's initial Guide to the Continuum of Evidence of Effectiveness. Researchers can use the information gained through rating the programs on these dimensions to influence the design of future school-based asthma programs design to prevent worsening asthma. The distinction assigned at each level was informed by the CDC guide to the Continuum.²²

The study's sample size is the number of participants that the study analyzed, and sample selection was identified by the author. Theory is an important backbone to program design. If the name of a particular theory or theoretical framework or model was explicitly stated by the author, I recorded it during my organization of the findings. The experimental design was identified by the authors of the study. Evaluation assessments and the number of data points per participants were important to identify. Some evaluation assessments are standardized and validated for their use; however, others lack the rigorous testing and validation. The number of data points per participants represents the level of data collection and adds detail about the study design. For instance, if only one data point is collected for each participant, the study will have a lack of data to see a change in time for an outcome. If four data points are collected for each participant, then the study's design included four different time points, producing more promising data validity than the study with only one data point. If possible, the statistical tests were identified and assessed for appropriateness of that test for the data collected.

First, the highest level of effect was represented by assigning a program with “found to be effective.” This designation was reserved for programs that were fully effective in the outcomes that the authors evaluated with a true or quasi-experimental design. True experiments randomly assign participants to either the intervention or control to see if the program is responsible for exhibited change. The groups can also be compared at multiple time points, creating a more complex study design. Quasi-experimental designs have comparison groups but do not randomly assign participants to either control or intervention arms. They also may have two or more data points per participants. “Some evidence of effectiveness” was assigned to a program with some evidence of effectiveness in the outcomes the authors evaluated, and “expected preventative effect” was designated to programs that have been evaluated with a less rigorous design and may have yielded effectiveness for some outcomes that were not the direct intent of the study. “Effect is undetermined” was assigned to studies that have did not have either a true or quasi-experimental design because any effectiveness may not be due to the program itself because of the lack of control or comparison. Studies identified below these levels are either ineffective or harmful.

Next, internal validity was determined mostly on the study’s design and the number of data points per participant. The highest designation for internal validity was a true experimental design and the second highest designation was a quasi-experimental design. Non-experimental designs have only a treatment group and no control or comparison group, and this design includes only pre- and post- assessments or only post- assessments. “Sound theory only” is reserved for studies that are exploratory, and “no research or sound theory” lack the fundamental link between the study activities and expected outcomes which shows a lack of internal validity compared to those with more rigorous research designs. Any study identified below these levels are those with findings that are either unsupported or harmful. An unsupported design can be a true or quasi-

experimental design which is unsupported by theory but has strong internal validity due to its design.

Third, the distinction of the type of research design answers the question about how effective the program is at achieving the outcomes.²² The research design is assessed similarly to internal validity; however, it is assessing the level of rigor of the design rather than judging the validity of data produced by the design. Randomized control trials are considered the most rigorous study designs with the highest likelihood of pointing to a cause-and-effect relationship due to their random assignment. Quasi-experimental designs are the next-most rigorous design compared to randomized control trials because of the lack of randomization. The control or comparison group may not be equivalent to the intervention group. A single-group design is less rigorous because a control or comparison group does not exist. Exploratory studies are below the single-group design, according to study rigor, because they lack the structure in determining standardized outcomes. Lastly, anecdotal or needs assessment studies are based upon subject matter opinion, not based on theory or previous research. These studies explore the needs of a community or population with less rigor than exploratory studies.

Next, independent replication was rated according to the number of times a program was replicated and evaluated and who performed the evaluation. The highest level of independent replication is “program replication and evaluation replication” performed by independent researchers in the exact same manner as the initial program. This level of independent replication may exist among well-supported or unsupported programs. Next, “program replication with evaluation replication not by the independent investigators” was assigned to programs that were implemented and evaluated with high fidelity to the original program in a separate but similar setting to the first program by the same investigators who implemented the program initially. This

similar but separate setting could be a different school with new students. “Partial program replication without replication” was designated to programs that were partially replicated and were not evaluated. Harmful programs may have had possible program replication with or without a formal evaluation due to its harmful effects. Some programs may have had no replication or did not explicitly state that a replication existed in the methods of the review program.

Next, implementation guidance was judged based upon level of fidelity carried out during the process of the program by the individuals implementing it.²² “Comprehensive implementation guidance” was assigned to programs that had availability and accessibility to all information necessary to carry out the program. “Partial implementation guidance” was assigned to programs that exhibited any potential flaws in fidelity of implementation such as limited accessibility to necessary program support. Lastly, “no implementation support” was assigned to programs that offered no assistance to the individuals implementing the program. Programs with a lack of implementation guidance have significant likelihood of implementation issues impacting the study. For purposes of this review, “comprehensive implementation guidance” was assigned to programs that demonstrated that staff implemented the program themselves, and partial implementation guidance was assigned to programs that trained other individuals (ie. School nurses, teachers) to carry out the activities of the study. The training of other individuals to implement the program can result in a loss of understanding of program expectations and process fidelity. The most rigorous way to evaluate implementation guidance would be to complete process evaluations of each program; however, process evaluations are not always available.

Lastly, external and ecological validity assessed the level at which the program can create preventative effects in multiple populations and applied settings. The highest level of external and ecological validity was applied to studies that implemented the program in two or more settings in

different locations with different populations. The next level was assigned to programs which implemented the program in two or more similar settings. “Real-world informed” was used to distinguish programs that have not been implemented in an applied setting but have components consistent with a “real world” setting or “mirror the real world.” The designation of “somewhat real-world informed” was given to programs that have likewise not been implemented in an applied setting and are not structured to be implemented in that way but some of their components resemble the “real world”. Programs that are “not real world-informed” are designed inconsistently with an applied settings and have no components that mirror it. Unsupported studies can have the distinction of being implemented in similar or different settings, and harmful programs could have been implemented in an applied setting but are still distinguished separately, as harmful.

This rigorous method, created by the CDC, allows researchers and HCPs to infer how effective a program is in multiple aspects. Each aspect adds insight into the program’s implementation, design, and overall effectiveness.

4.0 RESULTS

4.1 SCHOOL-BASED ASTHMA PROGRAM PUBMED SEARCH

4.1.1 Evidence of Effectiveness of School-based Asthma Programs

The literature search for school-based asthma programs resulted in programs with varying levels of effectiveness. Table 2 contains the results of the Continuum of Evidence of Effectiveness of the programs. When reviewing these programs for effectiveness, few programs achieved the highest score in all categories, had a high sample size, a strong sampling method and appropriate statistics. Most programs had convenience samples, pulling students available in the school where the program resides or randomized samples but stratified at the school-level by designating one or more schools to receive the intervention and one more other schools to receive the control level of care. The schools were either randomized to an arm of the study or kept as a comparison without randomization. In separating the arms of the study between different schools rather than keeping it at the same school, no crossover or contamination exists of the control or comparison group. The authors who utilized multiple schools in this manner found schools in the same school district or with similar populations so that the demographics of the arms of the study were as similar as possible.

This overall effectiveness rating was important to consider first when determining the most effective program because it encompassed the study design and the level at which the expected outcomes were achieved through the program activities. I next reviewed the internal validity because this showed the strength of the trial's design and reliability of the data. The programs authored by Halterman et al.,²³ Kintner et al.,²⁴⁻²⁶; Gerald et al.,¹⁸ Millard et al.,²⁷ and Horner and Fouladi²⁸ were rated the highest in both of these categories. Next, the sample size was reviewed to determine if these programs were effective for a small group or a larger group of the population. Between these five programs, Horner and Fouladi are the only authors who presented a program that had below 200 participants.²⁸ Higher sample sizes allow for more individuals in each arm the study, and thus more data to be compared. Clark et al. has the largest sample size among the programs reviewed; however, this program did not produce the highest level of significant outcomes.²⁹

Most of the programs lacked a formal theory; however, a few of the studies mentioned utilizing formal general health theories or asthma management-specific theories. Terpstra et al.³⁰ and Berg et al.³¹ utilized the Social Cognitive Theory and Social Learning Theory, respectively. Velsor- Friedrich and colleagues^{32,33} and Horner and colleagues³⁴ used formal theories to influence the creation of asthma self-management models. Lastly, Kintner and colleagues used an ecological model with a lifespan development perspective as well as the asthma acceptance model, which the author created.²⁶

In the literature analysis, no studies were revealed to be harmful. The study authored by Bowen et al. was shown to be ineffective with a rigorous study design for the outcomes that the authors were studying.³⁵ Five studies were found to have effects that were undetermined. Two of these studies had high internal validity with a quasi-experimental design, meaning that the

studies by Velsor-Friedrich and colleagues³³ and Terpstra and colleagues³⁰ had relatively strong studies with undetermined effects. Three other studies with undetermined effects, by Berg et al.,³¹ Brasler and Lewis,³⁶ and Carpenter et al.,³⁷ had non-experimental study designs with no replication so it is unknown if the lack of determined effect is because of the inconclusive outcome from the activities of the program or if the insufficient study design and data contributed to this. The level of effect rating takes into consideration the type of study design because the stronger the study design, the more reliable the results are.

Table 2. Continuum of Evidence of Effectiveness of School-Based Asthma Programs

Study Author(s)	Article Title(s)	Sample Size	Sample Type	Theory Name	Effect Rating	Experimental Design	Assessment(s) Used	No. of Data Points Per Participant	Interval validity	Statistical Test Utilized	Type of Evidence/ Research design	Independent replication	Implementation guidance	Exeternal and ecological validity
Carpenter DM, Alexander DS, Elio A, DeWalt D, Lee C, Sleath BL	Using Tailored Videos to Teach Inhaler Technique to Children With Asthma: Results From a School Nurse-Led Pilot Study.	25	Convenience	N/A	3	Single Group	Pre/Post Test; Pre/ 1 Month Follow-up	3	5	Non-parametric Wilcoxon Test	5	0	4	4
Horner SD, Brown A, Brown SA, Rew DL.	Enhancing Asthma Self-Management in Rural School-Aged Children: A Randomized Controlled Trial.	257	Stratified by Socioeconomic Status	Asthma Self-Management Theory and the Asthma Health Education Model	5	Randomized Control Logitudinal with 3 Arms	Severity of Chronic Asthma Scale; Home Management Survey (Parent); Asthma Inventory for Children scale; parent reported health outcomes; exhaled nitric oxide	4	7	Growth Curve Analysis	7	4	5	6
Bignall WJ, Luberto CM, Cornette AF, Haj-Hamed M, Cotton S.	Breathing retraining for African-American adolescents with asthma: a pilot study of a school-based randomized controlled trial.	30	Convenience	N/A	5	Randomized Control with Pre/Post Measures	Asthma Control Test, PedsQL 3.0; State Trait Anxiety	2	7	T-test; Analysis of Variance, Chi-Squared Test	7	0	5	4
Kintner E, Cook G, Marti CN, Stoddard D, Gomes M, Harmon P, Van Egeren LA.	Comparative Effectiveness on Cognitive Asthma Outcomes of the SHARP Academic Asthma Health Education and Counseling Program and a Non-Academic Program.	205	Convenience	Ecological model, Lifespan development perspective; acceptance of asthma model	6	Randomized Control with 2 arms	General Health History Survey; Asthma Health Behaviors Survey	4	7	Multilevel modeling using unconditional growth models	7	4	5	6
Cheung K, Rasberry CN, Dunville RL, Buckley R, Cook D, Daniels B, Robin L.; Rasberry CN, Cheung K, Buckley R, Dunville R, Daniels B, Cook D, Robin L, Dean B.	A multicomponent school-based asthma management program: enhancing connections to clinical care.; Indicators of asthma control among students in a rural, school-based asthma management program.	456	Convenience	N/A	6	Quasi-Experimental Cross-Sectional Design with Comparison Group and a one-group retrospective, longitudinal design	Asthma Control Questionnaire, forced expiratory volume at 1 second	1; 2	6	Analysis of variance, t-test, post-hoc multivariate logistic regression, Chi-square test, McNema's chi-square test	6	3	4	6
Halterman JS, Szilagyi PG, Fisher SG, Fagnano M, Tremblay P, Conn KM, Wang H, Borrelli B.	Randomized controlled trial to improve care for urban children with asthma: results of the School-Based Asthma Therapy trial.	523	Stratified by smoke-exposure	N/A	6	Randomized Control	Asthma symptom diary, Healthcare usage diary, and Salivary Cotinine levels	5	7	T-test, Chi-square test, linear-effects modeling	7	5	5	6

Table 2 Continued

Study Author(s)	Article Title(s)	Sample Size	Sample Type	Theory Name	Effect Rating	Experimental Design	Assessment(s) Used	No. of Data Points Per Participant	Interval validity	Statistical Test Utilized	Type of Evidence/ Research design	Independent replication	Implementation guidance	Exeternal and ecological validity
Terpstra JL, Chavez LJ, Ayala GX.	An intervention to increase caregiver support for asthma management in middle school-aged youth.	58	Convenience	Social Cognitive Theory	3	Quasi-Experimental Non-equivalent Comparison Groups with Pre/Post Measures	Parent Asthma Self-Efficacy Scale, Pediatric Asthma Caregiver Quality of Life Questionnaire; Asthma Responsibility Questionnaire; Impact on Family Scale	2	6	t-test, Chi-square test, Analysis of variance	6	0	4	5
Mosnaim GS, Li H, Damitz M, Sharp LK, Li Z, Talati A, Mirza F, Richardson D, Rachelefsky G, Africk J, Powell LH.	Evaluation of the Fight Asthma Now (FAN) program to improve asthma knowledge in urban youth and teenagers.	536	Stratified by age and clustered by school	N/A	4	Randomized Control with 3:1 Randomized: Control ratio with Pre/Post Measures	FAN Asthma Knowledge Questionnaire; FAN Spacer Competency Checklist	2	7	t-test; Wilcoxon rank sum test; cluster-adjusted Chi-square test; multilevel modeling	7	4	5	6
Gerald LB, McClure LA, Mangan JM, Harrington KF, Gibson L, Erwin S, Atchison J, Grad R.	Increasing adherence to inhaled steroid therapy among schoolchildren: randomized, controlled trial of school-based supervised asthma therapy.	290	Stratified by school	N/A	6	Randomized Control Longitudinal	Peak Flow Meter Readings; Rescue Medication use monitored by an electronic device; Juniper Pediatric Asthma Caregiver Quality of Life Questionnaire; Health Care utilization and smoke exposure reported by caregiver	88	7	Chi-square test; Generalized Estimating Equations	7	5	4	6
Bruzzese JM, Sheares BJ, Vincent EJ, Du Y, Sadeghi H, Levison MJ, Mellins RB, Evans D.	Effects of a school-based intervention for urban adolescents with asthma. A controlled trial.	345	Case detection and stratified by severity	N/A	5	Randomization with a wait-list control design	Pediatric asthma Quality of Life Questionnaire; Self-efficacy scale; self-reported number of prevention and symptom management steps	5	6	Normal regression, binomial, or poisson model generalized estimating equations	6	4	5	6
Bowen F.	Asthma education and health outcomes of children aged 8 to 12 years.	32	Convenience	N/A	2	Randomized Control Longitudinal	Pulmonary Function Tests; Child Asthma Control Test; Asthma Knowledge Test (OAS Curriculum); Pediatric Asthma Quality of Life Questionnaire	3	2	t-test; Chi-Square; Analysis of Variance, Generalized Estimating Equations	2	4	5	6
Millard MW, Johnson PT, McEwen M, Neatherlin J, Lawrence G, Kennerly DK, Bokovoy JL.	A randomized controlled trial using the school for anti-inflammatory therapy in asthma.	52	Randomized by school	N/A	6	Randomized Control	Average Peak Flows, Bronchodilator use, Nighttime awakenings due to asthma, school attendance, health care usage	28	7	Chi-square test; Analysis of Variance	7	4	5	6
Berg J, Tichacek MJ, Theodorakis R.	Evaluation of an educational program for adolescents with asthma	13	Convenience	Social Learning Theory	3	Single Group	Child Health Survey for Asthma, Teen Form; Power Breathing Program Evaluation, Focus Group	3	5	Not Specified	5	0	5	5

Table 2 Continued

Study Author(s)	Article Title(s)	Sample Size	Sample Type	Theory Name	Effect Rating	Experimental Design	Assessment(s) Used	No. of Data Points Per Participant	Interval validity	Statistical Test Utilized	Type of Evidence/ Research design	Independent replication	Implementation guidance	External and ecological validity
Velsor-Friedrich B, Pigott TD, Louloundes A.	The effects of a school-based intervention on the self-care and health of African-American inner-city children with asthma.	102	Convenience	Orem's Self-care Deficit Theory of Nursing	3	Quasi-Experimental with Comparison Group	Asthma Screening Survey, Open Airways Asthma Knowledge Test, Asthma Belief Survey, Denyes Self-care Agency Instrument, The Asthma Self-care Practice Instrument, Self-Perception Inventory/What I am Like, Asthma Diary	3	6	Repeated Measure Analysis (test not specified); Linear Regression	6	4	5	6
Velsor-Friedrich B, Pigott T, Srof B.	A practitioner-based asthma intervention program with African American inner-city school children.	52	Randomized by school	Orem's Self-care Deficit Theory of Nursing	5	Quasi-Experimental Randomized Comparison Groups	Asthma Screening Survey, Open Airways Asthma Knowledge Test, Asthma Belief Survey, Denyes Self-care Agency Instrument, The Asthma Self-care Practice Instrument, Self-Perception Inventory/What I am Like, Asthma Diary	4	6	Repeated Measure Analysis (test not specified); Linear Regression	6	4	4	6
Brasler M, Lewis M.	Teens: taking control of asthma.	108	Convenience	N/A	3	Case Study	Self-reported Questionnaires	3	5	Not Specified	5	0	4	5
Gerald LB, Redden D, Wittich AR, Hains C, Turner-Henson A, Hemstreet MP, Feinstein R, Erwin S, Bailey WC.	Outcomes for a comprehensive school-based asthma management program.	610	Randomized by school	N/A	5	Randomized and Delayed Intervention Group	Asthma Awareness: A Curriculum for the Elementary School Classroom Knowledge Test	2	7	Generalized Estimating Equations; Mixed Linear Equations	7	4	4	6
Horner SD, Fouladi RT.	Improvement of rural children's asthma self-management by lay health educators.	183	Randomized by school	N/A	6	Randomized Control Longitudinal	Questions About Asthma, Asthma Inventory of Children, Child Asthma Self-Efficacy, MDI Technique Scoring Tool	2	7	t-test, Chi-square test, Analysis of Variance, General Linear Mixed Effects Model Analysis	7	4	5	6
Clark NM, Shah S, Dodge JA, Thomas LJ, Andridge RR, and Little RJA	An Evaluation of Asthma Interventions for Preteen Students	1183	Randomized by school	N/A	4	Randomized Control Logitudinal with 3 Arms	Pediatric asthma Quality of Life Questionnaire; Author-created self-regulation, asthma management and symptom scale quesitonnaires	3	7	Linear, logistic, multinomial, and Poisson regressions, Intention to Treat Analysis, Linear and Nonlinear mixed models	7	4	5	6
Halterman JS, Riekert K, Bayer A, Fagnano M, Tremblay P, Blaakman S, and Borrelli B	A Pilot Study to Enhance Preventive Asthma Care among Urban Adolescents with Asthma	28	Convenience	N/A	6	Single Group	Pediatric Asthma Quality of Life Questionnaire; Pediatric Asthma Caregiver Quality of Life Questionnaire	3	5	Paired t-test, McNemar test for dichotomous outcomes	5	0	4	5

I found the following programs as effective when used in the school setting to improve health outcomes related to asthma and selected for additional detailed review to identify key components of an effective program. Halterman et al.,²³ Kintner et al.,²⁴⁻²⁶ Cheung et al.³⁸ and Rasberry et al.,³⁹ Gerald et al.,¹⁸ and Bruzzese et al.¹⁸ had varying levels of effectiveness for each aspect of the programs. The activities that lead to their effectiveness are found in Table 3. The School-Based Asthma Therapy trial (SBAT)²³ and the Staying Healthy—Asthma Responsible & Prepared (SHARP) program²⁴ were effective randomized control interventions that enrolled 523 and 205 individuals respectively. Their ratings were similar; however, SHARP²⁴ scored lower but still high on independent replication. The SBAT trial contained multiple replications with evaluation with high fidelity to the initial trial design with the program staff implementing it. SBAT²³ and SHARP²⁴ had high internal validity, independent replication, and external and ecological validity. The Kennett Public Schools (KPS) Asthma Management Program was proven effective overall but had a quasi-experimental design which caused it to have a lower internal validity rating and type of evidence/research design.³⁸ The high sample size, 456 students, intensive program activities, and its evaluation authored by Rasberry et al. warranted me to extensively review it.³⁹ The Randomized Controlled Trial of School Based Supervised Asthma Therapy by Gerald et al. ranked high on all levels including effectiveness with 290 participants which produced 88 data points per individual.¹⁸ It had a high internal validity ranking, independent replication with evaluation, high implementation guidance, and a high external and ecological validity level with multiple applied and similar settings.

Table 3. Details of Program Activities and Outcomes for Selected Programs

Authors	Program Title	Activities	Major Outcomes	P-values	Effect Sizes
Halterman JS, Szilagyi PG, Fisher SG, Fagnano M, Tremblay P, Conn KM, Wang H, Borrelli B. ²³	School-Based Asthma Therapy Trial (SBAT)	- Supervised Controller Administration - Parent Medication Technique Education	Symptom-free days Symptom-free nights Rescue Medication Use Activity Limitation Absenteeism Acute Exacerbation	P<0.001 P<0.001 P<0.001 P=0.003 P=0.002 P=0.05	0.92 (0.50 to 1.33)* -0.68 (-1.01 to -0.35)* -1.06 (-1.41 to -0.72)* -0.47 (-0.78 to -0.16)* -0.17 (-0.28 to -0.06)* 0.64 (0.41 to 1.00)¥
Kintner E, Cook G, Marti CN, Stoddard D, Gomes M, Harmon P, Van Egeren LA. ²⁴⁻²⁶	Staying Healthy—Asthma Responsible & Prepared (SHARP)	- Child Education - Parent/ Guardian Education	Episode Management Risk prevention behaviors Health Promotion Behaviors (Undisturbed sleep)	P=0.006 P<0.001 P=0.026	Not available for this program
Cheung K, Rasberry CN, Dunville RL, Buckley R, Cook D, Daniels B, Robin L. ³⁸	Kennett Public Schools Asthma Management Program (KPS)	- Asthma Care Management by School Nurse - Child and Parent Education - Asthma training for HCPs - Supervised Controller Administration	Asthma Control measured by: Asthma Control Questionnaire Forced Expiratory Volume at 1 Second Pre-post Poorly Controlled Well Controlled	P=0.0085 P= 0.74 P<0.01 P<0.01	1.548 (1.017 to 2.358) ⁺ Not available for this assessment.
Gerald LB, McClure LA, Mangan JM, Harrington KF, Gibson L, Erwin S, Atchison J, Grad R. ¹⁸	Randomized Controlled Trial of School Based Supervised Asthma Therapy	- Supervised Controller Administration - Inhaler Technique Education	Episodes of Poor Asthma Control	P=0.006	1.57 (1.20 to 2.06) ⁺⁺
Bruzzese JM, Sheares BJ, Vincent EJ, Du Y, Sadeghi H, Levison MJ, Mellins RB, Evans D. ^{15,40}	Asthma Self-Management for Adolescents (ASMA)	- Child Asthma Education and Skill Building: Coping, Barriers, self-management - Asthma Education for HCP	<u>1-year follow-up:</u> Symptom Days Nighttime Awakenings Activity Limitation School Absences <u>6 months post-intervention</u> Controller Medication Use Written Asthma Action Plan Use	P=0.12 P=0.001 P=0.003 P=0.004 P=0.006 P<0.0001	0.88 (0.74 to -1.04) ^{¥¥} 0.69 (0.60 to 0.86) ^{¥¥} 0.58 (0.43 to 0.78) ^{¥¥} 0.63 (0.46 to 0.85) ^{¥¥} 2.25 (1.28 to 3.93) ⁺⁺⁺ 3.60 (2.25 to 5.77) ⁺⁺⁺

* Difference (95% CI)

¥ Relative Risk (95% CI)

¥¥ Adjusted Relative Risk (95% CI)

⁺ Odds Ratio (95% CI)

⁺⁺ Odds Ratio (90% CI)

⁺⁺⁺ Adjusted Odds Ratio (95% CI)

4.1.2 School-Based Asthma Therapy Trial

The School-based asthma therapy (SBAT) trial's objective was to determine if supervised controller administration improved asthma outcomes measured by the number of asthma symptom-free days, number of nighttime awakenings due to asthma, number of days with limitation due to asthma, number of days requiring rescue inhaler, and absences due to asthma.²³ This trial, as documented by Halterman et al., had a high number of participants, was found to be effective, utilized appropriate statistical tests, and had the highest caliber for study designs among the analyzed programs.²³ SBAT lacked a formal theory but was built on a previously successful pilot study. The pilot study found that supervised therapy was successful in improving disease-related outcomes in individuals not exposed to tobacco smoke in a small sample size.⁴¹ Thus, the authors of SBAT sought a larger sample with the addition of the potential to change medication dosing if necessary and the addition of an environmental tobacco exposure-reduction program for the families of children exposed to tobacco smoke.²³

SBAT utilized a randomized control trial design, stratified for environmental tobacco smoke exposure, to follow 523 participants between three and ten years old for the seven- to nine-month trial. SBAT showed high internal validity and received the highest rating for the type of evidence/research design. All participants in the treatment arm of the study were prescribed the same inhaled corticosteroid with or without a long-acting beta-agonist, depending on his or her asthma severity and control, which was determined by the participant's HCP. This controller medication was administered daily by the school nurse during the school day.²³ Additional medications were sent home with the participants to be administered by the parent at home, but this administration was not recorded by the school nurse or assessed by the study team.

Parents/guardians of the control group were encouraged to discuss medication options with the participant's HCP and administered medications as needed. No medication was provided, no coverage for medication costs was provided, and no counseling on tobacco exposure was provided for the control group.²³

The intervention participants demonstrated more symptom-free days ($p < 0.001$, 0.92 difference 95% CI 0.50, 1.33), fewer nighttime awakenings due to asthma ($p < 0.001$, -0.68 difference 95% CI -1.01, -0.35), fewer days with limitation due to asthma ($p = 0.003$ -0.47 difference 95% CI -0.78, -0.16), fewer days using a rescue inhaler ($p < 0.001$, -1.06 difference 95% CI -1.41, -0.72), and fewer absences due to asthma ($p = 0.002$, -0.17 difference 95% CI -0.28, -0.06). The intervention group was also less likely to have an asthma exacerbation than the control group ($p = 0.05$, rr 0.64, CI 0.41, 1.00). Additionally, these benefits were seen in both children who were exposed to tobacco smoke *and* those who were not exposed; suggesting that the school-based intervention, not the motivational interviewing component, can be attributed to the improvement in outcomes. These outcomes were determined by participant-report assessments recorded in daily diaries.

Although it was limited to one type of inhaler corticosteroid, the SBAT trial shows improvement in asthma outcomes in a randomized control trial with a large sample size and was proven to be cost-effective.⁴² Each symptom-free day gained by the intervention participants saved ten dollars in productivity because of reduced absences and in medical care cost.⁴² The SBAT trial exhibited that supervised controller administration can reduce asthma symptoms, absenteeism, and the odds of experiencing an asthma exacerbation.

4.1.3 Staying Healthy—Asthma Responsible & Prepared (SHARP)

Staying Healthy—Asthma Responsible & Prepared (SHARP), as described by Kintner et al., utilized an ecological approach with a lifespan development perspective and the asthma acceptance model.⁴³ The program sought to improve “episode management, risk reduction/prevention and health promotion activities” among children ages nine to twelve year-olds through education program.²⁵ This age group was selected because students at this age are in a natural transition to disease self-management and this program met that need.²⁴ The SHARP trial used a true experimental design to measure potential improvements episode management behaviors, risk prevention behaviors, and health promotion behaviors through a school-based program that was applied to a real-world setting in multiple school settings.²⁴

Designed as a two-group, single-blinded study, the SHARP trial cluster-randomized 205 parent/guardian and student pairs to receive either the SHARP program or Open Airways in Schools, an asthma program developed by the American Lung Association for schoolchildren. Both programs were delivered by the same teachers at the same school and children were randomized between the two programs with Open Airways in Schools serving as the control because the program has been implemented in schools for a long time.²⁴

The SHARP Program, an asthma education program, consisted of ten sessions at the school for fifty minutes each where the students were taught about the three areas of focus for the study: episode management, risk reduction/prevention, and health promotion.²⁴ First, episode management involves preventative use of a short-acting bronchodilator, breathing techniques, behaviors to reduce stress and anxiety during acute episodes, and use of a peak flow meter in order to quantify breathing capacity. In order to improve the student’s comprehension of episode management, the SHARP program taught anatomy and physiology of the respiratory system,

asthma severity and control levels, and the steps to episode management. Second, risk reduction and prevention was taught by defining the purpose of controller medications, trigger avoidance, and the ability to recognize asthma symptoms. Lastly, SHARP taught asthmatic children about health promotion activities, defined as: exercise, obtaining sufficient sleep, eating a balanced diet, and using proper handwashing techniques. These health promotion activities were discussed during the SHARP sessions. The SHARP program also received feedback regarding the students' thoughts about having asthma, asthma self-management, and quality of life.²⁴

Additionally, a community health fair with a focused presentation on asthma, specifically the topics of: anatomy and physiology of the respiratory system, proper asthma self-management, the thoughts and feelings that the students had around asthma, and the quality of life of asthmatics.²⁵ The fair was intended to be for the parent/guardian and student dyads and other members of their social network. In order to reach all parents/guardians with this program activity, an information packet with the details from the health fair were provided to those who were randomized to this arm but were not able to attend the health fair.²⁵

The individuals randomized to the SHARP program exhibited an improvement in episode management behaviors between the intervention and control arms ($p=0.06$) and in the intervention arm pre-intervention to post-intervention ($p<0.001$), risk prevention behaviors ($p<0.001$) including trigger identification and avoidance and speaking with others when symptoms worsen, and health promotion behaviors such as undisturbed sleep for seven to nine hours ($p=0.026$). These changes in behavior were demonstrated by a pre- and post-testing of the Asthma Health Behaviors (AHB) survey,²⁴ which was previously designed and tested by the SHARP study team.⁴³ The control group also saw improvements in the above outcomes except for the improvement in asthma episode management behaviors. Thus, SHARP proved as effective in most measures as Open

Airways in Schools, except for improvement in episode management behaviors where SHARP showed to be more successful.²⁵ The SHARP program demonstrated that an education only program for children and adults can contribute to a change in asthma self-management behaviors.

4.1.4 Kennett Public Schools Asthma Management Program

The Kennett Public Schools Asthma Management Program (KPS), as explained by Cheung, Rasberry and colleagues, focused on 4 activities in a school-based program to improve asthma control among children in Kindergarten through twelfth grade: management of asthma care between the school nurse and the child's HCP, education for the asthmatic child and their parent/guardian, asthma training for HCPs and teachers and school staff, and supervised controller administration.^{38,39} The KPS asthma program based their education program and activities in the EPR-3 because this uses a language useful across all participants in child, parent, and teacher asthma education. It also provides reliable approaches to assessing control, administering medication, and educating on these topics.³⁸ The KPS asthma management program had a relatively large sample size of 456 and was statistically analyzed appropriately given the data collected. Although this trial lacked a formal theory and was conducted with a quasi-experimental design rather than a true experimental design, Rasberry et al. demonstrated an extensive evaluation of the program, and the program showed a high level of effectiveness.³⁹

The school nurse determined a child's asthma status by reviewing parent/guardian-completed medical cards and receiving emergency room alerts from local hospitals when a student was seen for an asthma exacerbation. Supervised controller medication administration was conducted in the health office for students who had poor controller medication adherence. The school nurse also assessed the students' asthma control by conducting spirometry, peak flows and

asthma control tests. This information was then shared with the student's HCP in addition to school-specific symptom experiences using an "Asthma Assessment Communication Tool" created for this program. The student's HCP provided Asthma Action Plans (AAP) and orders to use his or her inhaler during school, furthering care coordination with the school. The program staff coordinated education on EPR-3 for school nurses, HCPs, the staff of the HCP offices on asthma-specific care and teachers and school staff on how to recognize asthma symptoms and how to help asthmatics when they are experiencing symptoms.³⁸

Asthma education for students was provided in 3 forms: a school-based education session, weekend asthma workshops at a HCP's office, individual medication administration assessments and inhaler technique workshops.³⁸

Rasberry et al. conducted an evaluation of the KPS asthma program which asked if the students in the asthma program showed improved asthma control from baseline to follow up and as compared to students in a comparison group. The evaluators used a quasi-experimental, cross-sectional design with a convenience sample to assess the comparison of the asthma program participants and a comparison school district that did not receive the intervention. Furthermore, they utilized a longitudinal design without a comparison group to compare the outcomes at baseline and follow-up for the asthma program participants, as determined by the information in the nurse's records for those in the intervention.

Their evaluation found that the students in the intervention district had significantly improved asthma control, as demonstrated by the validated asthma control questionnaire (ACQ) ($p=0.0085$, OR 1.548, 95% CI 1.017, 2.358⁺). Those individuals in the intervention group with poorly controlled asthma had improved forced expiratory volume at one second (FEV₁) ($p<0.001$), and those individuals in the intervention with well-controlled asthma had significantly worse FEV₁

values ($p < 0.01$).³⁹ The authors noted that this calls for additional surveillance for asthmatic control. However, one of the biggest take-away results from this study is that intervention participants were 1.548 times more likely to have well-controlled asthma after the intervention as compared to before the intervention.³⁹ The KPS program demonstrated that even though it was a quasi-experimental design, the activities can result in improved asthma control.

4.1.5 Randomized Controlled Trial of School Based Supervised Asthma Therapy

Gerald and colleagues saw a need to improve adherence among asthmatic children, and they determined that school is a place where healthy habits can be created.¹⁸ This program focused on providing supervised therapy dosing in the school nurse's office in order to reduce the number of episodes of poor asthma control. Poorly controlled asthma was determined by school absences related to asthma or respiratory symptoms, moderate use of a weekly rescue inhaler treatment, and peak flow meter readings below 80% of the participant's best reading.¹⁸ Smaller and shorter studies were performed previously to test this theory; however, Gerald et al. had a stronger power with 240 participants for the longer, 15-month, randomized control trial with daily measurements of control for the participants.¹⁸

The study assigned that participants to receive a daily dose of an inhaled corticosteroid with the dose prescribed according to the participant's asthma severity.¹⁸ The study provided controller and rescue medications with medication refills supplied by mail. To ensure safety, other necessary medications could be taken; however, the study staff was only monitoring the dosing of the controller. For the participants randomized to the intervention arm, the study staff witnessed their administration of budesonide in the school nurse's office every week day, and if the participant incorrectly administered the medication, the staff corrected their administration

technique. Individuals in the control group were not supervised at school and were provided the standard of care of administration of medication at home.¹⁸

Overall, the supervised participants had improved asthma control ($p=0.006$).¹⁸ The supervised participants were 1.57 times more likely to exhibit an episode of poor asthma control at the baseline as compared to the follow-up period (OR 1.57, 90% CI 1.20, 2.06). The participants in the control group did not demonstrate a significant difference between the baseline and follow-up rate of episodes of poor asthma control.¹⁸

4.1.6 Asthma Self-Management for Adolescents

Asthma Self-Management for Adolescents (ASMA), authored by Bruzzese et al., was a school-based intervention that utilized two activities in order to improve asthma self-management, asthma medical management, health outcomes, and urgent health care use of ninth and tenth grade moderate to severe persistent asthmatics in high schools with primarily Latino/a and African American populations.⁴⁰ ASMA utilized a randomized, wait-list controlled study design to assess how an 8-week “intensive” program and “academic detailing” can improve these outcomes.⁴⁰ The “intensive” program utilized three 45- to 60-minute group sessions and five weekly individual sessions that included a health educator providing asthma self-management skills, chronic disease coping skills, barrier recognition and skills to overcome these barriers, and prompt the students seek care with their HCP. The “academic detailing” in ASMA consisted of asthma experts providing education presentations to HCPs regarding asthma therapy.⁴⁰

ASMA found that the sample of 175 participants had a higher self-efficacy to manage their asthma at six months and twelve months post-intervention, compared to the group’s baseline. The ASMA group also demonstrated higher levels of asthma medical management as compared to the

wait-list control group of 170 participants. The intervention group was 2.25 times as likely as the control group to use their controller medications at six months (adjusted OR 2.25, 95% CI 1.28, 3.93). The intervention group also exhibited 3.6 times the odds of using a written AAP at the six-month assessments as compared to the control group adjusted OR 3.6, 95% CI 2.25, 5.77). At one year after the intervention, the ASMA group, demonstrated significantly fewer asthma negative health outcomes including nighttime awakenings due to asthma, asthma symptom days, activity restriction due to asthma, and school absences as see in Table 3.

5.0 DISCUSSION

5.1 PROGRAM RECOMMENDATIONS

The literature analysis of school-based asthma programs provided a wealth of knowledge of the design of programs used in this setting. Additionally, I was able to understand school-based asthma programs in multiple dimensions. I was able to see the evidence and lack of evidence provided for each aspect on the continuum of evidence of effectiveness as well as my additional categories of sample size, sample selection, theory, experimental design, evaluation assessments, number of data points per participant contributing to the program's design, and appropriateness of the statistical test used. I will further discuss these aspects of school-based asthma programs in this section, commenting on the results and providing recommendations for future school-based asthma programs.

5.1.1 Sample Size and Selection

Programs with a higher sample size are able to provide more data for each individual in each arm of the study. These higher sample sizes provide more reliable results for any witnessed effect; the power behind the result is stronger. In this literature analysis, nine programs had above two hundred participants. The more individuals involved in the program gives more support to the results because more people from the population exhibited the changes.

As for participant selection, most of the studies in this analysis consisted of convenience sample. This convenience sample is likely due to the convenient nature of the school-based program. However, a self-selection bias occurs with convenience sampling because the individuals could have self-selected into the study or the school nurse could have selected individuals who he/she thought should participate. This could be especially true for the intervention schools because the perceived benefit of the asthma program could be high. However, I recommend that future studies explore other methods of sample selection as such as: stratified sampling, random sampling or a systematic sampling. These other methods of sample selection reduce the likelihood of bias among the program population. If the only individuals selected are from the same population, there is a bias in this selection, reducing the validity of the study results applying to other populations.

5.1.2 Intervention Theory

Although many of the analyzed programs as part of the literature review did not contain a formal theory, theory should influence health promotion programs. Theory can connect components of a program and make sense of why specific inputs and activities lead to specific outcomes.⁴⁴ Although formal theories cannot apply to all situations contextually, a connection should be made to link the multiple variables in a program. As mentioned previously, the CDC's Guide to the Continuum of Evidence of Effectiveness states that sound theory is required for a rigorous study design and a high level of internal validity.

The theories or models used to connect the components of school-based asthma programs were: the Social Cognitive Theory,³⁰ the Social Learning Theory,³¹ Orem's Self-care Deficit

Theory of Nursing,^{32,33} Asthma Self-management Theory,³⁴ Asthma Health Education Model,³⁴ and the Asthma Acceptance Model.²⁶

I believe that The Social Cognitive Theory as the most applicable to create changes in behavior through school-based asthma programs. This theory includes the relationship of learning new information, modeling a new behavior performed by someone else, and aligning an individual's innate beliefs to complete the new behavior. These three aspects must work together in order for an individual to perform the new behavior.

Self-efficacy is a construct of this theory. Self-efficacy is an individual's belief in his or her ability to complete a task. Self-efficacy in relation to health behaviors is an individual's belief that he or she is capable of doing the behavior that will improve his or her health. Self-efficacy is a key component to asthma self-management. Often, the relationship between acquiring knowledge and improving self-efficacy is not clearly defined. Green and Frankish offer theoretical connections of health education and improvements in self-efficacy with a specific focus on asthma.⁴⁵

The social learning theory states that in order for an individual to perform a new behavior, he or she must learn new ideas and have the behavior reinforced through modeling. These "new ideas" may or may not be new material; it could be information presented in a new way or from a new source.⁴⁵ Additionally, Bandura explains that self-efficacy can be influenced through four different approaches: enactive, vicarious, persuasive, or emotive.⁴⁶ In relation to asthmatic children, this means that they would need to successfully experience enacting an asthma management behavior in order to gain the confidence of being capable of completing the task.⁴⁵ Although persuasive influence does not often yield behavior change on its own,⁴⁵ it can be used in conjunction with these other aforementioned methods to encourage and urge the child to self-

manage his or her asthma. Lastly, Green and Frankish cite that the social learning theory calls for an emotive approach, which would include reinforcing the child's excitement and emotional connection to an improved sense of control over his or her asthma symptoms.⁴⁵

I recommend that future school-based asthma programs utilize a formal theory to connect the components of the program to the intended outcomes. The use of a formal theory provides support for the connection of these constructs because it has been utilized in the past to produce similar outcomes.

5.1.3 Program Design

In the literature analysis, the programs that rated the highest in overall effect score were those that were found to be produce significant effects and had a "true" or "quasi-experimental design". Moreover, internal validity's highest rating was that of a "true experiment". This true experimental design calls for randomly assigned groups, a control arm, and a longitudinal design. Thus, I would recommend that a school-based asthma program should include multiple data points to produce a longitudinal design and have randomly assigned control and intervention arms. Although it may not always be feasible due to time and funding constraints, a design involving a control arm is preferred over using a comparison group. Additionally, having two data points, as used in a pre-post design, is better than having only one data point, as used in a post-only design. It is also recommended to have the data from the same assessment from the control or comparison group to compare at the same time points.

The school programs that completed this often randomized at the school-level to keep the program fidelity high. No cross-contamination could occur if randomization occurred at this level. However, I would recommend that additional studies randomize within the same school. The

school setting may impact the outcomes of the study. Thus, randomizing participants within the same school, it is possible to control for the school environment.

5.1.4 Program Activities

The intervention activities that I found to produce the highest level of effectiveness include: include: an improved system of HCP and school nurse communication,^{38,40} daily supervised medication administration,^{23,38,18} and asthma education programs for children and adults.^{24,38,40} As part of the programs, these activities significantly improved asthma outcomes. However, it is unknown if the improved asthma outcomes can be related to one individual activity or the program as a whole. Thus, implementing all of these activities would result in a multitude of improved asthma outcomes including: improvement in child and parent asthma knowledge, improvement in the child's self-efficacy related to asthma self-management, improvement in the child's medication administration technique, improvement in the child's asthma control, a decrease in asthma exacerbations, and an improvement in asthma self-management.

Implementing a school-based program that includes all of these activities may be beyond the capacity of some organizations. Thus, it may be beneficial to understand that the activity with the highest effect size across multiple studies was supervised controller administration in the school nurse's office. As part of the SBAT program, it contributed to a relative risk ratio of 0.64 for asthma exacerbations for the control group.²³ Additionally, in the study by Gerald et al., this activity contributed to the intervention having 1.57 times the odds of experiencing an episode of poor asthma control at the pre-intervention measurement compared to post-intervention measurement.¹⁸ Lastly, supervised medication administration contributed to the odds of having well-controlled asthma among individuals in the intervention group in the KPS program

(OR=1.548; 95% CI, 1.017, 2.358).³⁸ Thus, I would recommend that a program utilize supervised medication administration to result in the highest effect among participants.

5.1.4.1 School Nurse and HCP Communication

As mentioned previously, the school nurse is a valuable support person for the school-based asthma programs. He/she has the capacity to provide improved care for his/her students, so he/she will be willing to support the activities of this intervention. HCPs are also motivated to provide improved care for their patients; thus, they will seek a better continuity in care, which may include communication with the school nurse.

The ASMA trial utilized “academic detailing” to improve communication between the patient and their HCP.⁴⁰ The HCP was asked to complete a written Asthma Action Plan (AAP), and the patient recorded information and questions during the intervention visits with the school nurses to take to the HCP’s office for their next visit.⁴⁰ This exchange of information worked in conjunction with the other aspects of ASMA to improve the patient’s self-efficacy significantly at six and twelve months ($p<0.0001$, $p=0.0003$, respectively) and asthma symptoms at twelve months follow-up as seen in Table 3.⁴⁰

School nurses have found AAPs to be valuable to providing care for asthmatic students especially during worsening symptoms,⁴⁷ and only half of asthmatic children receive an AAP from their HCP.⁴⁸ A study conducted by Pulcini and colleagues found that HCPs were more likely to provide AAPs if they were provided the student’s best peak flow along with the AAP request. HCPs stated they did not have peak flow data on file due to a lack of training, lack of time during the office visit, and lack of expected success of the parents following through the measure.⁴⁹ This request from a school nurse to a HCP yielded a higher success of a completed a AAP on file at the

school than a request from a school nurse to a parent.⁴⁹ Thus, implementation of this activity should include the school nurse providing the patient's best peak flow when requesting the AAP.

The KPS program utilized an Asthma Assessment Communication Tool³⁸ to communicate patient progress, daily peak flows, and potential changes to treatment monthly. In turn, the HCP will be requested to update the school nurse with the same form when the participant has routine or acute care visits. This improved communication system contributed to an improvement in asthma control among participants ($P=0.0085$).³⁸

5.1.4.2 Supervised Medication Administration

Supervised medication administration was associated with improvement in asthma control in the KPS Asthma Management Program³⁸ and Gerald et al.'s randomized control trial,¹⁸ and a reduced likelihood of experiencing an acute exacerbation in the SBAT trial.²³

Participants went to the nurse's office during the school day to be administered his or her controller medication. The programs that utilized supervised medication administration used the same medication for all participants to control for effectiveness of the medication. Additionally, most of the programs used a once daily dosing regimen because it was most feasible to use this method of administration once at the school. Once daily dosing was as effective as twice daily dosing for most inhaled corticosteroids.⁵⁰ Thus, supervised medication administration is feasible to be completed for asthma controller therapy in a school setting and contributed to improve asthma control^{23,38} and reduce the likelihood of an asthma exacerbation.^{18,23}

5.1.4.3 Child and Parent Asthma Education Sessions

Direct asthma education with children led to improved episode management ($p=0.006$), risk prevention behaviors ($p<0.001$), and health promotion behaviors ($p=0.026$) in the SHARP

program,²⁴ improvement in asthma control and increased odds to use controller medication and an AAP plan in the ASMA program as seen in Table 3,⁴⁰ and asthma control in the KPS program ($p=0.0085$).³⁸

These programs education on similar asthma education topics including the following: Anatomy of the respiratory system and asthma physiology, inhaler administration technique, identifying asthma symptoms and understanding asthma severity and control levels, medication use to prevent and treat symptoms, acute asthma episode management, asthma triggers, self-management skills, and health promotion activities. As these topics contributed to the previously mentioned improved asthma outcomes I recommend the use of these topics in an asthma education program.

In my review, the parent asthma education sessions were less rigid than the child asthma education sessions. Additionally, the parent education sessions were not always well attended. Whereas the child asthma education sessions were held at a convenient time and location for the child, adult programs were additional separate events such as a health fair,²⁴ meetings at a HCP's office,³⁸ or home visits.³⁸

I would suggest that these education sessions have a more formal structure, include process evaluation measures to ensure education fidelity, and incentives for parent participation. Additionally, to reduce the barrier of travel to a location, parent sessions could occur over the phone at a time designated by the parent or in-person at a location that is most suitable for the parent such as their home if they are willing to provide the space.

5.1.5 Program Evaluation

The intervention evaluation piece of a program plan includes multiple dimensions used in this literature analysis. First, the assessments used to evaluate the activities and outcomes of a program should be validated through previous research. Validated measurements are standardized so the values that these measurements produce can be assessed across multiple programs. Additionally, validated surveys have a determined sensitivity and specificity associated with them. Many of the programs in the literature review used validated measures.^{18,26,28-35,38-40,51-53} For example, ASMA used the Pediatric Asthma Quality of Life Questionnaire and the Pediatric Asthma Self-efficacy scale,⁴⁰ the KPS program used the Asthma Control Questionnaire,³⁸ and the SHARP study used the General Health History Survey.²⁶

When comparing effectiveness, these validated measures can be kept as a constant to equally compare the outcomes of these programs. Compare the outcomes of the programs that did not include validated measurements is difficult because the questions and the respondent's perceptions of the questions cannot be held at a constant. Additionally, measurements that are not validated lack a known specificity and sensitivity.

I recommend using a validated measurement in process and outcome evaluations of a school-based asthma program. If a validated measurement is unavailable, the measurement should be tested in a focus group of a similar population to ensure the questions appropriately convey the correct message and that it is understood by the population as Mosnaim and colleagues did.⁵⁴ This can contribute to a higher internal validity among responses.

5.1.6 Independent Program Replication

The highest rating in “independent replication” called for the program to be implemented and evaluated in multiple locations by independent investigators. Few of the programs demonstrated a high value in this category as replication with independent investigators was not always documented in the program articles. As mentioned in the limitations, additional implementation and evaluation of these programs by independent researchers may have occurred and I was unaware of it at the time of this literature analysis. However, I recommend that researchers utilize the highest level of rating for this concept when designing a program. A program can show a high level of feasibility in implementation if it can produce the same outcomes in a different population. In the literature analysis that I completed, information on independent replication was not pervasive. Thus, this could be a missing aspect in the current design of school-based asthma programs.

5.1.7 Program Implementation Guidance

The highest score in implementation guidance was given to the programs with the most involvement of the study staff in the activities of the program. Most of the programs scored the highest or second highest score in this category. High implementation guidance included the program staff’s direct involvement in the activities which is recommended for the fidelity of the implementation of the activities. However, many school-based asthma programs seek to implement a program *with* the school staff rather than *for* the school staff. I recommend that programs be implemented by the program staff until the school staff is trained and ready to conduct the program at the same level of fidelity as the program staff. Additionally, process evaluation

measures should be implemented to track the level of fidelity among the program staff and school staff.

5.1.8 Program External and Ecological Validity

External and ecological validity assesses whether a program can demonstrate the same effect among multiple different populations and in a “real world” setting. External and ecological validity is key to understanding if a program will produce the same outcomes in new populations and in applied settings. Once again, a limitation of this literature analysis method is that I did not search all available outlets to determine if a program was implemented in a new population or additional setting. However, I recommend that researchers remember this aspect of program implementation in the future. Implementation of a successful program with a new population can further show the effectiveness of that program. External and ecological validity is a missing aspect from the school-based asthma program literature during this search. Thus, it is important for researchers to consider this aspect when developing programs.

5.2 LIMITATIONS

Limitations exist in the methodology of this literature analysis. First of all, I was the only reviewer providing feedback and designations in this analysis. If additional individuals reviewed the programs, the designations would be more reliable. Additionally, I was the only individual to review the articles after the literature search was completed. Thus, it is possible that not all articles fitting the inclusion and exclusion are represented in this thesis. In the future, multiple individuals

should review the literature search results for school-based asthma programs and assess their effectiveness according to this rubric.

Additionally, the inclusion and exclusion criteria for articles excluded programs that took place, even in part, outside of the United States. Thus, it is possible that additional school-based asthma programs exist in other countries, and they were not included in this analysis. These school-based asthma programs outside of the United States could add additional insight into addressing this health issue in this setting.

Lastly, I only conducted this literature search in PubMed. By not including other search engines, it is possible that additional school-based asthma programs exist and they were not represented in this thesis. I additionally, did not search for the implementation of these programs with multiple populations or in different locations. I took each article at face-value and did not perform additional research to understand any additional program implementations.

These limitations pose a slanted view at the literature analysis performed. Although I was able to assess the effectiveness of these programs, this literature analysis is lacking multiple collaborators and the well-rounded look at countries outside of the United States and of programs that were not submitted or accepted by journals associated with PubMed.

6.0 CONCLUSION

Asthma is the number one chronic disease reason that children miss school. If not controlled, it can inhibit a child's ability to learn in school and greatly reduce quality of life. In the long-term, uncontrolled asthma causes lifelong irreversible effects on a child's respiratory system.

The objective of this thesis was to perform a literature search for effective school-based asthma programs. I analyzed the results of this searched and rated the programs for levels of effectiveness at multiple dimensions of the program. The programs that were found to be most successful in decreasing any level of asthma symptoms were further studied and analyzed for their individual levels of effectiveness. The literature analysis resulted in the suggestions for future school-based asthma programs.

In order for a school-based asthma program to be effective, it should be based on a formal theory and be designed as a randomized control trial. The researchers should consider implementation guidance, external and ecological validity, independent replication when planning the school-based asthma program. Additionally, program activities should include a system for improved school nurse and HCP communication, supervised medication administration, and asthma education for the child and caregiver. The program team should evaluate both the process and outcome objectives, ideally utilizing validated measurements.

Ultimately, these recommendations are rooted in the literature of school-based asthma programs and the effectiveness ratings that I provided. While limitations exist, this is the first step in understanding the scope of the literature on school-based asthma programs and within this scope, I am able to make recommendations for future programs.

APPENDIX: PUBMED SEARCHES

Date	Words Searched	Filters	No. of Sources
1/25/18	Asthma [MeSH] AND schools* [MeSH] and Absenteeism [MeSH] AND (Child[MeSH] OR Adolescent [MeSH])		58
2/14/18	("Asthma"[Mesh] OR asthma*[tiab] OR asthma*[ot]) AND ("Schools"[Mesh:NoExp] OR elementary school*[tiab] OR primary school*[tiab])) OR (elementary school*[ot] OR primary school*[ot]) AND (health promotion OR health education OR intervention OR evaluation) AND "Child"[Mesh:NoExp]		709
1/25/18	Asthma [MeSH] AND schools* [MeSH] and Absenteeism [MeSH] AND (Child[MeSH] OR Adolescent [MeSH])		58
2/14/18	("Asthma/epidemiology"[Mesh] OR "Asthma/prevention and control"[Mesh] OR Asthma/epidemiology/prevention and control[Mesh] OR asthma/epidemiology/therapy[Mesh])		21484
2/14/18	("Asthma/epidemiology"[Mesh] OR "Asthma/prevention and control"[Mesh] OR "Asthma/epidemiology/prevention and control"[Mesh] OR "asthma/epidemiology/therapy"[Mesh] OR "asthma/diagnosis"[Mesh])		35017
2/14/18	school*[Mesh]		10331
2/14/18	(school*[Mesh]) OR (school*) OR (primary school*) OR (secondary school*)		3391323
2/14/18	((student health service*[Mesh]) OR ((school*[Mesh]) OR (school*) OR (primary school*) OR (secondary school*)))		3393046
2/14/18	("Health Promotion"[Mesh]) OR ("Health Education"[Mesh]) OR ("prevention and control" [Subheading])		1327408
2/14/18	("Health Promotion"[Mesh]) OR ("health") OR (educate) OR (intervent*) OR (program*) OR (wellness program*) OR (health promotion*) OR (health campaign*) OR (health education) OR (community health education) OR ("Health Education"[Mesh]) OR ("prevention and control"[Subheading])		5904232
2/14/18	((((("Child/education"[Mesh] OR "Child/etiology"[Mesh] OR "Child/prevention and control"[Mesh] OR "Child/psychology"[Mesh] OR "Child/therapy"[Mesh])) AND ("Child, Preschool/drug therapy"[Mesh] OR "Child, Preschool/psychology"[Mesh] OR "Child, Preschool/therapy"[Mesh])) AND ("Adolescent/drug therapy"[Mesh] OR "Adolescent/psychology"[Mesh])) OR "Humans"[Mesh]) OR "Students"[Mesh]) OR "Parents"[Mesh]		16892117

2/14/18	((((("Child/education"[Mesh] OR "Child/etiology"[Mesh] OR "Child/prevention and control"[Mesh] OR "Child/psychology"[Mesh] OR "Child/therapy"[Mesh])) AND ("Child, Preschool/drug therapy"[Mesh] OR "Child, Preschool/psychology"[Mesh] OR "Child, Preschool/therapy"[Mesh])) AND ("Adolescent/drug therapy"[Mesh] OR "Adolescent/psychology"[Mesh])) OR "Humans"[Mesh] OR "Students"[Mesh] OR "Parents"[Mesh] OR (children*) OR (Child*) OR (Adolescent*) OR (Youth*) OR (Teen*) OR (Teenager*) OR (Parent*))		17267572
2/14/18	((((("Asthma/epidemiology"[Mesh] OR "Asthma/prevention and control"[Mesh] OR "Asthma/epidemiology/prevention and control"[Mesh] OR "asthma/epidemiology/therapy"[Mesh] OR "asthma/diagnosis"[Mesh])) OR (Asthma)) OR (Respirator*)) OR (asthmatic*))		682077
2/14/18	(((((((((Asthma/epidemiology[Mesh] OR Asthma/prevention and control[Mesh] OR Asthma/epidemiology/prevention and control[Mesh] OR asthma/epidemiology/therapy[Mesh] OR asthma/diagnosis[Mesh])))) OR (Asthma)) OR (Respirator*)) OR (asthmatic*)))) AND (((student health service*[Mesh] OR ((school*[Mesh] OR (school*) OR (primary school*) OR (secondary school*)))) AND (("Health Promotion"[Mesh] OR ("health") OR (educate) OR (intervent*) OR (program*) OR (wellness program*) OR (health promotion*) OR (health campaign*) OR (health education) OR (community health education) OR ("Health Education"[Mesh]) OR ("prevention and control"[Subheading])))) AND (((((("Child/education"[Mesh] OR "Child/etiology"[Mesh] OR "Child/prevention and control"[Mesh] OR "Child/psychology"[Mesh] OR "Child/therapy"[Mesh])) AND ("Child, Preschool/drug therapy"[Mesh] OR "Child, Preschool/psychology"[Mesh] OR "Child, Preschool/therapy"[Mesh])) AND ("Adolescent/drug therapy"[Mesh] OR "Adolescent/psychology"[Mesh])) OR "Humans"[Mesh] OR "Students"[Mesh] OR "Parents"[Mesh] OR (children*) OR (Child*) OR (Adolescent*) OR (Youth*) OR (Teen*) OR (Teenager*) OR (Parent*))		35475
2/19/18	(((((((((Asthma/epidemiology[Mesh] OR Asthma/prevention and control[Mesh] OR Asthma/epidemiology/prevention and control[Mesh] OR asthma/epidemiology/therapy[Mesh] OR asthma/diagnosis[Mesh])))) OR (Asthma)) OR (asthmatic*)))) AND (((student health service*[Mesh] OR ((school*[Mesh] OR (school*) OR (primary school*) OR (secondary school*)))) AND (("Health Promotion"[Mesh] OR ("health") OR (educate) OR (intervent*) OR (program*) OR (wellness program*) OR (health promotion*) OR (health campaign*) OR (health education) OR (community health education) OR ("Health Education"[Mesh]) OR ("prevention and control"[Subheading])))) AND (((((("Child/education"[Mesh] OR "Child/etiology"[Mesh] OR "Child/prevention and control"[Mesh] OR "Child/psychology"[Mesh] OR "Child/therapy"[Mesh])) AND ("Child, Preschool/drug therapy"[Mesh] OR "Child, Preschool/psychology"[Mesh] OR "Child, Preschool/therapy"[Mesh])) AND ("Adolescent/drug therapy"[Mesh] OR "Adolescent/psychology"[Mesh])) OR "Humans"[Mesh] OR "Students"[Mesh] OR	• Clinical Study • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Evaluation Studies • Multicenter Study • Observational Study • Pragmatic Clinical Trial • Randomized Controlled Trial	2430

	"Parents"[Mesh] OR (children*) OR (Child*) OR (Adolescent*) OR (Youth*) OR (Teen*) OR (Teenager*) OR (Parent*)		
2/18/18	((((((((Asthma/epidemiology[Mesh] OR Asthma/prevention and control[Mesh] OR Asthma/epidemiology/prevention and control[Mesh] OR asthma/epidemiology/therapy[Mesh] OR asthma/diagnosis[Mesh]))) OR (Asthma)) OR (asthmatic*)))) AND (((student health service*[Mesh] OR ((school*[Mesh] OR (school*) OR (primary school*) OR (secondary school*)))) AND (("Health Promotion"[Mesh]) OR ("health") OR (educate) OR (intervent*) OR (program*) OR (wellness program*) OR (health promotion*) OR (health campaign*) OR (health education) OR (community health education) OR ("Health Education"[Mesh]) OR ("prevention and control"[Subheading]))) AND (((((((("Child/education"[Mesh] OR "Child/etiology"[Mesh] OR "Child/prevention and control"[Mesh] OR "Child/psychology"[Mesh] OR "Child/therapy"[Mesh])) AND ("Child, Preschool/drug therapy"[Mesh] OR "Child, Preschool/psychology"[Mesh] OR "Child, Preschool/therapy"[Mesh])) AND ("Adolescent/drug therapy"[Mesh] OR "Adolescent/psychology"[Mesh])) OR "Humans"[Mesh]) OR "Students"[Mesh]) OR "Parents"[Mesh] OR (children*) OR (Child*) OR (Adolescent*) OR (Youth*) OR (Teen*) OR (Teenager*) OR (Parent*))	• Clinical Study • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Evaluation Studies • Multicenter Study • Observational Study • Pragmatic Clinical Trial • Randomized Controlled Trial • Preschool Child: 2-5 years • Child: 6-12 years • Adolescent: 13-18 years • Child: birth-18 years	1629

BIBLIOGRAPHY

1. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. *Most Recent Asthma Data*. 2017.
2. Price JH, Khubchandani J, McKinney M, Braun R. Racial/ethnic disparities in chronic diseases of youths and access to health care in the United States. *BioMed research international*. 2013;2013:787616.
3. Akinbami LJ, Moorman JE, Garbe PL, Sondik EJ. Status of childhood asthma in the United States, 1980-2007. *Pediatrics*. 2009;123 Suppl 3:S131-145.
4. U. S. Department of Health and Human Services, Centers for Disease Control and Prevention, Vital Signs. Asthma in Children. 2018;
<https://www.cdc.gov/vitalsigns/childhood-asthma/>. Accessed February 9, 2018, 2018.
5. National Hospital Ambulatory Medical Care Survey:2014 Emergency Department Summary Tables [press release]. 2015.
6. Weiss KB, Sullivan SD, Lyttle CS. Trends in the cost of illness for asthma in the United States, 1985-1994. *The Journal of allergy and clinical immunology*. 2000;106(3):493-499.
7. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. *Asthma Facts: CDC's National Asthma Control Program Grantees*.
8. Nunes C, Pereira AM, Morais-Almeida M. Asthma costs and social impact. *Asthma research and practice*. 2017;3:1.
9. Rhee H, McQuillan B, Chen DG, Atis S. Perceptions about interpersonal relationships and school environment among middle school students with asthma. *The Journal of asthma : official journal of the Association for the Care of Asthma*. 2017;54(9):905-910.
10. Meng YY, Babey SH, Wolstein J. Asthma-related school absenteeism and school concentration of low-income students in California. *Preventing chronic disease*. 2012;9:E98.
11. U. S. Department of Health and Human Services, Centers for Disease Control and Prevention. *Asthma Stats: Asthma-related missed school days among children aged 5-17 years old*. 2015.
12. Tsakiris A, Iordanidou M, Paraskakis E, et al. The presence of asthma, the use of inhaled steroids, and parental education level affect school performance in children. *BioMed research international*. 2013;2013:762805.
13. Moricca ML, Grasska MA, M BM, Morpew T, Weismuller PC, Galant SP. School asthma screening and case management: attendance and learning outcomes. *The Journal of school nursing : the official publication of the National Association of School Nurses*. 2013;29(2):104-112.

14. National Heart L, and Blood Institute of the National Institutes of Health,. *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma*. August 28, 2007 2007.
15. Bruzzese JM, Kingston S, Sheares BJ, Cespedes A, Sadeghi H, Evans D. Feasibility and preliminary outcomes of a school-based intervention for inner-city, ethnic minority adolescents with undiagnosed asthma. *Patient education and counseling*. 2011;85(2):290-294.
16. Virchow JC, Backer V, de Blay F, et al. Defining moderate asthma exacerbations in clinical trials based on ATS/ERS joint statement. *Respiratory medicine*. 2015;109(5):547-556.
17. Weinstein AG. The potential of asthma adherence management to enhance asthma guidelines. *Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology*. 2011;106(4):283-291.
18. Gerald LB, McClure LA, Mangan JM, et al. Increasing adherence to inhaled steroid therapy among schoolchildren: randomized, controlled trial of school-based supervised asthma therapy. *Pediatrics*. 2009;123(2):466-474.
19. Hughes HK, Matsui EC, Tschudy MM, Pollack CE, Keet CA. Pediatric Asthma Health Disparities: Race, Hardship, Housing, and Asthma in a National Survey. *Academic pediatrics*. 2017;17(2):127-134.
20. National Center for Education Statistics. Average number of hours in the school day and average number of days in the school year for public schools, by state: 2007–08. *Schools and Staffing Survey* https://nces.ed.gov/surveys/sass/tables/sass0708_035_s1s.asp. Accessed March 4, 2018, 2018.
21. Garwick AW, Svavarsdottir EK, Seppelt AM, Looman WS, Anderson LS, Orlygsdottir B. Development of an International School Nurse Asthma Care Coordination Model. *Journal of advanced nursing*. 2015;71(3):535-546.
22. Puddy R.W., N. W. *Understanding Evidence Part 1: Best Available Research Evidence. A Guide to the Continuum of Evidence of Effectiveness*. . Atlanta, GA: Centers for Disease Control and Prevention;2011.
23. Halterman JS, Szilagyi PG, Fisher SG, et al. Randomized controlled trial to improve care for urban children with asthma: results of the School-Based Asthma Therapy trial. *Archives of pediatrics & adolescent medicine*. 2011;165(3):262-268.
24. Kintner EK, Cook G, Marti CN, Gomes M, Meeder L, Van Egeren LA. Effectiveness of a school-based academic asthma health education and counseling program on fostering acceptance of asthma in older school-age students with asthma. *Journal for specialists in pediatric nursing : JSPN*. 2015;20(1):49-61.
25. Kintner EK, Cook G, Marti CN, et al. Effectiveness of a school- and community-based academic asthma health education program on use of effective asthma self-care behaviors in older school-age students. *Journal for specialists in pediatric nursing : JSPN*. 2015;20(1):62-75.
26. Kintner E, Cook G, Marti CN, et al. Comparative Effectiveness on Cognitive Asthma Outcomes of the SHARP Academic Asthma Health Education and Counseling Program and a Non-Academic Program. *Research in nursing & health*. 2015;38(6):423-435.
27. Millard MW, Johnson PT, McEwen M, et al. A randomized controlled trial using the school for anti-inflammatory therapy in asthma. *The Journal of asthma : official journal of the Association for the Care of Asthma*. 2003;40(7):769-776.

28. Horner SD, Fouladi RT. Improvement of rural children's asthma self-management by lay health educators. *The Journal of school health*. 2008;78(9):506-513.
29. Clark NM, Shah S, Dodge JA, Thomas LJ, Andridge RR, Little RJ. An evaluation of asthma interventions for preteen students. *The Journal of school health*. 2010;80(2):80-87.
30. Terpstra JL, Chavez LJ, Ayala GX. An intervention to increase caregiver support for asthma management in middle school-aged youth. *The Journal of asthma : official journal of the Association for the Care of Asthma*. 2012;49(3):267-274.
31. Berg J, Tichacek MJ, Theodorakis R. Evaluation of an educational program for adolescents with asthma. *The Journal of school nursing : the official publication of the National Association of School Nurses*. 2004;20(1):29-35.
32. Velsor-Friedrich B, Pigott T, Srof B. A practitioner-based asthma intervention program with African American inner-city school children. *Journal of pediatric health care : official publication of National Association of Pediatric Nurse Associates & Practitioners*. 2005;19(3):163-171.
33. Velsor-Friedrich B, Pigott TD, Louloundes A. The effects of a school-based intervention on the self-care and health of African-American inner-city children with asthma. *Journal of pediatric nursing*. 2004;19(4):247-256.
34. Horner SD, Brown A, Brown SA, Rew DL. Enhancing Asthma Self-Management in Rural School-Aged Children: A Randomized Controlled Trial. *The Journal of rural health : official journal of the American Rural Health Association and the National Rural Health Care Association*. 2016;32(3):260-268.
35. Bowen F. Asthma education and health outcomes of children aged 8 to 12 years. *Clinical nursing research*. 2013;22(2):172-185.
36. Brasler M, Lewis M. Teens: taking control of asthma. *The Journal of school health*. 2006;76(6):269-272.
37. Carpenter DM, Alexander DS, Elio A, DeWalt D, Lee C, Sleath BL. Using Tailored Videos to Teach Inhaler Technique to Children With Asthma: Results From a School Nurse-Led Pilot Study. *Journal of pediatric nursing*. 2016;31(4):380-389.
38. Cheung K, Rasberry CN, Dunville RL, et al. A multicomponent school-based asthma management program: enhancing connections to clinical care. *The Journal of school health*. 2015;85(2):135-140.
39. Rasberry CN, Cheung K, Buckley R, et al. Indicators of asthma control among students in a rural, school-based asthma management program. *The Journal of asthma : official journal of the Association for the Care of Asthma*. 2014;51(8):876-885.
40. Bruzzese JM, Sheares BJ, Vincent EJ, et al. Effects of a school-based intervention for urban adolescents with asthma. A controlled trial. *American journal of respiratory and critical care medicine*. 2011;183(8):998-1006.
41. Halterman JS, Szilagyi PG, Yoos HL, et al. Benefits of a school-based asthma treatment program in the absence of secondhand smoke exposure: results of a randomized clinical trial. *Archives of pediatrics & adolescent medicine*. 2004;158(5):460-467.
42. Noyes K, Bajorska A, Fisher S, Sauer J, Fagnano M, Halterman JS. Cost-effectiveness of the School-Based Asthma Therapy (SBAT) program. *Pediatrics*. 2013;131(3):e709-717.
43. Kae Kintner E. Testing the acceptance of asthma model with children and adolescents. *Western journal of nursing research*. 2007;29(4):410-431.
44. Brazil K, Ozer E, Cloutier MM, Levine R, Stryer D. From theory to practice: improving the impact of health services research. *BMC health services research*. 2005;5:1.

45. Green LW, Frankish CJ. Theories and principles of health education applied to asthma. *Chest*. 1994;106(4 Suppl):219s-230s.
46. Bandura A. Health promotion by social cognitive means. *Health education & behavior : the official publication of the Society for Public Health Education*. 2004;31(2):143-164.
47. McLaughlin T, Maljanian R, Kornblum R, Clark P, Simpson J, McCormack K. Evaluating the availability and use of asthma action plans for school-based asthma care: a case study in Hartford, Connecticut. *The Journal of school health*. 2006;76(6):325-328.
48. Zahran HS, Bailey CM, Damon SA, Garbe PL, PN. B. Vital Signs: Asthma in Children — United States, 2001–2016. *MMWR Morb Mortal Wkly Rep*. 2018;67:149-155.
49. Pulcini J, DeSisto MC, McIntyre CL. An intervention to increase the use of Asthma Action Plans in schools: a MASN RN study. *The Journal of school nursing : the official publication of the National Association of School Nurses*. 2007;23(3):170-176.
50. Boulet LP. Once-daily inhaled corticosteroids for the treatment of asthma. *Current opinion in pulmonary medicine*. 2004;10(1):15-21.
51. Bignall WJ, Luberto CM, Cornette AF, Haj-Hamed M, Cotton S. Breathing retraining for African-American adolescents with asthma: a pilot study of a school-based randomized controlled trial. *The Journal of asthma : official journal of the Association for the Care of Asthma*. 2015;52(9):889-896.
52. Gerald LB, Redden D, Wittich AR, et al. Outcomes for a comprehensive school-based asthma management program. *The Journal of school health*. 2006;76(6):291-296.
53. Halterman JS, Riekert K, Bayer A, et al. A pilot study to enhance preventive asthma care among urban adolescents with asthma. *The Journal of asthma : official journal of the Association for the Care of Asthma*. 2011;48(5):523-530.
54. Mosnaim GS, Li H, Damitz M, et al. Evaluation of the Fight Asthma Now (FAN) program to improve asthma knowledge in urban youth and teenagers. *Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology*. 2011;107(4):310-316.