8-10-2021

A Descriptive Examination of the Prevalence of Asthma Education, Medication Use and Medical Outcomes among Children with Asthma in a Multi-Year Cross-Sectional Study

Eric S. Coil
Georgia State University

doi: https://doi.org/10.57709/24042342

Spring 5-15-2021

A Descriptive Examination of the Prevalence of Asthma Education, Medication Use and Medical Outcomes among Children with Asthma in a Multi-Year Cross-Sectional Study

Eric Coil
Georgia State University

A Descriptive Examination of the Prevalence of Asthma Education, Medication use and Medical Outcomes among Children with Asthma in a Multi-Year Cross-Sectional Study

By

Eric Coil

BSc Biological Sciences MPH Epidemiology Candidate,
Georgia State University

A thesis submitted to the graduate faculty of Georgia State University in partial fulfillment of the requirements for the degree of Master of Public Health

Atlanta, GA 30303

Abstract

INTRODUCTION: Asthma is a chronic lifelong condition that cannot be cured; however, it can be effectively controlled in most cases with medication. One of the most significant asthma treatment challenges is the multi-factorial nature of the disease and the complexity of current treatment protocols which contribute to a lack of medication use and the need for ongoing asthma education.

AIM: To examine (a) the prevalence of medication use and asthma education to the severity of asthma outcomes (b) whether any demographic characteristics are associated with differing rates of asthma severity, medication use and asthma education.

METHODS: Datasets (National Health Interview Survey (NHIS) [2008, 2013, 2018]), were combined to increase the number of observations of sample children. Children below the age of 18 were the target population; children who were diagnosed with asthma within this group were the focus of the examination. An asthma severity scale was created as a proxy, based on asthma outcomes. A comparison of outcomes to rates of medical adherence and asthma education was conducted to determine the rates of each.

RESULTS: Children with higher levels of asthma severity tended to have higher response rates for medication use as well as asthma education. Non-Hispanic black children had higher rates of severe asthma outcomes (8.27% [5.14%, 11.40%]) compared to non-Hispanic white children (3.32% [1.74%, 4.90%]).

CONCLUSION: Race, age groups, mother's education, income, and insurance status were all related with poor asthma outcomes, medication use, asthma education and access to medical services. While medication use and asthma education appear to be negatively associated with asthma severity in these cross-sectional data, a longitudinal study is needed to determine their true significance.

A Descriptive Examination of the Prevalence of Asthma Education, Medication use and Medical Outcomes among Children with Asthma in a Multi-Year Cross-Sectional Study

By

Eric Coil

Approved:

Committee Chair:
Dr. Ike Okosun MS, MPH, PhD

Committee Member:
Dr. Barbara Yankey PhD, MPA, MPH, BSc

Committee Member
Dr. Alex Kirpich PhD

Date:
16 July 2021

Acknowledgement

In regard to everyone who believed in me and never lost faith in me, you will always be remembered and you will always have a place in my heart. To my family, friends, professors who gave me the chance to succeed in life and continue my goals and career.

Authors Statement Page

In presenting this thesis as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to publish this thesis may be granted by the author or, in his/her absence, by the professor under whose direction it was written, or in his/her absence, by the Associate Dean, School of Public Health. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this thesis which involves potential financial gain will not be allowed without written permission of the author.

Eric Coil

Signature of Author

Table of Contents

CHAPTER I: INTRODUCTION

Asthma is defined in the National Heart, Lung, and Blood Institute (NHLBI) "Guidelines for the Diagnosis and Management of Asthma 2007" Expert Panel Report 3 (EPR-3) as "…a common chronic disorder of the airways that is complex and characterized by variable and recurring symptoms, airflow obstruction, bronchial hyper-responsiveness, and an underlying inflammation."[1]

The word "asthma" has its origin in the Greek word "aazein" meaning "panting". The first written description of an asthma attack is attributed to Greek physician Aretaeus of Cappadocia in the second century of the Common Era: "They open the mouth since no house is sufficient for their respiration, they breathily standing, as if desiring to draw in all the air which they possibly can inhale… the neck swells with the inflation of the breath, the precordia retracted, the pulse becomes small and dense, and if the symptoms persist the patient "may produce suffocation after the form of epilepsy".[2] [Aretaeus. The extant works of Aretaeus the Cappadocian. Adams F, editor-translator. London: The Sydenham Society; 1861. Ch. XI, pp. 73–75.]

According to the 2018 National Health Interview Survey (NHIS), the prevalence rate of childhood asthma is 7.5%, and it affects approximately 5.5 million children who are less than 18 years of age. The prevalence rate of asthma in children who are less than 18 years old has declined from a high of 9.6% in 2009 to 7.5% in 2018.[3] The prevalence of asthma is lowest in the children who are who are less than 5 years of age with rate of 4.4%. The observed rate in the above age group may be attributable to the lack of a definitive clinical diagnosis due to a young age. Non-Hispanic Black children tend to have higher prevalence rates than non-Hispanic Whites and non-Hispanic Asians (10.7% versus 8.0% and 4.5%, respectively). Puerto Rican children are disproportionately affected by asthma, exhibiting a prevalence rate of 14.0%.[4]

Asthma is known to impact quality of life in children and is associated with a lack of physical activity, abnormal sleep patterns and contributes to interruptions in school attendance. Treatment for asthma can be complex and expensive depending on the severity and families are impacted by both direct medical costs and indirect costs such as missed work/school days. (Akinbami, Moorman, Garbe, & Sondik, 2009).[5]

The current literature on asthma diagnosis and treatment indicates that asthma education and medication use play central roles in asthma management and improved asthma outcomes. Better asthma management enhances a patients' quality of life and can reduce the economic burden to the patient, the family, and the healthcare system.

1.1 Scientific Objective

The purpose of this thesis is to examine the prevalence of asthma education and medication use to asthma outcomes in children. This study hypothesizes that a child who is armed with education regarding asthma management, and adherence to medication use will have better asthma outcomes. This study hypothesizes that children with better asthma outcomes will have a higher prevalence rate of medication use and asthma education than children with poorer asthma outcomes.

CHAPTER II: LITERATURE REVIEW

2.1 The Scope and Magnitude of Asthma

According to the 2018 Global Asthma Network report, asthma affects an estimated 339 million people worldwide (~ 4.4% of the 2018 global population). Asthma was ranked the 16th leading cause of 'years lived with disability' and the 28th leading cause of 'burden of disease' as measured by disability adjusted life years (DALYs). The global economic burden of asthma - though significant in both direct and indirect costs - is difficult to quantify due to the variability of country-level health systems' data quality and availability.[6]

Asthma has been extensively studied in the United States. Sir William Osler, one of the co-founders of the John Hopkins Medical School, accurately described asthma in his first (1892) edition of the textbook Principles and Practice of Medicine.[7] In the first half of the 20th century, asthma was treated as a disease of bronchospasm using bronchodilators without a clear clinical understanding of the underlying causes of the episodic bronchospasms. By the 1980s, new treatments employing inhaled corticosteroids were introduced after research identified the role of allergen exposures in triggering the mast cells, resulting in bronchial hyper-responsiveness.

The National Health Interview Survey (NHIS) began collecting surveillance data on the health of the civilian noninstitutionalized population in 1957; however, the first NHIS contained only one Yes/No question regarding having asthma during the past 12 months. Since 1997, the NHIS has collected national surveillance data on lifetime asthma and asthma episodes using the Sample Adult Core and Sample Child Core questionnaires and in 2001, it began collecting additional information on current asthma status.[8]

Some of the environmental or behavioral risk factors that have been associated with the higher prevalence rate in Puerto Rican children are: cigarette smoking and second hand smoke, prematurity, allergens, air pollution, diet, vitamin D insufficiency, obesity, exposure to violence, chronic psychosocial stress, inadequate access to healthcare, low health literacy, and poor adherence to prescribed treatment (i.e. due to concerns about side effects or medication costs.)[9]

The study "Prevalence and Costs of Five Chronic Conditions in Children"[10], published in 2016 in the Journal of School Nursing, identified asthma as the chronic condition with the highest prevalence rate in children (8.5%) followed by epilepsy, diabetes, food allergies, and hypertension. The study used Medical Expenditure Panel Survey (MEPS) data to estimate a higher average yearly medical cost of US $1,549.88 ($p \leq .001$) for children aged 6–11 years with asthma compared to children without asthma.

The 2010 Medical Expenditure Panel Survey data chartbook [Figure 1A] ranks asthma as the most prevalent chronic disease among children age 17 and younger. Asthma is a chronic lifelong condition that cannot be cured; however, it can be effectively controlled in most cases with two types of medication: fast acting inhalers (Short-Acting Beta Agonists – SABAs) and maintenance medication (Inhaled corticosteroids). Fast acting inhalers are rescue medications typically taken when an asthma episode commences. Maintenance medication is taken on a daily basis by asthma patients who have more frequent severe asthma episodes which do not adequately resolve with the use of a fast-acting inhaler. The severity of asthma in people can vary greatly. While asthma is usually not life-threatening and does not exhibit a high mortality rate, it can certainly affect the quality of life by limiting the kinds of physical activities a person with asthma feels comfortable engaging in. According to CDC asthma statistics, 192 children died from asthma in the United States in 2018, resulting in a death rate of 2.6 people per 1,000,000.[11]

People with asthma are at increased risk for complications, the most frequent being influenza or other respiratory infections. For this reason, the Advisory Committee on Immunization Practices (ACIP) recommends vaccination against influenza and pneumonia (EPR-3, P. 166).[12] A recent study using National Inpatient Sample (NIS) data found that hospitalizations for serious infections were higher in patients with asthma (10% vs. 7%).[12] [41] Additionally, the 1997 EPR-2 documented that people with asthma are at risk for specific complications during and after surgery. These complications include acute bronchoconstriction triggered by intubation, hypoxemia and possible hypercapnia, impaired effectiveness of cough, atelectasis, and respiratory infection.[12] [42]

People living with uncontrolled asthma are frequently not able to engage in the physical activities they would like to engage in. The 2010 REACT study, published in the Annals of Allergy, Asthma and Immunology, found that uncontrolled asthma was associated with a greater than 2-fold risk of outdoor (odds ratio [OR], 2.58; 95% confidence interval [CI], 1.90–3.51) or physical (OR, 2.62; 95% CI, 1.90–3.61) activity limitations and a 66% increased risk of daily activity limitations (OR, 1.66; 95% CI, 1.09–2.51).[14]

Asthma can present a significant economic burden to both the patient and the health care system. According to a study by the Division of Environmental Hazards and Health Effects of the National Center for Environmental Health at the CDC, the annual cost of asthma in the United States was estimated to be approximately 81.9 billion dollars in

2013.[15] [16] [17] The cost estimate was calculated from calendar years 2008–2013 Medical Expenditure Panel Survey (MEPS) data and included healthcare use, expenditures, payment source, and health insurance coverage. The indirect costs were based on MEPS self-reported data on missed work/school days and were derived using a negative binomial model to produce two predicted values for missed days: one for persons with asthma and one for the same persons without asthma. A recent study published in 2019 entitled "The Projected Economic and Health Burden of Uncontrolled Asthma in the United States."[19] [12] estimated that uncontrolled asthma will cost the U.S. economy an approximately $300 billion (in 2018 dollar values) in the next 20 years in direct medical costs and an estimated $963 billion if costs due to loss of work productivity are included. This study examined the economic costs of asthma in U.S. adults only and didn't include the pediatric asthma population. The direct economic cost of asthma in the pediatric population were estimated at $5.92 billion in 2013, according to a literature review of current evidence published in Pharmacoeconomics in 2019.[18]

2.2 Asthma Education

Simply having medication to use is not sufficient; education is a critical component in understanding how and when to use medication. There are asthma management classes for children that can train them to better recognize their symptoms and improve their medication use. If a child or parent is properly educated on the subject matter, they will be more prepared to respond appropriately to asthma episodes and produce better asthma outcomes overall. Figure 1B demonstrates the complexity of asthma treatment, detailing a multitude of differing factors which can create challenges and barriers to proper treatment.

The standard of treatment for pediatric asthma, as set forth by the CDC and NHLBI (EPR-3), is the inclusion of an asthma action plan developed between the patient and clinician. The asthma action plan is an individually tailored treatment protocol based on the patient's asthma and the symptoms they present. Figure 1E shows a typical asthma action plan mapping a complex treatment regimen in a simplified manner to assist the patient in better understanding the treatment steps. Asthma action plans are based on symptomology that highlight what kind of medication a child should take, how often to take it, as well as what to avoid to prevent triggering an episode.

In a systematic literature review of over 25 different articles examining children who received school-based asthma education, the authors concluded based on the results that children who had asthma education also were more likely to have better knowledge on asthma, self-efficacy and improved asthma management behaviors.[19] The authors however, did not find a significant difference in quality of life, number of school absences, and symptoms for both days and nights due to having received school-based asthma education.

An article published in Respiratory Medicine examining a Cochrane systematic review of 12 randomized control trials (RCT)[20] showed that adults who took classes providing information on asthma (but not asthma management) had a reduction in asthma symptoms; however, the review did not see reductions in hospitalizations or doctor visits. The authors found that asthma management courses, however, did make a significant difference as seen by reductions in hospitalizations, doctor visits and the number of days of school and work missed.

A 2005 study by Butz et al. for Johns Hopkins University, observed the effects of an asthma education program on rural children (n = 288) aimed at monitoring differences in asthma knowledge, self-efficacy, and quality of life.[21] [29] In a randomized control trial using two groups of children, the researchers established a baseline of the rates of asthma and symptoms. The control group was given a standard asthma education, while the other group was given a comprehensive intervention that included two child educational workshops, one coloring book, and one parental/caregiver workshop. The researchers found that the introduction of the asthma intervention improved asthma knowledge, self-efficacy, and reduced reports of asthma symptoms.

2.3 Medication use

Medication use is a critical component to achieving success in the treatment of any disease condition.[22] Poor adherence can compromise patient outcomes and increase patient mortality. Medication use is defined by the World Health Organization (WHO) as "the degree to which the person's behavior corresponds with the agreed recommendations from a health care provider."[23] The WHO issued a report on medication use in 2003.[24] [25] According to the report, adherence among patients who have chronic diseases in developed countries averages only 50%. Barriers to medication use include poor provider-patient communication, inadequate knowledge about a drug and its use, not being convinced of the need for treatment, fear of adverse effects of the drug, long term drug regimens, complex regimens that require numerous medications with varying dosing schedules, cost and access barriers.[26] Rates of adherence to medication regimens among children with chronic diseases are similar to those among adults with chronic diseases, averaging about 50 percent, with decrements in adherence occurring with time.[27] A meta-analysis of 50 years' of research into patient adherence to medical treatments found the average non-adherence rate to be 24.8%, with pulmonary disease having one of the lowest adherence rates.[28]

With respect to asthma, rates of nonadherence range from 30% to 70%.[29] Lack of adherence to an asthma self-management plan can have clinical consequences from poor asthma control (such as exacerbation of asthma) and decreased quality of life for the patients, as well as economic consequences (such as increased hospitalization and emergency department visits) resulting in unnecessarily high costs of health care.

The level of adherence to medications can have a significant impact on the outcome of the treatment. For example, patients with bacterial infections who do not faithfully adhere to their medication plan as prescribed by a doctor could experience a recurrence of the same infection, only more resistant to the previously prescribed antibiotics.

A study of adherence to antibiotic treatment in ambulatory respiratory infections reviewed 63 studies over a 30-year period. The study found that if the patient is adherent, the odds of a good outcome are almost three-fold higher than for those who are non-adherent. The study authors also hypothesized that non-adherence to antibiotics could result in the storage of unused antibiotics for future self-medication needs, resulting in the possible emergence of bacterial resistance.[30]

2.4 Demographic Factors

Factors like age, gender, place, and region of residence have all been significant predictors of health status in populations. A key component of epidemiology is to look at demographic characteristics which may be related to risk of disease occurrence. Looking at rates of an illness through the lens of demographic characteristics can often provide insight into the nature of the disease. Stratifying some of the characteristics can also show differing rates within subpopulations; stratifying by race/ethnicity, for example, can show how rates can differ among racial and ethnic populations for certain diseases.

When stratifying by race/ethnicity, data from the CDC indicate that Puerto Ricans have historically demonstrated higher rates of asthma than other groups. Puerto Ricans are disproportionately affected by asthma more than any other group having a rate of 13.6% (SE: 1.89).[4]

A June 2012 Japanese study published in *Pediatric Allergy and Immunology* found that low birth weight, obesity, and pet ownership were significantly associated with uncontrolled asthma in children ages 6 to 11.[13] In a 2015 study by Toskala et al. obesity was shown to be a major risk factor contributing to a child developing asthma.[32] Factors like these do show that certain population characteristics can affect asthma prevalence and severity.

There is also increasingly clear evidence that genetics plays an important role in the development of asthma. A family history of asthma can be one of the best predictors of a child developing asthma as found in a study published in the *American Journal of Preventive Medicine* by Burke et al. 2003.[33]

2.5 Household and Socioeconomic Factors

Children often experience more severe asthma episodes due to environmental factors. Low-income housing may expose populations to known pollutants such as secondhand smoke, vehicle emissions, industrial contamination, and known environmental triggers such as pet and roach dander, excess dust, and mold. Living in a low-income household can produce emotional stress due to such factors as uncertainty of parental employment and income, food scarcity, and residence in areas of higher crime rates. Children have no say in where they live; their exposures are dependent upon living circumstances. A study by Chen E. et al in 2003, found that stress due to low socioeconomic status had an association with immune responses, which may be responsible for triggering asthma episodes.[34]

Lack of access to medical services has been shown to be associated with asthma severity. In a 2020 study done by Federico M. et al. for *The Journal of Allergy and Clinical Immunology: In Practice,* the authors indicate that social determinants of health, including access to care, play a major role in the health of the child with asthma.[35] Factors that are known to be barriers to access of care include insurance, poverty, transportation, parental education status, family/cultural beliefs and geographic location.

2.6 Environmental Factors

The EPR-3 has identified two environmental factors that play a significant role in the development of asthma: airborne allergens and viral respiratory infections. Allergen exposure and respiratory infections function interactively in the development of asthma.

The role of allergens in the development of asthma is not completely understood, but early studies demonstrated that exposure to animal dander was associated with the development of asthma. More recent studies have established a link between exposures to dust mite and cockroach allergens and the development of asthma.[36] [37] [38] One 2005 study by Gruchalla et al., published by the *Journal of Allergy and Clinical Immunology* concluded that roach parts are more likely to induce an asthma episode than dust mites and animal dander.[39] Allergen exposure can cause persistent airway inflammation and increase the likelihood of an exacerbation.

Respiratory viral infections during infancy have been linked with the subsequent development of asthma. Studies have shown that respiratory syncytial virus (RSV) and parainfluenza virus cause bronchiolitis that exhibit many of the symptoms of childhood asthma.[40] [41] Interestingly, there is also evidence suggesting that some childhood respiratory infections or repeated viral infections can protect against the development of asthma.[42] [43] Researchers have proposed a “hygiene hypothesis” of asthma which theorizes that early childhood infections stimulate the development of a more robust immune system which reduces the risk of developing asthma and other autoimmune diseases. The hygiene hypothesis is one possible explanation for the relationship between large family size, later birth order, daycare attendance, and a reduced risk of asthma.[42] [44]

Asthma attacks can be triggered by either man-made pollutants like vehicle emissions and smoking, or naturally occurring substances such as animal dander and pollen. One of the most common asthma triggers is exposure to cockroach allergens contained in the exoskeleton, saliva, and feces. Cleaning and vacuuming in areas that contain allergens from pets, dust mites and/or cockroaches can cause them to become airborne and inhaled, thus triggering an asthma episode. These environmental factors can be major determinants in asthma prevalence, frequency, and severity. Families with more disposable income are able to address the problems that affect children with asthma by purchasing hypoallergenic pets and products, living in areas further from cities and industrial areas, better air filtration units, better cleaning products and equipment, and using exterminators to rid themselves of vermin that could produce higher amounts of allergens. Higher income families can also provide their child with access to healthcare services and medications to better manage their asthma.

Other common environmental exposures such as tobacco smoke, air pollution, occupational exposures, and diet may increase the risk of developing asthma.[45] [46] Heavy exercise outdoors in areas with high ozone levels was shown to be associated with a higher risk of asthma among school-age children.[47]

2.7 Diagnostic Tools and Accuracy

Within the United States, asthma is the most common chronic disease in children and is usually diagnosed around age 7. [1A,] [48] According to the EPR-3, a clinician will make an initial diagnosis of asthma based on symptomology and family history. The clinician will closely examine upper airways visually or audibly to get better feedback on the patient's condition. Once a diagnosis of asthma is suspected, there are additional confirmatory tests to that can be performed.[49] The most common asthma diagnostic tool is a spirometer, which tests pulmonary function. The patient is asked to blow into a machine that measures the strength of the air stream and the volume of air. The test is repeated multiple times during a 30-45 minute session and a corticosteroid may be administered during the test to determine whether the pulmonary function improves.

In addition to spirometry testing, clinicians can use an exhaled nitric oxide test and a challenge test to confirm the initial asthma diagnosis. Nitric oxide is produced during the inflammatory process in the lungs and a doctor who suspects a child of having asthma may measure the levels of nitric oxide being exhaled. Higher levels of exhaled nitric oxide serve as an indicator for asthma.

Challenge testing is used when other tests do not clearly produce enough evidence to confirm the asthma diagnosis. A clinician will have the patient inhale small, but increasing doses of methacholine or mannitol. Both agents are intended to produce asthma symptoms by causing airways to narrow and spasm. The test is considered to produce positive results when lung function lowers. A bronchodilator is then introduced to alleviate the asthma symptoms.[50]

There is no one definitive test for asthma; rather much of the diagnostic process requires observations of the symptoms, inquiry into family history, and performances on a battery of tests. A study published in the journal *Family Practice* in 2002 found that clinicians accurately diagnosed asthma 59% of the time, so under-diagnosis of asthma may be fairly common.[51] The use of multiple diagnostic tests can eliminate the possibility of other illnesses and give a more accurate diagnosis of asthma.

CHAPTER III: METHODS

3.1 Data Source: The National Health Interview Survey (NHIS)

Data for this analysis were obtained from the National Health Interview Survey. The NHIS ‘User Note’ document describes the NHIS as a national federally funded face-to-face health survey of approximately 36,000 people in 35,000 households each year. The survey has been administered annually since 1957, making it the longest-running national health cross-sectional survey in the United States. It covers a wide variety of topics including immunizations, developmental disabilities, general medical questions, basic health indicators, demographic characteristics, socioeconomic factors, and asthma. The data is broken up into several data sets for each year, those being sample child, sample adult, person, household and family.[52, 53]

The NHIS is the principal source of information on the health of the U.S. population, covering such topics as general health status, the distribution of acute and chronic illness, functional limitations, access to and use of medical services, insurance coverage, and health behaviors (such as exercise, diet, and tobacco and alcohol consumption). On average, the survey covers 100,000 persons in 45,000 households each year. According to the IPUMS.org website ‘User Notes’ document, “NHIS is a harmonized set of data covering more than 50 years (1963-present) of the National Health Interview Survey (NHIS).[52] [53] The IPUMS NHIS facilitates cross-time comparisons of these invaluable survey data by coding variables identically across time.”

According to the NHIS User Notes, the NHIS employs a complex, multistage probability sample that incorporates stratification and clustering. The sample design selects clusters of households and non-institutional group quarters nested within primary sampling units (PSUs). A PSU can consist of a county, a small group of adjacent counties, or a metropolitan statistical area. The first stage of sampling involves dividing the U.S. into approximately 1,700 geographically defined PSUs.

The U.S. Census Bureau, under a contractual agreement, is the data collection agent for the National Health Interview Survey. The NHIS data collection is carried out by Census interviewers throughout the year, producing nationally representative samples each quarter to minimize potential seasonal biases. Face-to-face interviews are conducted in respondents' homes using computer-assisted personal interviewing (CAPI), but follow-ups to complete interviews may be conducted over the telephone. Each household address selected for participation in the NHIS is mailed a letter prior to the interviewer's visit. For the Household Composition section of the questionnaire, one household member who is at least the age of legal majority for the state of residence is identified as the "household respondent." The Family Core questionnaire is administered separately to each family in the household. For the Sample Child questionnaire, one child (the "sample child") is randomly selected. Information about the sample child is obtained from the sample child respondent who is an adult residing in the household who is knowledgeable about the child's health. For the Sample Adult questionnaire, one adult per family (the "sample adult") is randomly selected, with increased chances of selection for any black, Hispanic, or Asian persons aged 65 years or older.

3.2 Eligibility Criteria

The inclusion criteria for this study were children, less than 18, who were diagnosed with asthma and who completed the survey.

This study used data from three differing years of the National Center for Health Statistics (NCHS), National Health Interview Survey (NHIS).

- 2008 NHIS included an unweighted sample child frequency of 8815
- 2013 NHIS included an unweighted sample child frequency of 12860
- 2018 NHIS included an unweighted sample child frequency of 8269

The combined data have a total number of 29,944 observations that fit the inclusion criteria of this study. Thirty-three observations were dropped from the data set as they lacked a response to the race/ethnicity question. From the 29,911 children who completed the survey, 3998 had an asthma diagnosis. This was the population that was used in the study.

Response Rates per Survey Year

NHIS Response Rates 2008

2008 Survey Year

File / Type of Records	Eligible	Interviewed	Conditional Response Rate (%)	Final Response Rate (%)
Household / Households	33,911	28,790	84.90	N/A
Family / Families	29,569	29,421	99.50	84.47
Sample Child / Person	10,303	8,815	85.56	72.27
Sample Adult / Person	29,370	21,781	74.16	62.65

NHIS Response Rates 2013

2013 Survey Year

File / Type of Records	Eligible	Interviewed	Conditional Response Rate (%)	Final Response Rate (%)
Household / Households	54,612	41,335	75.69	N/A
Family / Families	42,766	42,321	98.96	74.90
Sample Child / Person	13,969	12,860	92.06	68.95
Sample Adult / Person	42,294	34,557	81.71	61.20

NHIS Response Rates 2018

2018 Survey Year

File / Type of Records	Eligible	Interviewed	Conditional Response Rate (%)	Final Response Rate (%)
Household / Households	46,500	29,839	64.17	N/A
Family / Families	30,700	30,309	98.73	63.35
Sample Child / Person	8,845	8,269	93.49	59.23
Sample Adult / Person	30,297	25,417	83.89	53.15

The sample child conditional response rate was calculated by taking the number of interviewed children of each year respectively and dividing that by the number of eligible children of that year. The final response rate was calculated by taking aforementioned sample child conditional response rate and the final response rate of the family category. The family final response rate was calculated by multiplying the conditional response rates for both household and family categories and then multiplying that value to get the final response rate for the family category.

3.3 Description of Variables

3.3.1 Dependent Variables

Asthma severity was tested against medication use, asthma education, and the other general inquiry variables. These were all again stratified by demographic variables to find any differences among these variables and to determine any significance across the previously listed groups.

3.3.2 Independent Variables

The independent variables for this study were grouped into demographics, symptomology, medical adherence, asthma education and general inquiry variables to produce tables that have commonality for evaluation.

3.3.3 Variable List

Demographic Variables

Prompt	Description	Variable Code
Household number	*Household identifier*	**HHX (08, 13, 18)**
Family Number	*Family identifier*	**FMX (08, 13, 18)**
Person Number	*Person identifier*	**FPX (08, 13, 18)**
Weight - Final Annual		**WTFA_SC (08, 13, 18)**
Pseudostrat	*Pseudostratum for public use file variance estimation*	**STRAT_P (08, 13) PSTRAT (18)**
PseudoPSU	*PseudoPSU for public use file variance estimation*	**PSU_P (08, 13) PPSU (18)**
Survey Year	*Year of Survey taken*	**SRVY_YR (08, 13, 18)**
Region	*US Region SC is located*	**REGION (08, 13, 18)**
Age	*Age of individual in years*	**AGE_P (08, 13, 18)**
Sex	*Biological Sex of individual*	**SEX (08, 13, 18)**
Ethnicity	*Qualifier for Hispanic/Latino subgroup*	**HISPAN_I (08, 13, 18)**
Race	*Race optimized for OMB standards*	**RACERPI2 (08, 13, 18)**
BMI	*Body Mass Index*	**BMI_SC (08, 13, 18)**
Family Poverty LVL	*Ratio of family income to poverty threshold (Fam file)*	**RAT_CAT2 (08, 13) RAT_CAT4 (18)**
Insurance	*Insurance status (prsn file)*	**NOTCOV (08, 13, 18)**
Mother EDUC	*Maternal education level (prsn file)*	**MOM_ED (08, 13, 18)**

Design Variables

Asthma Diagnoses	*Ever been told SC has asthma*	**CASHMEV (08, 13, 18)**
Asthma Symptoms Present	*Still have asthma*	**CASSTILL (08, 13, 18)**
Suffered Asthma ATK 12m	*Had an asthma attack past 12 months*	**CASHYR (08, 13, 18)**
Asthma caused ER dept	*Had to visit ER due to asthma past 12 m*	**CASMERYR (08) CASERYR1 (13, 18)**
Asthma ER dept overnight	*Admitted overnight to ER due to asthma past 12 m*	**CASMHSP (08) CASMHSP1 (13, 18)**
Longterm management talk	*Health prof. talk w/ you about long-term management of asthma*	**CASMMC (08)**
# of days school/work missed	*# of days school/work missed b/c of asthma, past 12 m*	**CWZMSWK (08) CWZMSWK1 (13) CWZMSWKP (18)**
Inhaler/Nebulizer?	*Used inhaler/disk inhaler or nebulizer most often?*	**CASMTYP (13, 18)**
Ever used a Rx inhaler	*Ever used a prescription inhaler*	**CWZPIN (08)**
Med Prof shown SC to use inhaler	*Has a health prof. shown SC how to use inhaler*	**CASMINST (08)**
Used RX inhaler past 3m	*Used prescription inhaler orally to provide quick relief from asthma symptoms past 3 m*	**CASMPMED (08) CASMMED1 (13, 18)**
Used 3+ of canister past 3m	*Used more than 3 canisters of this type of inhaler, past 3 m*	**CASMCAN (08) CASMCAN1 (13, 18)**
Taken to prevent ATK	*Ever taken the preventive kind of asthma meds every day to protect lungs and keep from having attacks?*	**CASMED (08)**

Taking RX daily	*Now taking this medication daily or almost daily?*	**CASMDTP (08) CASMDTP2 (13, 18)**
Taking Rx Meds	*Taking prescription medication past 3 m*	**PROBRX (08, 13, 18)**
Asthma action plan	*Doctor ever give an asthma action plan*	**CASWMP (08) CASWMP1 (13, 18)**
Asthma Course	*Ever took a course or class on how to manage asthma*	**CASCLASS (08, 13, 18)**
Parents recognize ATK	*Doctor ever taught parent how to recognize early signs of asthma episode*	**CAS_REC (08, 13, 18)**
Parents Respond to ATK	*Doctor ever taught parent how to respond to episodes of asthma*	**CAS_RES (08, 13, 18)**
Peak Flow	*Dr. ever taught parent how to monitor peak flow for daily therapy*	**CAS_MON (08, 13, 18)**
Doc recommend changes	*Doctor ever advised to change things in home to improve asthma*	**CAPENVLN (08, 13, 18)**
Doc Advice Followed	*Amount of Doctor Advice that was followed*	**CAPENVDO (08)**
Doc ask for Asthma Checkup	*# of times saw doctor/other health professional for routine asthma checkup?*	**CAROUTIN (13) CAROUTP (18)**
Doc ask freq of Symptoms	*Doctor/other health professional ask how often child had asthma symptoms?*	**CASYMPT (13, 18)**
Doc ask freq of inhaler	*Doctor/other health professional ask how often child used quick relief inhaler?*	**CARESCUE (13, 18)**
Doc ask for limitations	*Doctor/other health professional ask how often asthma symptoms limited daily activities?*	**CAACTLIM (13, 18)**
Limitations	*Impairment/Health problem limit crawl/walk/run/play*	**IHMOB (08, 13, 18)**
Special Equipment	*Needs Special Equipment due to impairment/health problem*	**IHSPEQ (08, 13, 18)**
Healthcare	*Place usually go to for routine/preventative healthcare*	**CHCPLKND (08, 13, 18)**
General MD	*Seen/talked to general doctor, past 12 m*	**CHCSYR82 (08, 13, 18)**
Specialist	*Seen/Talked to Medical Specialist, past 12 m*	**CHCSYR81 (08, 13, 18)**
Flu Shot	*Flu Shot Received past 12 m*	**CSHFLUYR (08) CSHFLU12 (13, 18)**

The table above shows the NHIS variables that were available for the study. Variables that appeared in all three selected years and had no discernable modifications except for possible changes in the code name were selected for the study. These variables were examined because of their relation with asthma, education, and medication. NHIS variables that did not appear in all three years of interest were highlighted in red. Variables highlighted in yellow, were found in all years, but had slightly different formats. These were recoded for uniformity in the study.

Variable choice reasoning:

The NHIS contains variables to consolidate the data files within each year to link observations together. These variables were included as identifiers to ensure the observations were linked across all data sets and years. These included the variables "household number" (HHX), "family number" (FMX), and "person number" (FPX). The variables "sample child weight final annual" (WTFA_SC), "pseudostratum", "pseudoPSU" and "survey year" were included to ensure the observations were weighted and had estimations for multiyear usage.

Standard demographic variables [8 variables] were included to stratify the data by race, sex, age, region, body mass index (BMI), income-to-poverty ratio, mother's education, and insurance status. All the aforementioned demographic characteristics were recoded to facilitate the analysis, produce more simplified results and give higher statistical power. For example, 'age by year' was regrouped into three distinct age categories to provide a greater 'n' value for each category, allowing for more statistically significant results. Similarly, recodes were done for race/ ethnicity, BMI, poverty level, mother's education, and insurance coverage.

The study universe consisted of all positive responses to the question: 'Ever been told SC has asthma?' Symptomatic variables [5 variables] were utilized as proxies for asthma severity. These included: 'had an asthma attack in the past 12 months'; 'went to the ER due to asthma in the past 12 months' and 'stayed overnight in the ER due to asthma in the past 12 months'.

Medication use variables [4 variables] were analyzed to determine the percentage of children with asthma who indicated they used their medication to prevent their symptoms from appearing or to alleviate their symptoms during an asthma episode. The medication use variables were also utilized to determine how frequently medication was administered, as well as the quantity used in a given time frame.

Asthma education variables [6 variables] were analyzed to determine whether receiving different forms of education had an impact on the frequency and severity of their asthma. These education variables included the receipt of asthma action plans, taking asthma education classes and the parents' knowledge of the signs of an asthma attack and the appropriate response. Asthma education variables were also examined by demographic characteristics to identify any significant associations.

General inquiry variables [7 variables] were stratified against demographic characteristics, medication use and asthma education variables to identify any significant associations. The general inquiry variables include 'doctor visits', 'specialist visits', 'limitations in ability to play/run/walk', 'Influenza vaccinations' and 'missed school/work because of asthma'.

Variable recodes and formatting

The following variables were reformatted and recategorized to provide more statistical power in the analysis.

The raw data files contained 6 different race codes and 12 different ethnicities that were reformatted and collapsed into 4 groups. The HISPAN_I variable had 12 different response options representing various Hispanic origins. The raw responses were [00] Multiple Hispanic, [1] Puerto Rican, [2] Mexican, [3] Mexican-American, [4] Cuban/Cuban American, [5] Dominican, [6] Central or South American, [7] Other Latin American (type not specified), [8] Other Spanish, [9] Hispanic/Latino/Spanish (non-specific type), [10] Hispanic/Latino/Spanish (type refused), [11] Hispanic/Latino/Spanish (type not ascertained), [12] Not Hispanic/Latino/Spanish. A response from 0 to 11 was the prerequisite to be classified as Hispanic. Respondents to the 12th option 'Not of Hispanic or Latino origin' were categorized as non-Hispanic and the other race variables were taken into consideration.

The raw file had six different response options for race: [1] White, [2] Black, [3] AIAN, [4] Asian, [5] Race group not releasable, and [6] Multiracial. These options were collapsed into a new race variable with three options: 'White', 'Black', and 'Other'. The 'Other' variable consisted of the AIAN (American Indian / Alaskan Native), Asian and Multiracial responses. Respondents that chose the 'Race group not releasable' option were not used in the analysis. Respondents 'Not of Hispanic or Latino origin' who indicated their race was 'White', 'Black', or 'Other' (with the exception of 'Race group not releasable') were recategorized into 'non-Hispanic White', 'non-Hispanic Black' or 'non-Hispanic Other' respectively. These were then integrated into the new race format and used for stratification during the analysis.

The age variable was reformatted into three distinct age categories (less than 5; 5-11; 12-17) in order to increase the statistical power for stratification and to facilitate subsequent analysis. The rationale for collapsing age into three distinct age groups was to create groups with similar characteristics - 'young children', 'older children', and 'teens' with sufficient populations in each to derive the statistical significance of observed associations during stratification.

Body mass index (BMI) is a measure of body fat based on height and weight and is calculated using the formula: BMI = weight (lb.) / [height (in)]^2 x 703. BMI was presented in the raw NHIS data files as a four-digit continuous value representing a two-digit number with two decimals. In children, BMI is presented as a ‘BMI for age’ percentile grouping rather than an absolute value. The raw BMI responses were split into five categories for analysis: ‘underweight’ BMI = 0-18.49), ‘proper weight’ BMI = 18.50-24.99), ‘overweight’ (BMI = 25.00-29.99), ‘obese’ BMI = 30.00-34.99), and ‘extremely obese’ (BMI = 35.00 or greater).

The analysis data file contained an insurance status variable which consisted of two response options: ‘covered’ and ‘not covered’. Respondents who answered ‘covered’ were assumed to have insurance coverage from either the private or public sector. The analysis data file constructed for this thesis did not include the more granular health insurance variables consisting of detailed responses with respect to health insurance (i.e. private insurance, Medicare, Medicaid, Children’s Health Insurance Program (CHIP), a state-sponsored health plan, other government programs, or military health plans).

Income to poverty ratio was used to identify children from families with low income and compare them to children from higher income households. The responses were predetermined categories expressed as decimal ranges. If a respondent was under a ratio of 1.00 then it was grouped into a ‘low income to poverty’ ratio while children of 1.00 or more were grouped into a ‘high-income’ bracket. These two categories were used to examine the role income plays in asthma management.

Mother’s education was included in the thesis as a potential predictor of observed differences in the prevalence of asthma education, medication use and medical outcomes in the child. The mother’s educational level was split into two categories; mothers who did not complete high school or completed high school and did not seek any form of higher education versus mothers who completed high school and had sought a higher education.

3.4 Statistical Methods

Data were analyzed using Statistical Analysis Software version 9.4 (SAS Institute Carey, North Carolina). The years 2008, 2013, and 2018 of the NHIS data sets were selected because they contained the asthma component questions.

An analysis data set was constructed by combining the NHIS 'sample child', 'household', 'family', and 'person' files for each year. The years were then merged together and frequency distributions were performed to obtain a better understanding of the data structure and contents. The SAS procedure statement 'PROC SURVEYFREQ' was run against the data set to determine the number of observations and percent for each variable in the data, these were done simultaneously for each of the four asthma outcome variables. Additional parameters for the Stratum and PSU variables were taken into account and used as directed by the survey description, according to the NHIS User Note document.[52] [53] This is to assist with variance estimation and to improve statistical efficiency in various statistical estimation procedures.

The PROC SURVEYFREQ statement was used to provide prevalence estimates by producing two-way frequency and crosstabulation tables from the NHIS sample children survey data. This proc statement provided a way to test null hypothesis of equal proportions for a one-way frequency table.

The first three columns in table 1 show a frequency distribution of the demographic characteristics variables in the data set. The remaining table columns show the prevalence of asthma by demographic characteristics. The additional tables in this study were the product of two-way frequency of the dependent and independent variables in the data set. These were performed to estimate prevalence rates between the variables. Four asthma outcome variables ('asthma symptoms'; 'asthma attack in past 12 months'; 'sent to hospital because of attack in past 12 months'; and 'stayed overnight in hospital because of asthma in past 12 months') served as proxies for mild intermittent, mild persistent, moderate and severe asthma, respectively. These outcomes were compared to other variable groups, including medication use, asthma education, and general inquiries. Percentages of children who responded positively to both variables were recorded into the tables.

Descriptive statistics were used to examine the distribution of children within the outcome variables of interest and the independent variables: age, sex, race/ethnicity, region, BMI, income to poverty level, mother's education and insurance status. Demographic characteristics were compared with all four variable groups, controlling for asthma symptoms. All children in these tables indicated having asthma symptoms. The percentage of children who responded positively to each variable was recorded and put into the tables.

Rao Scott Chi-square tests were additionally used to determine whether any demographic variables were significant. According to SAS/STAT User's Guide specifying the CHISQ option while using the PROC SURVEYFREQ provides the Rao-Scott chi-square test.[58][63] The two-way tables used the CHISQ option to derive associations between the row and column variables. The P-values that resulted from the Rao-Scott chi-square test were used to determine statistical significance and the need for further analysis. If the response had a P-value less than 0.05, the results were considered statistically significant. Confidence intervals were generated using an alpha level of 0.05. Results were statistically significant if confidence intervals did not overlap.

CHAPTER IV: RESULTS

4.1 Demographic Characteristics of Study Participants

Table 1:

Demographic Characteristics	Total No.	%	No. w/o asthma	%	No. w/ asthma	%
Male	15,468	51.7%	13,098	84.7%	2,370	15.3%
Female	14,443	48.3%	12,815	88.7%	1,628	11.3%
NH White	14,153	47.3%	12,494	88.3%	1,659	11.7%
NH Black	4,323	14.5%	3,437	79.5%	886	20.5%
NH Other	3,206	10.7%	2,801	87.4%	405	12.6%
Hispanic	8,174	27.3%	7,137	87.3%	1,037	12.7%
less than 5 years old	8,258	27.6%	7,767	94.1%	491	5.9%
5 to 11 years old	10,868	36.3%	9,261	85.2%	1,607	14.8%
12 to 17 years old	10,785	36.1%	8,885	82.4%	1,900	17.6%
Northeast	4,718	15.8%	4,006	84.9%	712	15.1%
Midwest	6,047	20.2%	5,297	87.6%	750	12.4%
South	11,029	36.9%	9,451	85.7%	1,578	14.3%
West	8,117	27.1%	7,159	88.2%	958	11.8%
Underweight	1,877	6.3%	1,613	85.9%	264	14.1%
Proper weight	5,815	19.4%	4,860	83.6%	955	16.4%
Overweight	1,561	5.2%	1,213	77.7%	348	22.3%
Obese	576	1.9%	430	74.7%	146	25.3%
Extremely Obese	244	0.8%	156	63.9%	88	36.1%
Poverty LVL <100%	5,136	17.2%	4,281	83.4%	855	16.6%
Poverty LVL >=100%	22,763	76.1%	19,869	87.3%	2,894	12.7%
Mom EDUC <=HS	10,292	34.4%	8,915	86.6%	1,377	13.4%
Mom EDUC >HS	17,227	57.6%	14,984	87.0%	2,243	13.0%
Insurance	27,545	92.1%	23,811	86.4%	3,734	13.6%
No Insurance	2,231	7.5%	1,983	88.9%	248	11.1%
Total	29,911					

A total of 29,911 children less than 18 years of age participated in the survey. Of these, 25,913 (87.28% [86.79, 87.79]) did not have asthma and 3,998 (12.71% [12.21, 13.21]) had asthma and were included in the analysis. The response rates for each year were 72.27%, 68.95% and 59.23% for the 2008, 2013 and 2018 NHIS survey respectively.

4.2 Prevalence of Asthma Condition and Medication use Variables

Table 2:

			Medication use			
Asthma Condition	N	Weighted Percentage	% Taking Rx Medication past 3 months	% Used Medication daily or almost daily	% Used Rx Inhaler for quick relief past 3 months	% Used 3+ of canister past 3 months
No Asthma	25913	87.28 (86.79, 87.79)	N/A			
Diagnosed w/ Asthma	3998	12.71 (12.21, 13.21)	37.28 (35.39, 39.16)	78.30 (75.30, 81.30)	67.78 (65.31, 70.26)	13.32 (11.44, 15.20)
Presents Asthma Symptoms	2574	66.65 (64.82, 68.47)	47.44 (44.98, 49.89)	78.57 (75.59, 81.55)	68.37 (65.83, 70.87)	13.50 (11.60, 15.41)
Asthma Attack	1463	38.95 (36.87, 41.04)	54.32 (51.14, 57.50)	81.77 (78.19, 85.36)	79.71 (76.91, 82.51)	15.14 (12.64, 17.63)
ER Visit	531	17.23 (15.54, 18.92)	55.87 (50.57, 61.17)	83.15 (78.68, 87.62)	82.36 (77.86, 86.87)	24.66 (18.97, 30.35)
ER Overnight	116	5.21 (3.91, 6.52)	63.80 (52.62, 74.98)	91.49 (80.92, 100.0)	83.34 (73.10, 93.58)	31.35 (18.05, 44.64)

Table 2 shows the number of children with (n=3998) and without (n=25913) asthma, as well as a crosstabs of the asthma condition variables and medication use group with incremental levels of asthma severity by the medical adherence variables. Confidence interval of 95% (alpha = 0.05).

4.3 Prevalence of Asthma Condition and Asthma Education Variables

Table 3:

	Asthma Education					
Asthma Condition	% Given an Asthma Action plan	% Taken course on Asthma Management	% Parents taught to recognize asthma episode	% Parents taught to respond to asthma episode	% Parents taught how to monitor peak flow	% had Doctor recommend changes in home
No Asthma	N/A					
Diagnosed w/ Asthma	47.00 (44.38, 49.61)	11.02 (9.56, 12.48)	78.97 (76.89, 81.05)	78.97 (76.89, 81.05)	49.05 (46.61, 51.49)	49.76 (47.18, 52.35
Presents Asthma Symptoms	47.10 (44.46, 49.73)	10.86 (9.37, 12.34)	73.29 (71.04, 75.48)	79.00 (76.90, 81.11)	49.14 (46.65, 51.62)	49.90 (47.26, 52.53)
Asthma Attack	52.42 (48.95, 55.90)	12.24 (10.23, 14.25)	77.61 (74.96, 80.26)	84.08 (81.68, 86.47)	52.06 (48.97, 55.14)	54.14 (50.78, 57.51)
ER Visit	59.55 (54.27, 64.84)	17.66 (13.65, 21.67)	82.03 (78.20, 85.87)	86.82 (83.52, 90.12)	60.14 (55.11, 65.17)	60.70 (55.70, 65.70)
ER Overnight	60.85 (49.17, 72.53)	24.37 (14.59, 34.16)	84.57 (75.75, 93.39)	88.65 (81.46, 95.84)	71.87 (62.11, 81.63)	71.08 (61.68, 80.48)

Table 3 shows the percent of children diagnosed with asthma by incremental level of asthma condition (severity) who responded positively to the asthma education variables: given an action plan; taken an asthma management course; parental education on recognizing and responding to an asthma episode; and had doctor recommend changes in the child's home. Confidence interval of 95% (alpha = 0.05).

4.4 Prevalence of Asthma Condition and General Inquiry Variables

Table 4:

	General Inquiry						
Asthma Condition	% Limit ability to crawl/walk/ run/play?	% Needs Special equipment for health problem	% Seen/talked to general doctor past 12 mo.	% Seen/talked to specialist past 12 mo.	% had a checkup past 12 mo.	% Received Flu shot past 12 mo.	% Missed School\Work because of Asthma past 12 mo.
No Asthma	N/A						
Diagnosed w/ Asthma	6.07 (5.02, 7.12)	2.43 (1.76, 3.10)	88.54 (87.31, 89.76)	22.86 (21.14, 24.58)	83.86 (82.35, 85.36)	47.91 (45.83, 49.98)	49.57 (46.82, 52.31)
Presents Asthma Symptoms	8.45 (6.91, 9.97)	3.27 (2.32, 4.22)	90.34 (88.92, 91.76)	25.66 (23.37, 27.95)	84.91 (82.98, 86.85)	50.09 (47.58, 52.59)	49.97 (47.16, 52.77)
Asthma Attack	11.52 (9.10, 13.95)	3.75 (2.35, 5.16)	91.80 (90.04, 93.55)	28.97 (25.93, 32.01)	86.71 (84.38, 89.04)	52.09 (48.75, 55.43)	56.84 (53.38, 60.30)
ER Visit	12.21 (8.64, 15.77)	2.80 (1.11, 4.49)	94.00 (91.73, 96.26)	30.07 (24.88, 35.25)	88.74 (85.84, 91.64)	59.62 (54.46, 64.78)	77.20 (72.95, 81.45)
ER Overnight	13.92 (6.17, 21.66)	4.68 (0.00, 9.79)	95.55 (92.50, 98.59)	36.92 (24.87, 48.97)	84.33 (76.81, 91.85)	54.18 (42.52, 65.83)	82.51 (73.15, 91.88)

Table 4 shows the percent of children diagnosed with asthma by incremental level of asthma condition (severity) who responded to the general inquiry variables: ‘indicating limitations in physical ability’; ‘need for special equipment’; ‘visits to a healthcare professional in the past 12 months’; ‘receipt of a flu shot in the past 12 months’; and ‘lost school/work days in the past 12 months’. Confidence interval of 95% (alpha = 0.05).

4.5 Demographic Characteristics and Symptomatic Variables
Table 5

Symptomatic Variables

Demographic Characteristics	% Asthma Symptoms	P-Value	% Asthma Attack past 12 mo.	P-Value	% Asthma sent to ER	P-Value	% Stayed Overnight in ER	P-Value
Male	66.52 (64.18, 68.86)	0.88	39.28 (36.67, 41.89)	0.71	17.39 (15.21, 19.58)	0.053	6.17 (4.29, 8.05)	0.06
Female	66.82 (63.87, 69.77)		38.49 (35.22, 41.75)		17.00 (14.40, 19.60)		3.90 (2.37, 5.42)	
NH White	65.34 (62.56, 68.13)	<0.001	39.80 (36.67, 42.94)	0.15	11.75 (9.70, 13.81)	<0.001	3.32 (1.74, 4.90)	0.01
NH Black	75.55 (71.82, 79.29)		41.57 (37.14, 46.00)		27.26 (22.83, 31.69)		8.27 (5.14, 11.40)	
NH Other	63.47 (57.27, 69.68)		40.09 (33.30, 46.89)		15.37 (10.20, 20.53)		6.33 (1.75, 10.90)	
Hispanic	63.13 (59.10, 67.16)		34.87 (30.94, 38.80)		20.07 (16.60, 23.54)		5.45 (3.18, 7.72)	
less than 5 years old	79.62 (75.25, 83.98)	<0.001	54.33 (48.82, 59.85)	<0.001	36.08 (30.47, 41.69)	<0.001	14.24 (9.27, 19.20)	<0.001
5 to 11 years old	70.37 (67.51, 73.23)		43.29 (40.05, 46.53)		20.67 (17.82, 23.52)		4.96 (3.17, 6.75)	
12 to 17 years old	59.39 (56.51, 62.26)		30.34 (27.68, 33.00)		8.27 (6.65, 9.89)		2.01 (0.86, 3.15)	
Northeast	67.19 (63.05, 71.32)	0.35	38.73 (33.95, 43.50)	0.98	18.33 (14.27, 22.39)	0.6	3.69 (1.61, 5.77)	0.13
Midwest	68.38 (63.99, 72.76)		39.03 (34.03, 44.03)		17.08 (13.16, 21.01)		6.14 (2.54, 9.75)	
South	67.12 (64.25, 69.99)		38.58 (35.39, 41.77)		17.95 (15.20, 20.70)		6.50 (4.24, 8.75)	
West	63.52 (59.83, 67.22)		39.77 (35.30, 44.24)		15.16 (12.02, 18.30)		3.09 (1.27, 4.91)	
Underweight	58.83 (51.58, 66.08)	0.73	29.28 (22.79, 35.76)	0.31	8.47 (3.95, 12.99)	0.17	2.70 (0.0, 7.46)	0.71
Proper weight	58.78 (54.81, 62.76)		30.87 (27.03, 34.71)		7.37 (5.34, 9.40)		1.44 (0.29, 2.60)	
Overweight	56.31 (50.21, 62.40)		27.59 (22.30, 32.89)		8.16 (4.79, 11.54)		2.90 (0.33, 5.46)	
Obese	61.01 (51.98, 70.05)		38.69 (29.36, 48.01)		13.84 (7.29, 20.40)		3.64 (0.0, 8.60)	
Extremely Obese	66.09 (54.78, 77.39)		35.03 (22.01, 48.05)		13.82 (3.58, 24.07)		0.91 (0.0, 2.71)	
Poverty LVL <100%	70.78 (66.77, 74.79)	0.03	43.02 (38.60, 47.44)	0.03	21.33 (17.77, 24.90)	0.004	6.92 (4.51, 9.33)	0.02
Poverty LVL >=100%	65.57 (63.37, 67.78)		37.65 (35.22, 40.08)		15.74 (13.86, 17.63)		3.98 (2.69, 5.27)	
Mom EDUC <=HS	67.07 (64.01, 70.12)	0.82	38.20 (34.81, 41.59)	0.49	18.86 (15.90, 21.82)	0.15	7.80 (5.33, 10.27)	0.006
Mom EDUC >HS	66.61 (64.19, 69.03)		39.75 (36.98, 42.52)		16.24 (14.04, 18.43)		4.04 (2.48, 5.60)	
Insurance	67.22 (65.31, 69.13)	0.02	38.95 (36.75, 41.15)	0.92	17.24 (15.47, 19.01)	0.96	4.99 (3.63, 6.35)	0.1
No Insurance	57.13 (48.78, 65.49)		39.37 (31.15, 47.60)		17.04 (10.01, 24.07)		9.54 (2.78, 16.31)	

Table 5 is a two-way frequency table of the demographic characteristic variables stratified by asthma outcomes. This table includes a 95% confidence interval (alpha = 0.05) as well as p-values for each demographic characteristic variable.

4.6 Demographic Characteristics and Medication use Characteristics

Table 6

Medication use Variables

Demographic Characteristics	% Taking Rx Medication past 3 mo.	P-Value	% Used Medication daily or almost daily	P-Value	% Used Rx Inhaler for quick relief past 3 mo.	P-Value	% Used 3+ of canister past 3 mo.	P-Value
Male	38.08 (35.57, 40.59)	0.32	79.34 (75.53, 83.16)	0.4	69.10 (65.99, 72.21)	0.21	14.78 (12.23, 17.33)	0.1
Female	36.13 (33.21, 39.04)		76.44 (71.03, 81.85)		65.94 (62.01, 69.86)		11.33 (8.35, 14.31)	
Non-Hispanic White	42.96 (40.02, 45.90)	<0.001	78.02 (73.50, 82.54)	0.09	70.05 (66.70, 73.40)	0.34	10.14 (7.62, 12.65)	0.001
Non-Hispanic Black	34.14 (30.00, 38.28)		79.53 (74.00, 85.07)		66.56 (61.45, 71.67)		14.28 (10.34, 18.22)	
Non-Hispanic Other	30.68 (25.07, 36.30)		66.40 (51.92, 80.89)		63.79 (55.94, 71.64)		14.52 (8.52, 20.52)	
Hispanic	31.41 (27.76, 35.06)		82.99 (78.00, 87.99)		66.03 (60.56, 71.50)		19.71 (14.67, 24.75)	
less than 5 years old	36.92 (31.14, 42.71)	0.045	83.56 (76.27, 90.86)	0.27	69.31 (62.85, 75.76)	0.86	14.72 (8.43, 21.01)	0.02
5 to 11 years old	40.14 (37.05, 43.24)		78.35 (74.01, 82.69)		67.22 (63.68, 70.76)		16.11 (12.76, 19.46)	
12 to 17 years old	34.65 (31.86, 37.43)		75.81 (70.48, 81.15)		67.90 (64.01, 71.79)		10.19 (7.69, 12.70)	
Northeast	35.19 (31.03, 39.35)	0.0002	79.96 (75.02, 84.90)	0.09	70.16 (64.06, 76.25)	0.29	16.80 (13.19, 20.40)	0.01
Midwest	43.41 (38.94, 47.89)		83.30 (78.96, 87.64)		70.08 (65.04, 75.12)		9.36 (5.13, 13.58)	
South	38.22 (35.05, 41.40)		74.47 (69.11, 79.82)		64.84 (60.81, 68.87)		15.78 (12.73, 18.82)	
West	30.92 (27.31, 34.52)		78.47 (70.35, 86.59)		68.94 (63.81, 74.07)		10.34 (6.63, 14.05)	
Underweight	32.69 (25.93, 39.45)	0.005	74.31 (63.04, 85.58)	0.047	63.70 (54.38, 73.01)	0.53	5.03 (2.46, 7.60)	0.002
Proper weight	33.75 (29.97, 37.53)		74.06 (66.21, 81.90)		70.98 (66.15, 75.81)		11.22 (8.16, 14.27)	
Overweight	34.25 (27.61, 40.89)		85.39 (80.18, 90.60)		67.19 (58.87, 75.51)		7.97 (3.20, 12.73)	
Obese	40.92 (31.22, 50.62)		71.50 (65.12, 77.88)		72.56 (63.09, 82.03)		20.05 (12.28, 27.82)	
Extremely Obese	59.22 (46.90, 71.54)		88.66 (79.44, 97.88)		72.89 (59.36, 86.43)		8.64 (1.33, 15.96)	
Poverty LVL <100%	38.38 (33.80, 42.96)	0.63	84.67 (78.28, 91.06)	0.045	69.62 (64.77, 74.48)	0.30	17.23 (13.09, 21.37)	0.037
Poverty LVL >=100%	37.13 (34.91, 33.37)		76.44 (72.91, 79.97)		66.69 (63.80, 69.59)		12.36 (10.09, 14.63)	
Mom EDUC <=HS	34.51 (31.22, 37.81)	0.01	81.12 (76.00, 86.24)	0.17	66.57 (62.09, 71.05)	0.37	15.61 (12.18, 19.04)	0.13
Mom EDUC >HS	39.73 (37.15, 42.30)		76.64 (72.64, 80.64)		68.94 (65.90, 71.98)		12.40 (9.99, 14.81)	
Insurance	38.09 (36.05, 40.13)	0.002	78.44 (75.41, 81.47)	0.74	67.88 (65.30, 70.47)	0.64	13.42 (11.45, 15.39)	0.63
No Insurance	25.16 (18.02, 32.29)		76.56 (65.17, 87.95)		65.62 (56.31, 74.92)		11.99 (6.82, 17.16)	

Table 6 is a two-way frequency table of medication use variables stratified by demographic characteristics. Confidence intervals of 95% (alpha = 0.05) as well as p-values for each demographic variable are shown.

4.7 Demographic Characteristics and Asthma Education Variables

Table 7

Asthma Education Variables

Demographic Characteristics	% Given an Asthma Action plan	P-value	% Taken course on Asthma Management	P-value	% Parents taught to recognize asthma episode	P-value
Male	48.49 (45.06, 51.92)	0.16	10.83 (8.97, 12.68)	0.77	74.51 (71.68, 77.34)	0.2
Female	44.89 (41.03, 48.74)		11.29 (8.86, 13.73)		71.57 (68.07, 75.07)	
Non-Hispanic White	45.82 (42.03, 49.62)	0.01	8.11 (6.11, 10.11)	0.0002	72.90 (69.71, 76.09)	0.29
Non-Hispanic Black	54.14 (48.77, 59.52)		15.69 (11.98, 19.40)		77.04 (72.48, 81.59)	
Non-Hispanic Other	40.69 (32.91, 48.47)		7.13 (2.76, 11.50)		71.71 (64.31, 79.10)	
Hispanic	44.53 (39.33, 49.74)		13.92 (10.76, 17.07)		70.81 (65.75, 75.86)	
less than 5 years old	43.26 (37.18, 49.33)	0.42	9.08 (5.18, 12.98)	0.17	73.03 (67.39, 78.68)	0.7
5 to 11 years old	47.07 (43.10, 51.04)		10.07 (7.98, 12.16)		74.31 (71.00, 77.63)	
12 to 17 years old	48.37 (44.24, 52.51)		12.85 (10.34, 15.35)		72.24 (68.78, 75.70)	
Northeast	44.64 (38.88, 50.39)	0.19	12.62 (8.62, 16.62)	0.04	77.02 (72.76, 81.29)	0.27
Midwest	50.48 (44.90, 56.06)		7.78 (5.32, 10.24)		72.81 (68.38, 77.24)	
South	48.24 (43.72, 52.76)		12.79 (10.45, 15.13)		73.45 (69.69, 77.21)	
West	42.84 (37.91, 47.77)		9.63 (6.58, 12.68)		70.21 (65.36, 75.06)	
Underweight	52.27 (42.78, 61.76)	0.22	10.42 (5.18, 15.67)	0.22	70.62 (62.71, 78.54)	0.04
Proper weight	50.11 (44.79, 55.44)		13.89 (10.51, 17.27)		75.88 (71.21, 80.55)	
Overweight	42.57 (34.87, 50.27)		11.13 (6.81, 15.45)		62.17 (54.26, 70.09)	
Obese	56.95 (46.74, 67.16)		17.09 (9.19, 24.99)		74.86 (65.50 ,84.22)	
Extremely Obese	42.45 (26.41, 58.48)		5.45 (0.66, 10.25)		69.55 (54.31, 84.79)	
Poverty LVL <100%	42.37 (37.30, 47.45)	0.025	13.54 (10.16, 16.92)	0.04	69.77 (64.99, 74.54)	0.08
Poverty LVL >=100%	48.99 (45.92, 52.05)		9.88 (8.30, 11.47)		74.71 (72.07, 77.36)	
Mom EDUC <=HS	42.84 (38.28, 47.39)	0.006	12.41 (9.67, 15.14)	0.17	69.03 (65.13, 72.94)	0.007
Mom EDUC >HS	50.66 (47.29, 54.04)		10.03 (8.15, 11.90)		75.92 (72.93, 78.91)	
Insurance	47.68 (45.00, 50.35)	0.015	11.06 (9.55, 12.57)	0.44	73.82 (71.58, 76.07)	0.03
No Insurance	34.96 (25.28, 44.64)		8.64 (3.26, 14.02)		63.48 (53.51, 73.45)	

Asthma Education Variables (cont.)

Demographic Characteristics	% Parents taught to respond to asthma episode	P-value	% Parents taught how to monitor peak flow	P-value	% had Doctor recommend changes in home	P-value
Male	79.66 (76.92, 82.40)	0.44	49.49 (46.27, 52.72)	0.68	50.21 (46.84, 53.59)	0.69
Female	77.99 (74.76, 81.21)		48.43 (44.63, 52.22)		49.12 (44.99, 53.24)	
Non-Hispanic White	79.61 (76.84, 82.37)	0.39	46.92 (43.06, 50.79)	0.001	50.40 (46.56, 54.25)	0.12
Non-Hispanic Black	80.32 (76.02, 84.62)		57.53 (52.51, 62.55)		53.84 (48.79, 58.90)	
Non-Hispanic Other	80.94 (74.49, 87.40)		40.55 (33.29, 47.81)		46.19 (37.73, 54.65)	
Hispanic	75.67 (70.77, 80.57)		48.25 (42.78, 53.72)		45.32 (40.04, 50.60)	
less than 5 years old	81.06 (76.14, 85.99)	0.51	43.57 (37.38, 49.77)	0.17	51.14 (45.05, 57.23)	0.63
5 to 11 years old	79.37 (76.42, 82.33)		50.34 (46.60, 54.08)		50.61 (46.61, 54.60)	
12 to 17 years old	77.70 (74.34, 81.05)		49.70 (45.90, 53.50)		48.26 (44.33, 52.20)	
Northeast	84.43 (80.59, 88.28)	0.059	50.41 (45.52, 55.29)	0.002	50.05 (45.02, 55.07)	0.28
Midwest	78.45 (74.51, 82.38)		43.66 (38.74, 48.58)		46.41 (40.48, 52.82)	
South	78.36 (74.64, 82.08)		53.81 (49.54, 58.09)		52.45 (48.08, 56.82)	
West	75.89 (71.31, 80.47)		44.36 (39.29, 49.43)		47.73 (42.59, 52.87)	
Underweight	77.89 (70.62, 85.15)	0.056	52.19 (43.48, 60.56)	0.18	55.58 (47.63, 63.54)	0.20
Proper weight	81.70 (77.30, 86.10)		48.10 (43.01, 53.19)		46.71 (41.41, 52.01)	
Overweight	70.12 (62.42, 77.82)		43.58 (35.56, 51.60)		48.56 (40.37, 56.75)	
Obese	75.53 (66.22, 84.84)		60.31 (49.92, 70.69)		58.29 (48.01, 68.57)	
Extremely Obese	71.48 (56.12, 86.84)		49.90 (33.57, 66.23)		53.51 (36.74, 70.28)	
Poverty LVL <100%	75.66 (71.34, 79.97)	0.07	47.61 (42.62, 52.60)	0.54	50.24 (44.99, 55.48)	0.93
Poverty LVL >=100%	80.14 (77.68, 82.59)		49.35 (46.56, 52.14)		49.98 (46.98, 52.99)	
Mom EDUC <=HS	75.81 (72.18, 79.45)	0.02	48.28 (44.11, 52.44)	0.55	46.19 (41.79, 50.60)	0.026
Mom EDUC >HS	81.14 (78.35, 83.93)		49.93 (46.56, 53.31)		52.45 (49.08, 55.82)	
Insurance	79.50 (77.41, 81.58)	0.02	49.75 (47.26, 52.25)	0.006	50.33 (47.65, 53.01)	0.03
No Insurance	69.24 (59.30, 79.18)		35.80 (26.46, 45.14)		39.62 (30.29, 48.95)	

Table 7 is a two-way frequency table of asthma education variables stratified by demographic characteristics variables and includes confidence intervals of 95% (alpha = 0.05) as well as p-values for each demographic characteristic variable.

4.8 Demographic Characteristics and General Inquiries Variables

Table 8:

General Inquiries

Demographic Characteristics	% Limit ability to crawl/walk/ run/play?	P-value	% Needs Special equipment for health problem	P-value	% Seen/talked to general doctor past 12 mo.	P-value	% who had well child checkup	P-Value
Male	5.59 (4.13, 7.06)	0.29	2.32 (1.47, 3.17)	0.68	87.91 (86.25, 89.57)	0.23	83.63 (81.73, 85.53)	0.75
Female	6.75 (5.23, 8.28)		2.59 (1.56, 3.61)		89.43 (87.58, 91.29)		84.18 (81.52, 86.83)	
Non-Hispanic White	7.19 (5.49, 8.90)	0.026	2.52 (1.58, 3.45)	0.6	90.26 (88.57, 91.94)	0.071	81.91 (79.46, 84.37)	0.004
Non-Hispanic Black	4.13 (2.25, 6.02)		2.73 (0.92, 4.54)		87.16 (84.11, 90.20)		89.02 (86.54, 91.50)	
Non-Hispanic Other	8.33 (4.46, 12.20)		3.24 (0.44, 6.04)		87.73 (83.15, 92.31)		84.63 (79.71, 89.55)	
Hispanic	4.65 (3.09, 6.22)		1.65 (0.84, 2.46)		86.27 (83.52, 89.03)		82.65 (79.14, 86.16)	
less than 5 years old	7.37 (3.37, 11.38)	0.49	5.84 (2.72, 8.97)	0.0002	94.04 (91.63, 96.44)	0.002	92.46 (89.78, 95.14)	<0.001
5 to 11 years old	5.36 (3.86, 6.85)		2.08 (1.15, 3.00)		88.14 (86.15, 90.14)		84.23 (81.85, 86.61)	
12 to 17 years old	6.38 (4.90, 7.85)		1.78 (1.12, 2.44)		87.33 (85.46, 89.20)		81.03 (78.61, 83.39)	
Northeast	6.03 (3.53, 8.53)	0.86	3.08 (1.30, 4.87)	0.31	92.41 (90.02, 94.80)	0.006	91.70 (89.20, 94.21)	<0.001
Midwest	6.74 (4.00, 9.48)		1.62 (0.66, 2.58)		89.66 (87.18, 92.14)		82.20 (78.50, 85.90)	
South	6.12 (4.50, 7.73)		2.87 (1.61, 4.12)		87.72 (85.73, 89.70)		82.70 (80.18, 85.23)	
West	5.33 (3.43, 7.23)		1.88 (0.78, 2.98)		85.71 (82.57, 88.84)		81.16 (78.10, 84.23)	
Underweight	5.83 (2.19, 9.48)	0.066	2.29 (0.41, 4.18)	0.54	89.40 (84.50, 94.30)	0.61	85.70 (80.66, 90.75)	0.54
Proper weight	6.22 (3.71, 8.73)		1.40 (0.61, 2.19)		88.24 (85.70, 90.78)		82.24 (78.82, 85.66)	
Overweight	5.49 (3.04, 7.93)		1.82 (0.30, 3.33)		84.85 (79.96, 89.74)		81.93 (76.94, 86.92)	
Obese	9.78 (4.06, 15.49)		2.26 (0.00, 5.11)		85.66 (78.91, 92.40)		79.99 (72.53, 87.45)	
Extremely Obese	15.94 (7.14, 24.73)		3.93 (0.33, 7.53)		86.90 (79.04, 94.76)		76.74 (67.25, 86.24)	
Poverty LVL <100%	8.55 (5.61, 11.49)	0.035	4.15 (2.16, 6.15)	0.003	86.66 (83.99, 89.33)	0.13	84.62 (81.68, 87.56)	0.64
Poverty LVL >=100%	5.55 (4.40, 6.70)		1.80 (1.20, 2.41)		89.00 (87.49, 90.51)		83.82 (81.97, 85.66)	
Mom EDUC <=HS	7.61 (5.50, 9.72)	0.7	2.93 (1.48, 4.39)	0.23	85.07 (82.58, 87.56)	<0.001	79.57 (76.65, 82.50)	<0.001
Mom EDUC >HS	5.39 (4.04, 6.74)		2.02 (1.31, 2.73)		91.46 (90.07, 92.85)		87.06 (85.11, 89.00)	
Insurance	6.19 (5.09, 7.29)	0.39	2.56 (1.85, 3.27)	0.01	89.73 (88.50, 90.97)	<0.001	85.18 (83.64, 86.73)	<0.001
No Insurance	4.50 (1.00, 8.01)		0.49 (0.00, 1.18)		71.45 (63.99, 78.91)		63.65 (55.73, 71.57)	

General Inquiries (cont.)

Demographic Characteristics	% Seen/talked to specialist past 12 mo.	P-value	% Received Flu shot past 12 mo.	P-value	% Missed School\ Work because of Asthma past 12 mo.	P-value
Male	23.57 (21.31, 25.83)	0.33	47.30 (44.56, 50.04)	0.46	50.61 (46.86, 54.36)	0.41
Female	21.85 (19.17, 24.54)		48.78 (45.73, 51.83)		48.14 (43.86, 52.42)	
Non-Hispanic White	26.88 (24.29, 29.48)	<0.001	45.70 (42.68, 48.72)	0.01	44.38 (40.20, 48.55)	<0.001
Non-Hispanic Black	20.97 (17.14, 24.81)		47.30 (42.92, 51.67)		58.13 (52.15, 64.10)	
Non-Hispanic Other	19.03 (13.76, 24.30)		57.88 (51.05, 64.72)		40.82 (33.07, 48.56)	
Hispanic	17.97 (14.68, 21.27)		48.13 (44.04, 52.22)		55.40 (49.62, 61.18)	
less than 5 years old	28.56 (23.26, 33.86)	0.04	56.22 (50.31, 62.14)	0.001	49.92 (42.65, 57.18)	0.028
5 to 11 years old	22.22 (19.57, 24.87)		49.22 (46.11, 52.34)		53.30 (49.30, 57.29)	
12 to 17 years old	21.84 (19.47, 24.21)		44.26 (41.06, 47.46)		45.27 (40.88, 49.66)	
Northeast	23.69 (20.02, 27.37)	0.07	54.93 (50.00, 59.86)	0.026	52.23 (44.87, 59.59)	0.037
Midwest	24.51 (20.84, 28.17)		46.24 (41.48, 50.99)		42.05 (36.46, 47.63)	
South	23.92 (20.99, 26.85)		46.58 (43.41, 49.75)		52.56 (48.28, 56.85)	
West	18.46 (14.83, 22.09)		46.32 (41.73, 50.90)		49.34 (43.52, 55.16)	
Underweight	25.11 (18.91, 31.31)	0.063	42.20 (34.85, 49.55)	0.62	42.88 (34.21, 51.55)	0.008
Proper weight	22.09 (18.97, 25.21)		44.05 (39.81, 48.28)		40.58 (35.16, 46.01)	
Overweight	16.68 (12.23, 21.14)		39.51 (33.03, 45.99)		45.72 (37.51, 53.92)	
Obese	29.26 (20.18, 38.35)		48.25 (38.65, 57.84)		51.87 (42.11, 61.45)	
Extremely Obese	25.05 (14.49, 35.62)		43.21 (30.36, 56.06)		68.11 (53.10, 83.12)	
Poverty LVL <100%	17.75 (14.30, 21.20)	<0.001	47.00 (42.53, 51.46)	0.47	51.27 (45.98, 56.56)	0.48
Poverty LVL >=100%	24.88 (22.77, 26.98)		48.85 (46.39, 51.31)		49.08 (45.83, 52.32)	
Mom EDUC <=HS	17.36 (14.62, 20.09)	<0.001	44.43 (40.98, 47.88)	0.029	51.62 (46.81, 56.44)	0.26
Mom EDUC >HS	26.49 (24.16, 28.83)		49.32 (46.55, 52.08)		48.23 (44.75, 51.70)	
Insurance	23.79 (21.97, 25.60)	<0.001	49.11 (46.93, 51.29)	<0.001	49.16 (46.33, 51.99)	0.22
No Insurance	9.23 (4.11, 14.36)		29.54 (22.36, 36.73)		56.94 (45.09, 68.78)	

Table 8 is a two-way frequency table of the general inquiries variables stratified by demographic characteristics. Confidence intervals of 95% (alpha = 0.05) as well as p-values for each demographic variable are included.

CHAPTER V: DISCUSSION AND CONCLUSION

The objective of this study was to examine the prevalence of asthma education and medication use to asthma severity outcomes and identify any significant correlations between sociodemographic and socioeconomic characteristics when run against asthma outcomes, medication use, asthma education and general inquiries.

Demographic Characteristics of Study Participants (Table 1)

Table 1 shows a frequency distribution of the NHIS study sample by demographic characteristics, including a univariate analysis of the demographic characteristics variables by asthma status (Y/N). Examining the distribution of asthma prevalence by demographic characteristic provides insight into which population factors are the most likely to be associated with higher rates of asthma. Of the participants who met the study inclusion criteria, 86.6% (25,913) did not have asthma; however, 13.4% (3,998) indicated they had received a diagnosis of asthma by a clinician at some prior point. According to the CDC, asthma prevalence in children 18 years of age or younger was 7.5% in 2018, so the NHIS sample in this study was significantly higher regarding asthma prevalence. This was also seen in a breakout of asthma prevalence by sex, where 15.3% of the boys in the NHIS sample and 11.3% of the girls had been diagnosed with asthma, compared to the 2018 CDC estimate of 8.3% and 6.7%, respectively.

Non-Hispanic Blacks had the highest asthma rate of any race/ethnicity (20.5%), followed by Hispanic (12.7%), Non-Hispanic Other (12.6%), and Non-Hispanic White (11.7%).

The age group with the highest asthma rate was the 12 to 17 year old group (17.6%), followed by the 5 to 11 year old group (14.8%) and the less than 5 year old group (5.9%).

The region with the highest asthma rate was the Northeast (15.1%), followed by the South (14.3%), the Midwest (12.4%) and the West (11.8%).

An analysis of the BMI variable indicated that extreme obesity had the highest rate of asthma (36.1%), followed by obese (25.3%), overweight (22.3%), proper weight (16.4%), and finally underweight (14.1%).

Respondents with a poverty level less than 100% had the highest asthma rate (16.6%), compared to respondents with a poverty level greater than 100% (12.7%).

Children of mothers with a high school diploma or less had an equivalent asthma rate to children of mothers with more than a high school education. (13.4% and 13.0%, respectively).

Insurance status appeared to show an inverse relationship to asthma rates, as the rate of asthma in respondents with no insurance was lower than the rate of those with insurance (11.1% and 13.6%, respectively).

Asthma Condition (Severity) and Medication use (Table 2)

The frequency of each asthma condition (severity) variable stratified by medication use variables indicates that children with more severe asthma had higher rates of medication use. For example, children who spent the night in the ER due to an asthma attack had an overall 91.49% (80.92, 100.0) response rate for having taken their medication daily or almost daily, whereas children who indicated they only had asthma symptoms had a response rate of 78.57% (75.59, 81.55). Children with severe asthma outcomes had a response rate for taking prescription medication in the past 3 months of 63.80% (52.62, 74.98), whereas children who were diagnosed with asthma had a response rate 37.28% (35.39, 39.16). For quick relief, children diagnosed with asthma had a rate of 67.78% (65.31, 70.26). Children with asthma outcomes that require an overnight stay in the hospital had a rate of 83.34% (73.10, 93.58). 31.35% (18.50, 44.64) of the children with severe asthma outcomes responded positively to using three or more canisters of asthma medication in the past three months, while children who merely exhibit asthma symptoms had a rate of 13.50% (11.60, 15.41). Of note, children with a more severe case of asthma tended to have higher rates of medication use than children with mild asthma. Across all four medication use variables, the data show that as asthma severity increased, so did the rates of medication use.

Asthma Condition (Severity) and Asthma Education (Table 3)

Asthma condition (severity) variables were stratified by asthma education variables to assess whether asthma education was associated with a reduction in the severity of asthma. Children with severe asthma outcomes that required a visit to the ER had higher response rates for the education variables of interest. Children with mild asthma symptoms had a response rate of 52.42% (48.95, 55.90) for having an asthma action plan, whereas children with severe symptoms that required an overnight stay at a hospital had a response rate of 60.85% (49.17, 72.53). Children with severe asthma who had to spend a night at the ER showed higher rates of having taken an asthma management class [24.37% (14.59, 34.16)] while children with mild asthma who only had an asthma attack in the past 12 months [12.24% (10.23, 14.25)]. Of the children with severe asthma, 84.57% (75.75, 93.39) responded positively to having a parent who was taught to recognize an asthma episode, while children with mild asthma had a rate of 77.61% (74.96, 80.26). Of the children who had severe asthma, 88.65% (81.46, 95.84) responded positively to having a parent who was taught to respond to an asthma episode, whereas children with mild asthma symptoms had a response rate of 84.08% (81.68, 86.47). Of the children with mild asthma, 52.06% (48.97, 55.14) indicated that their parents were taught how to monitor peak flow tests, whereas children with severe asthma indicated 71.87% (62.11, 81.63) of their parents had been taught to how to monitor peak flow tests. Of the children with mild asthma, 54.14% (50.78, 57.51) indicated that a doctor had recommended changes in their home to reduce asthma triggers, while 71.08% (61.68, 80.48) of the children with severe asthma outcomes indicated that a doctor had recommended changes. The data appear to show a positive relationship between asthma severity, medication use and asthma education. As asthma severity increases, so do the rates of medication use and asthma education. This is possibly due to the limitations of a cross-sectional study, which cannot measure changes in outcomes (asthma severity) over time due to the introduction of an intervention (medication use and asthma education). Cross-sectional studies are limited to a single point in time rather than a chronological sequence of events involving interventions and outcomes.

Asthma Condition (Severity) and General Inquiries (Table 4)

Table 4 is a two-way frequency table of asthma condition (severity) variables and the general inquiry variables. The seven general inquiry variables were stratified against the asthma condition (severity) variables. The analysis indicated that children with severe asthma outcomes (ER overnight past 12 mo.) were the most likely to have a limited ability to walk/run/play [13.92% (6.17, 21.66)], whereas children with mild persistent asthma outcomes (asthma attack past 12 mo.) had a response rate of 11.52% (9.10, 13.95). Children with severe asthma outcomes had a 4.68% (0.00, 9.79) response rate for requiring special equipment for their health needs, whereas children with mild persistent asthma had a response rate of 3.75% (2.35, 5.16). Of the children with severe asthma, 95.55% (92.50, 98.59) indicated they saw a general physician during the past 12 months, while children with mild persistent asthma had a response rate of 91.80% (90.04, 93.55). Of the children with severe asthma, 36.92% (24.87, 48.97) indicated they saw a specialist during the past 12 months, while children with mild persistent asthma had a rate of 28.97% (25.93, 32.01). Of the children with severe asthma, 84.33% (76.81, 91.85) indicated they had a checkup in the past 12 months, whereas children with mild asthma outcomes had a response rate of 86.71% (84.38, 89.04). Of the children with severe asthma, 54.18% (42.52, 65.83) indicated they had received a flu vaccination in the past 12 months compared to children with mild persistent asthma, who exhibited a rate of 52.09% (48.75, 55.43). Individuals with moderate asthma who had an ER visit had the highest influenza immunization rate of 59.62% (54.46, 64.78), whereas respondents indicating an overnight stay in the ER (a severe outcome) had a lower rate at 54.18% (42.52, 65.83). Respondents reporting only mild asthma indicated an influenza immunization rate of 52.09% (48.75, 55.43). The differing rates seen between asthma severity and receipt of an influenza immunization are not significant, since the confidence intervals overlap. Finally, of the children with severe asthma, 82.51% (73.15, 91.88) indicated they missed school and/or workdays because of their asthma, while children with mild persistent asthma had a response rate of 56.84% (53.38, 60.30).

Five of the seven general inquiry variables showed a liner increase in prevalence rates as the asthma severity level increased. The two exceptions were seen with the ‘limited ability to crawl/walk/run/play’ against ‘ER Visit’ rate and the ‘Received a flu shot in the past 12 months’ against ‘ER overnight’ rate.

Demographic Characteristics and Symptomatic Variables Analysis (Table 5)

There were a number of demographic characteristic variables that appeared to be good indictors for asthma severity. All p-values less than 0.05 were highlighted in green in the table. The two-way frequency table was conducted to determine the relationship between grouped demographic characteristics (sex; race/ethnicity; age; region; BMI/weight; poverty level; mother’s education; and insurance status) and the four symptomatic variables (asthma severity outcomes).

The income to poverty ratio appeared to be an excellent indicator of asthma severity across all symptomatic variables among these children. Children with asthma who came from families whose poverty levels were less than 100% indicated higher rates of asthma severity compared to their peers coming from families with poverty levels of 100% or more. Children with mild asthma (‘asthma symptoms’ variable) were more likely to respond with ‘yes’ if they came from families with a poverty level less than 100% (70.78% [66.77, 74.79]), while children coming from families with poverty levels greater than or equal to 100% had a response rate of 65.57% (63.37, 67.78) (p-value: 0.03). This trend continued for every incremental level of asthma severity. Asthma attacks for respondent from families with a poverty level less than 100% had a rate of 43.02% (38.60, 47.44), while respondents from families with a poverty level greater than or equal to 100% had a rate of 37.65% (35.22, 40.08). Children from families with a poverty level less than 100% were more likely to be sent to the ER than children from families with a poverty level greater than or equal to 100% (21.33% (17.77, 24.90) and 15.74% (13.86, 17.63) (p-value: 0.004) respectively) . Finally, children from families with a poverty level less than 100% were 2 times as likely to indicate an overnight stay in the ER as children from families with a poverty level greater than or equal to 100% (6.92 (4.51, 9.33) and 3.98% (2.69, 5.27) (p-value: 0.02) respectively). The income to poverty ratio for asthma severity proved to be an excellent predictor for asthma outcomes. It makes sense that children from lower income families who potentially live in areas with lower standards of living, higher levels of pollution and allergens, and who are unable to afford medications to alleviate their asthma symptoms have worse asthma outcomes.

The race/ethnicity demographic appears to show that non-Hispanic Black children are more likely to have asthma symptoms (response rate 75.55% (71.82, 79.29)) when compared to their non-Hispanic White (65.34% (62.56, 68.13)), non-Hispanic Other (63.47% (57.27, 69.68)) and Hispanic children (63.13% (59.10, 67.16)). With the exception of the symptomatic variable 'reported asthma attacks in past 12 months' (p-value: 0.15), the observation of non-Hispanic Black children having higher rates of reported asthma outcomes continued with the outcome variables 'being sent to the ER' and 'staying overnight in the ER'. The race/ethnicity response rates for being sent to the ER were as follows: Non-Hispanic Black children, 27.26% (22.83, 31.69); Hispanic children, 20.07% (16.60, 23.54); non-Hispanic Other, 15.37% (10.20, 20.53); and non-Hispanic White children, 11.75% (9.70, 13.81) (p-value: <0.001). The non-Hispanic Black children response rate for having had an overnight stay in the ER due to asthma was nearly 2.5 times the rate of non-Hispanic White children (8.27% (5.14, 11.40) and 3.32% (1.74, 4.90), respectively).

Across all symptomatic variables (measures of asthma severity), the response rate for the youngest age group (less than 5 years old) was noticeably higher than that of the other two age groups of older children. One possible explanation is that younger children simply have not yet learned to manage their asthma symptoms very well; older children and teenagers have more experience on asthma management and know how and when to use their medication, resulting in fewer severe asthma episodes requiring medical attention. Also, it is likely that families monitor the health of younger children more closely, resulting in strong recall bias and more frequent healthcare utilization. There is also the possibility that older children underreport their asthma symptoms to reaffirm a self-belief that they have 'grown out' of their asthma because they experience less frequent symptoms as they grow older. According to the literature, this is a false belief, as asthma is considered a lifelong diagnosis.

It appears that the younger the child is, the higher the prevalence rate for asthma outcomes. This trend was observed for every level of asthma severity.

The following response rates by age group and 'having an asthma attack in the past 12 months' were observed: children less than 5, 54.33% (48.82, 59.85); children 5 to 11, 43.29% (40.05, 46.53); and children 12 to 17, 30.34% (27.68, 33.00) (p-value: <0.001).

Children aged 12 to 17 had a rate of being sent to the ER of 8.27% (6.65, 9.89), while children aged less than 5 had a rate of 36.08% (30.47, 41.69) which was 4 times higher.

Finally, for the most severe asthma outcome where children stayed overnight in the ER, the 12 to 17 age group had a rate of 2.01% (0.86, 3.15), while the less than 5 had a rate of 14.24% (9.27, 19.20). (p-value: <0.001).

The following were found to be statistically significant with only one of the four asthma symptom (outcome) variables. Children who had insurance were more likely to report asthma symptoms than children who did not have insurance (67.22% (65.31, 69.13) and 57.13% (48.78, 65.49) (p-value: 0.02), respectively). Additionally, children whose mother's education was limited to high school or less had a higher prevalence rate for staying overnight in the ER due to asthma than those whose mother's education was greater than high school (7.80% (5.33, 10.27) and 4.04% (2.48, 5.60) (p-value: 0.006), respectively).

Demographic Characteristics and Medication use Analysis (Table 6)

The two-way frequency table shows the relationship between demographic characteristics and medication use variables revealed several significant associations. With the variable race/ethnicity, the highest rate for taking prescription medication in the past 3 months was non-Hispanic White children (42.96% (40.02, 45.90), followed by non-Hispanic Black children (34.14% (30.00, 38.28), Hispanic children 31.41% (27.76, 35.06); and finally non-Hispanic Other 30.68% (25.07, 36.30) (p-value: <0.001). From these results, it's reasonable to assume that Non-Hispanic White children are more likely to have access to medication and to use it. However, when it came to utilizing three or more asthma medication canisters in a three-month period, Hispanics had the highest prevalence rates with 19.71% (14.67, 24.75), whereas the rate for non-Hispanic White children was half the rate of their Hispanic counterparts at 10.14% (7.62, 12.65) (p-value: 0.001). This indicates that Hispanic children were more likely to use three or more canisters of prescription asthma medication within a three-month span of time.

With respect to medication use levels of the differing age groups, the data indicate that 5 to 11 year-olds were more likely to have taken their medication in the past three months (40.14% (37.05, 43.24)), than the less than 5 age group (36.92% (31.14, 42.71)) and the 12 to 17) age group (34.65% (31.86, 37.43) (p-value: 0.045)). Not only were teens the least likely to use prescription medication during the past 3 months, but they were also the least likely to use three or more canisters of asthma medication in a three-month period

(10.19% (7.69, 12.70) (p-value: 0.02)). This again could partly be a consequence of the perception teens may harbor that they are ‘growing out’ of asthma, because their asthma symptoms are less frequent and less severe as they age.

Body mass index showed a consistent trend, as BMI levels went up, so too did the prevalence rate of respondents who answered ‘yes’ to the question of having taken RX medication in the past three months. The prevalence rate for medication use in the past three months was the highest for extremely obese children (59.22% (46.90, 71.54)), while the prevalence rate children with normal weight was nearly half that at 33.75% (29.97, 37.53); (p-value: 0.005). Overweight and extremely obese individuals were more likely to take their asthma medication daily (85.39% (80.18, 90.60) and 88.66% (79.44, 97.88) respectively); underweight children had a prevalence rate of 74.31% (63.04, 85.58) (p-value: 0.047). Obese children had the highest prevalence rate for using 3 or more canisters in the past 3 months at 20.05% (12.28, 27.82). This rate was twice as high as the second highest rate which was the proper (normal) weight (11.22% (8.16, 14.27) (p-value: 0.002)).

Children with insurance were more likely to have taken their prescription medication in the past 3 months than uninsured children (38.09 (36.05, 4013) and 25.16 (18.02, 32.29) (p-value 0.002), respectively).

Other studies have shown similar trends in asthma outcomes and medication use. According to a study (Bloomberg et al. 2009), where researchers examined multi-role factors contributing to asthma outcomes, they noted that despite substantial use of daily controller medication, children still experienced poor asthma outcomes and reduced quality of life. A review of the recommended guidelines on controller medication and the level of asthma control indicated that patients needed to be ‘stepped up’ in their use of medication, which points to possible clinician error in diagnosing asthma severity and prescribing the appropriate medication regimen. The researchers went on to state that while Medicaid and family structure were significant predictors associated with poorly controlled asthma, more emphasis should be placed on the importance of medication use and other quality of life indicators in reducing morbidity among children with asthma.[59] [17]

Demographic Characteristics and Asthma Education Analysis (Table 7)

The two-way frequency table shows the relationship between demographic characteristics and asthma education variables revealed several significant associations. Three modes of asthma education were compared against the demographic characteristics of the respondents to determine whether there were quantifiable differences in the manner of promoting better asthma management. This type of analysis could help identify demographic groups who would benefit most from distinct kinds of asthma education. It can also help identify the type of asthma education that results in the best response rates. It is also important for identifying which groups of people need more education to better manage their asthma. Education can provide some of the most cost effective methods for increasing the knowledge of an illness and how to effectively manage it.

The response rates to the education variable ‘having been given an asthma action plan’ were compared by race/ethnicity. Based on the analysis, non-Hispanic Black children were the most likely to respond with having gotten an asthma action plan (54.14% (48.77, 59.52)). Non-Hispanic White children were next with a response rate of 45.82% (42.03, 49.62) closely followed by Hispanic children, with a response rate of 44.53% (39.33, 49.74). Finally, Non-Hispanic Other children had a rate of 40.69% (32.91, 48.47) (p-value: 0.01).

Race/ethnicity also appeared to be a factor with respect to the education variable ‘having taken a course on asthma management’. Again, non-Hispanic Black children were more likely to have taken an asthma management course (15.69% (11.98, 19.40)), followed by Hispanic children (13.92% (10.76, 17.07)). Non-Hispanic White children and Non-Hispanic Other children had rates of 8.11% (6.11, 10.11) and 7.13% (2.76, 11.50) (p-value: 0.0002), respectively. Finally, Non-Hispanic Black children demonstrated higher prevalence rates for the asthma education variable of 'parents being taught to monitor peak flow', with a response rate of 57.53% (52.51, 62.55). This was followed by Hispanic children with a rate of 48.25% (42.78, 53.72), Non-Hispanic White children with a rate of 46.92% (43.06, 50.79) and finally Non-Hispanic Other with a rate of 40.55% (33.29, 47.81) (p-value: 0.001).

Income to poverty ratio showed that children coming from families with a poverty ratio higher than 100% were more likely to have an asthma action plan (48.99% (45.92, 52.05)) than children from families with ratios lower than 100% (42.37% (37.30, 47.45)) (p-value: 0.025). Interestingly, children with income to poverty ratios less than 100% were more likely to have taken an asthma management course than children with poverty ratios greater than or equal to 100% (13.54% (10.16, 16.92) and 9.88% (8.30, 11.47), respectively.) (p-value: 0.04).

A mother's educational level appeared highly correlated for asthma education variables with four being statistically significant. Children whose mother's education was greater than high school were more likely to be given an asthma action plan than children whose mother's education was less than or equal to high school (50.66% (47.29, 54.04) and 42.84% (38.28, 47.39), respectively.) (p-value: 0.006). Mother's educational level was also significantly associated with the variable on 'having been taught to recognize an asthma episode'. Mothers with an educational level greater than high school had a higher response rate than mothers with an educational level less than or equal to high school (75.92% (72.93, 78.91) and 69.03% (65.13, 72.94), respectively (p-value: 0.007)). This trend was also evident with the ‘parents taught to respond to asthma episode’, in which mothers who had greater than a high school education had a response rate of 81.14% (78.35, 83.93) compared to mothers who were limited to a high school education or less (75.81% (72.18, 79.45) (p-value: 0.02)). Finally, mothers with an education greater than high school were more likely to have been told by a doctor to make changes in the home (52.45% (49.08, 55.82) than mothers with a high school education or lower (46.19% (41.79, 50.60) (p-value: 0.026). This may indicate that doctors feel more comfortable making recommendations on changes to the home environment with mothers possessing higher educational levels. Conversely, mothers with higher education levels might be more prone to engage with doctors and ask questions than mothers limited to a high school education.

Insurance status appeared to be a good predictor of positive responses to the asthma education variables. Children covered by insurance had a much higher response rate for having been given asthma action plans than children not covered by insurance (47.68% (45.00, 50.35) and 34.96% (25.28, 44.64) (p-value: 0.015), respectively). This is a difference of nearly 15% between the two categories of insurance status. This trend continued for the ‘parents taught to recognize asthma episodes’ where children covered by insurance had a response rate of 73.82% (71.58, 76.07), while children with no insurance had a rate of 63.48% (53.51, 73.45) (p-value: 0.03). Additionally, respondents with insurance had a 10% higher rate for the education variable ‘parents taught to recognize an asthma episode’ than their non-insured peers (79.50% (77.41, 81.58) and 69.24% (59.30, 79.18) (p-value: 0.03), respectively). The response rates for the variable ‘parents taught to monitor peak flow’ was again higher for children with insurance than for children without insurance (49.75% (47.26, 52.25) and 35.80% (26.46, 45.14) (p-value: 0.006), respectively). Finally, insurance coverage status also appeared to be correlated for having a doctor who recommends changes at home for asthma. Children with insurance had a response rate of 50.33% (47.65, 53.01) while children without insurance had a rate of 39.62% (30.29, 48.95) (p-value: 0.05).

Demographic Characteristics and General Inquiries Analysis (Table 8)

Race/ethnicity appeared to be significantly associated with five of the seven general inquiry variables. The Non-Hispanic Black children response rate to having had a well-child checkup was 89.02% (86.54, 91.50). This was followed by the Non-Hispanic Other group with a rate of 84.63% (79.71, 89.55). The Hispanic group had a rate of 82.65% (79.14, 86.16), while the Non-Hispanic White children group had the lowest rate with 81.91% (79.46, 84.37) (p-value: 0.004).

Differences by race/ethnicity were particularly evident when examining the response rates for having visited a specialist in the past 12 months. Here, Non-Hispanic White children had the highest rate (26.88% (24.29, 29.48)), followed by Non-Hispanic Black children (20.97% (17.14, 24.81)). Non-Hispanic Other had a rate of 19.03% (13.76, 24.30), and finally Hispanic children had a rate of 17.97% (14.68, 21.27) (p-value:<0.001). This may indicate that Non-Hispanic White children enjoy greater access to specialists or have access due to insurance coverage. The racial/ethnic prevalence rates for having received an influenza shot in the past 12 months were as follows: Non-Hispanic Other had the highest rate (57.88% (51.05, 64.72), followed by Hispanic (48.13% (44.04, 52.22)), Non-Hispanic Black 47.30% (42.92, 51.67) and Non-Hispanic White (45.70% (42.68, 48.72), (p-value: 0.01). Raising awareness of the importance for children with asthma to get vaccinated for influenza could help increase this response rate in future surveys.

For children who missed school or work due to asthma, non-Hispanic Black children tended to have the highest rates with 58.13% (52.15, 64.10). Hispanic children followed close behind with a rate of 55.40% (49.62, 61.18). Non-Hispanic White children had a rate of 44.38% (40.20, 48.55) and non-Hispanic Other children had a rate of 40.82% (33.07, 48.56) (p-value: <0.001). It has been previously established in the published literature that non-Hispanic Black children tend to have worse asthma outcomes than any other racial/ethnic group and this information shows that these children are more likely to have missed days of school due to their asthma severity.

Children age less than 5 were nearly three times more likely to have needed special equipment for a health problem than the other two age groups. Their response rate was 5.84% (2.72, 8.97), whereas children aged 5 to 11 had a rate of 2.08% (1.15, 3.00) and children aged 12 to 17 had a response rate of 1.78% (1.12, 2.44) (p-value: 0.0002). Children age less than 5 were also more likely to have seen or talked to a general doctor in the past 12 months than the other two age groups (94.04% (91.63, 96.44) compared to 88.14% (86.15, 90.14) for 5 to 11 and 87.33% (85.46, 89.20) for 12 to 17, respectively) (p-value: 0.002). This is likely due to parents visiting their child's doctor more frequently during the infant years when asthma symptoms begin to manifest, and a diagnosis is sought. This same trend is observed with the variable on well-child checkups. Children aged less than 5 had a prevalence rate of 92.46% (89.78, 95.14) for having had a well-child checkup compared to teens aged 12 to 17 (81.03% (78.61, 83.39), (p-value: <0.001). The lower the child's age, the more likely they would go to see a medical specialist. Children aged less than 5 had a prevalence rate of 28.56% (23.26, 33.86) for seeing a specialist, while teens aged 12 to 17 had a rate of 21.84% (19.47, 24.21) (p-value: 0.04). With respect to having received an influenza vaccination, children aged less than 5 were more likely to have gotten immunized for influenza (56.22% (50.31, 62.14)) compared to teens aged 12 to 17 (44.26% (41.06, 47.46)), (p-value: 0.001). Finally, children aged 5 to 11 were the most likely to have missed school due to asthma with a response rate of 53.30% (49.30, 57.29) (p-value: 0.028).

Insurance status continued to be an excellent predictor for use of medical services. Children with insurance (public or private) had a higher response rate for the health care services factors in the general inquiry variables. Children with insurance were 5 times more likely to respond that special equipment was needed for a health problem than children who were not covered by insurance (2.56% (1.85, 3.27) and 0.49% (0.00, 1.18), respectively.) (p-value: 0.01). This trend continued for children with asthma who visited a physician. Children who were covered had a prevalence rate of 89.73% (88.50, 90.97) while children with asthma without any insurance had a prevalence rate of 71.45% (63.99, 78.91) (p-value: <0.001). Children with asthma who had a well-child checkup had a response rate of 85.18% (83.64, 86.73) while children who did not have any insurance had a rate of 63.65% (55.73, 71.57) (p-value: <0.001). Furthermore, children with insurance, were 2.5 times more likely to have seen a specialist than those without insurance, (23.79% (21.97, 25.60) and 9.23% (4.11, 14.36), respectively). Children with insurance were 66% more likely to respond 'yes' to influenza vaccinations as opposed to uninsured children (49.11% (46.93, 51.29) and 29.54% (22.36, 36.73), respectively).

Poverty level was a moderate predictor for health care use for children. Children from families with income to poverty ratios greater or equal to 100% were less likely to respond that they had physical limitations due to their asthma than children from families with income to poverty ratios less than 100% (5.55% (4.40, 6.70) and 8.55% (5.61, 11.49), respectively.) (p-value: 0.035). This indicates that poverty level may influence a child's physical ability to exercise and play, possibly due to the families' inability to afford medication or due to exposure to environmental factors (pollutants, cockroach and dust mite infestations, pets, etc.) present in the residence/low income community, which are likely to trigger an asthma attack. This trend was also observed for children who claimed they needed special equipment for their health problem. Children from families with an income to poverty ratio of less than 100% had a response rate of 4.15% (2.16, 6.15), while children from families that had a poverty ration of 100% or more had a response rate of 1.80% (1.20, 2.41) (p-value: 0.003). Finally, children from families with income to poverty ratios greater than or equal to 100% were more likely to have seen a specialist than children coming from families with an income to poverty ratio of less than 100% (24.88% (22.77, 26.98) and 17.75% (14.30, 21.20), respectively.) (p-value: <0.001). It is not unreasonable to imagine that families with higher incomes would be more likely to go to a specialist for their child's asthma as opposed to families with lower incomes.

Stratifying the 7 general inquiry variables by the mother's educational level revealed that 4 of the variables had statistical significance. Children from a mother whose educational level was greater than high school had a higher prevalence of seeing a general doctor in the past 12 months than children whose mother's education was limited to high school or less (91.46% (90.07, 92.85) and 85.07% (82.58, 87.56), respectively.) (p-value: <0.001). This trend was also observed for children having had a well-child checkup. Children whose mothers had an educational level greater than high school were more likely to have had a well-child checkup than those whose mother's education was limited to high school or less (87.06% (85.11, 89.00) and 79.57% (76.65, 82.50), respectively.) (p-value: <0.001). A mother's educational level continued to be a good predictor for the percentage of children who had seen a specialist in the past 12 months. Children whose mothers had an educational level greater than high school were more likely to have seen a specialist in the past 12 months compared to children whose mothers had a high school education or less

(26.49% (24.16, 28.83) and 17.36% (14.62, 20.09, respectively.) (p-value: <0.001). Finally, children whose mothers had an educational level greater than high school were more likely to have received an influenza shot in the past 12 months than children whose mothers had a high school education or less. (49.32% (46.55, 52.08) and 44.43% (40.98, 47.88), respectively.) (p-value: 0.029). Two possible explanations as to why mothers with less education don't seek to have their children with asthma vaccinated against the flu are a lack of financial resources or possessing a cultural/religious belief system that discourages immunizations. A lack of knowledge regarding the increased risk people with asthma have for developing respiratory complications after contracting influenza could also be a factor.

Finally, insurance status was the fourth general inquiry variable that appeared to be an excellent predictor for higher response rates among children with asthma. Children covered by insurance had a higher response rate for needing special equipment than those who had no insurance, 2.56% (1.85, 3.27) and 0.49% (0.00, 1.18), respectively.) (p-value: 0.01). Insurance status was a significant predictor for having seen a general doctor in the past 12 months. Children with insurance were 25% more likely to have seen or talked to a general doctor in the past 12 months than children without insurance (89.73% (88.50, 90.97) and 71.45% (63.99, 78.91), respectively.). The same trend held true for well-child checkups. Children who were covered by insurance were 22% more likely to have had a well-child checkup than children without insurance (85.18% (83.64, 86.73) and 63.65% (55.73, 71.57), respectively.) (p-value: <0.001). Seeing a specialist was also heavily influenced by insurance status. Children who had insurance were 12% more likely to have seen a specialist in the past 12 months than children without insurance (23.79% (21.97, 25.60) and 9.23% (4.11, 14.36), respectively.) (p-value: <0.001). With respect to Influenza vaccinations, children with insurance were nearly 20% more likely to have received an influenza vaccination in the past 12 months than children without insurance (49.11% (46.93, 51.29) and 29.54% (22.36, 36.73), respectively.) (p-value: <0.001).

5.1 Public Health Practice and Policy Implications

Some of the results of this study appear to contradict the conventional wisdom about current best practices for the control of asthma as outlined in the EPR-3 and the GINA. The literature - though at times contradictory about the level of effectiveness of any particular asthma intervention - is largely corroborative of the importance of asthma education and medication use to controlling asthma and reducing severe outcomes. Yet, this descriptive study of NHIS data shows that children with higher prevalence rates of asthma education and medication use were also more likely to have severe asthma outcomes. While this finding is likely the result of limitations in the use of cross-sectional data (which came first – the chicken or the egg?), what has become clear from the review of current literature is that asthma education interventions need to be individually tailored and reinforced by the clinician. Asthma is a complicated disease influenced by a multitude of factors (environmental, genetic, physical, emotional, etc.). Asthma treatment is no less complicated. Treatment modalities must address all the factors that potentially play a role in asthma management. The level of complication inherent in the disease and its treatment makes it essential that a working knowledge of both be held by the patient and the clinician. The patient and the clinician will become more effective partners by educating them on the knowledge and techniques necessary to manage asthma. The use of effective asthma education interventions should be promoted in the current public health practice as a critical link in asthma management. An increased working knowledge of asthma and its treatment will also lead to better medication use. Patients with severe asthma are often prescribed several medications that have different treatment modalities. The clinician is responsible for informing the patient on when to ‘step up’ or ‘step down’ on the medication based on the frequency and severity of their asthma symptoms. Educating the patient on when and how to do this is the role of an asthma action plan, developed in partnership with the clinician; it should clearly lay out the steps the patient should take to control his/her asthma.

If the asthma action plan accurately models the patient’s asthma and is understood by the patient and the clinician, the level of medication use should show improvement, provided the patient has access to the medication.

One policy implication that arises from the findings in this study is how health care organizations and local, state, and federal governments should allocate scarce resources to address disparities in asthma prevalence due to patient insurance status, poverty level, lifestyle, environmental factors and lack of access to services. While the policy implications from some of these factors could be quite expensive to address, others, such as prohibitions on outdoor burning, restrictions on smoking in public housing, and regulations requiring pest control in public housing could be enacted through legislative action at relatively little expense.

5.2 Strengths and Limitations of the Study

Strengths

One of the foundational strengths to this study is that it uses NHIS data sets. The NHIS is arguably the oldest annual national health survey available to the public for analysis. It has undergone rigorous scrutiny over the years and revisions to the survey have been designed to minimize any impact on the ability to analyze data across multiple years. The

NHIS study design and study protocols are well-established, and the data are already weighted within years.

Another strength that the NHIS data provided to this study was the ability to use a large sample size in the compiled data set (29,911 respondents less than 18 years of age participated). This allowed for a more granular level of review while maintaining enough sub-populations in individual cells to establish statistical significance. The inclusion of a wide variety of demographic variables was very much a strength. Some of the more unique variables like body mass index, mother's education, poverty level and insurance status were quite insightful in identifying associations that might not have surfaced otherwise.

The NHIS also has a variety of data files containing information on developmental disabilities, immunizations, and other various infectious illnesses that can be linked for additional analysis.

Limitations

The most significant limitation to this study was the cross-sectional nature of the data. Since cross-sectional data reflect one point in time, there was no practical way to demonstrate that an intervention was significantly related to or resulted in an outcome (i.e.: an asthma education intervention resulting in a less severe asthma outcome over time.). Another limitation to the study was the reliance on NHIS questions that may not have been framed in a manner that would have collected data more useful for examining the topic of asthma. The child asthma component in NHIS is not collected annually and does not provide sufficient granularity for a robust examination of asthma in some significant areas. Questions varied greatly and covered a wide variety of items; however, the child asthma component lacked specific questions, which would have been useful to this study like how frequent, and how severe the respondent's asthma is, what the respondent's symptomology is, or the types of medication prescribed. As a result, many questions were used as proxies to ascribe asthma severity, medication use and asthma education.

Another limitation was the low number of children who indicated they had stayed overnight at a hospital. As the severity of asthma increased, the missing frequency of responses increased. This was apparently due the poor structure of one of the survey questions, which allowed respondents to skip a question if they answered the previous question 'no'. For example, respondents who answered 'yes' to the question: 'Do you still have asthma?' would then be asked if they 'had an asthma attack in the past 12 months', while children who answered 'no' to the 'still have asthma' question would not be asked the follow up question, even though they had previously indicated they were diagnosed with asthma and it's a lifelong chronic disease.

One final limitation is the fact that NHIS responses are self-reported and not medically verified since the study is conducted by interview. This means that there is likely substantial recall bias inherent in the responses. (The respondent may not be able to accurately remember an event and may provide information that is not completely true.) It's also likely that there is interview bias in the data collected. (The respondent may provide answers which are not completely accurate to 'look better' to the interviewer). Interpretation bias may also be a factor in the respondent's answers if the survey questions are not clear and unambiguous. For example, the question 'do you still have asthma', was likely meant by NHIS to elicit a response as to whether the respondent still had asthma symptoms rather than asthma, since an asthma diagnosis was previously established and asthma is a lifetime chronic disease. It is not unreasonable to believe that some of the respondents interpreted the question as a means to determine whether they had they 'grown out' of asthma and believed that they no longer had it.

5.3 Conclusion

As has often been stated in the research literature, asthma is a complex chronic respiratory condition with many factors directly or indirectly contributing to its complexity. Asthma affects a significant proportion of the population and the economic impact of asthma on both the health care system and the individual can be substantial. In children, asthma is the most prevalent chronic condition.

This study used cross-sectional data from the NHIS to examine the relationship between asthma education and medication use to select asthma outcomes in children less than 18. Establishing a causal relationship between an intervention (such as asthma education) and a medical outcome is not possible using cross-sectional data, but the analysis of cross-sectional data can identify correlations between variables of interest which are useful to researchers. While the demonstration of causality between asthma education, medication use and select asthma outcomes was not possible with the NHIS data, this thesis did corroborate correlations between the socio-demographic characteristics of the study sample and the variables for asthma education and medication use documented in the literature.

Certain demographic characteristics appear to be correlated to a range of variables of interest in this study. The severity of asthma (measured using proxy variables) appears to be correlated with race/ethnicity, age, and poverty level. The indicators for having received some form of asthma education appear to be most highly correlated with race/ethnicity, poverty level, educational level of the mother and insurance status. The indicators for medication use appear to be most highly correlated with race/ethnicity, BMI, region, and poverty level. The mother's educational level and the insurance status of the respondent were correlated with having taken prescription medication within the past 3 months. The general inquiries variables covered the patient's physical status and interactions with health care services. Race/ethnicity appears to be most highly correlated with physical limitations due to asthma, lost school days, and accessing health care services (well-child check-up, seeing a specialist, and receiving a flu shot in the past 12 months). The respondent's age was correlated to all general inquiry variables except for physical limitations. Poverty level appeared to be most highly correlated to physical limitations, the need for special equipment, and seeing a specialist in the past 12 months. The mother's educational level appeared correlated to health care service access (seeing a doctor or specialist in the past 12 months and receiving a flu shot in the past 12 months). Insurance status appeared to be most highly correlated to the need for special equipment and all four health care service access variables.

The four tables stratified by the demographic characteristics showed major disparities for certain groups. In the table labeled "Symptomatic Variables", the race/ethnicity group showed that non-Hispanic black children were more likely to have higher rates of asthma outcomes, especially with respect to having gone to the ER for an asthma episode. Age groups also showed significant disparities in asthma outcomes; young children under the age of five were three times more likely to have an overnight stay in the ER compared to the 5 to 11-year-old group. In the table labeled "Medication Use Variables", the Midwest Region had the highest rate for having taken medication in the past 3 months (P-value = 0.0002); however, without further analysis, the reason couldn't be determined. Non-Hispanic whites in this instance had the highest rates for having used prescription medication in the past 3 months, while Hispanic children had the highest rate of using three or more canisters of medication in the past three months. Further analysis would be required to discern the reasons why this exists. In the table labeled "Asthma Education" showed that race/ethnicity had several variables that were significant; in this instance non-Hispanic Black children were more likely to have received some form of asthma education.

Overall, race and ethnicity exhibited the most disparities across the tables, with 13 variables showing significance. Non-Hispanic Black children had higher rates for asthma outcomes, asthma education, and general inquiries about health care use and limitations. Age group and poverty level had 12 variables each that were significant. The age group disparities were consistent across all categories except for asthma education, where no significant differences were found. Poverty level had 12 variables that were significant across all tables. These were likely the result of economic factors that prevent some individuals from accessing the medical system and getting the medications and education they need to properly manage their asthma. Insurance showed significance across 11 variables. Similar to poverty level, lack of insurance is a barrier to accessing medical services. Finally, mother's education had 10 variables that were significant across all tables. Mothers with less education had children with more severe asthma outcomes and lacked medication usage and education. Poverty level, insurance status and educational level have all been shown in the literature to be predictors of low socioeconomic status, which is a well-documented barrier to adequately accessing the health care system. These demographic and socioeconomic characteristics show that there are disparities for these children that should be addressed by expanding healthcare systems for these children who are more vulnerable.

The multi-factorial nature of asthma and the steps involved in its management requires that treatment protocols be tailored to the individual and take into account not only the environmental and genetic factors involved, but also personal attributes and predispositions (nutrition, exercise, weight, stress, etc.) which may also contribute to the frequency and severity of the disease. There is no 'one size fits all' treatment plan for asthma, so it's imperative that the clinician proactively works with the patient to tailor a comprehensive treatment strategy and to ensure that the patient is educated sufficiently to be able to implement it.

Medication use is inextricably linked to asthma education. Patients who have not been adequately educated on which medications to use, when to use them, how frequently, and in what quantity will often end up under-medicating or over-medicating themselves. Educating the patient to ensure he/she has sufficient knowledge and understanding of asthma and asthma management strategies can minimize medication use failures. With the recent technological advances in medicine and the development of new medications, asthma should not deter anyone from living life fully.

REFERENCES

1. Pathophysiology and Pathogenesis of Asthma, and Natural History of Asthma, page 12; August 28, 2007
2. Aretaeus. The extant works of Aretaeus the Cappadocian. Adams F, editor-translator. London: The Sydenham Society; 1861. Ch. XI, pp. 73–75.
3. CDC Asthma Website, Table 4.1 Current Asthma Prevalence Percents by Age, United States: National Health Interview Survey, 2009; https://www.cdc.gov/asthma/nhis/09/table4-1.htm
4. Centers for Disease Control and Prevention. National Health Interview Survey 2017 – 2019. Most Recent National Asthma Data. 2021. https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm
5. Akinbami LJ, Moorman JE, Garbe PL, Sondik EJ. Status of childhood asthma in the United States, 1980-2007. Pediatrics. 2009 Mar;123 Suppl 3:S131-45. doi: 10.1542/peds.2008-2233C. PMID: 19221156.
6. S. Ade, G. Agodokpessi, V. Agiurre. The Global Asthma Report. Global Asthma Network. 2018.
7. Holgate ST. A brief history of asthma and its mechanisms to modern concepts of disease pathogenesis. Allergy Asthma Immunol Res. 2010 Jul;2(3):165-71. doi: 10.4168/aair.2010.2.3.165. Epub 2010 May 6. PMID: 20592914; PMCID: PMC2892047.
8. Health Interview Survey Procedure 1957-1974. U.S. Department of Health, Education, and Welfare. National Center for Health Statistics. 1975.
9. Szentpetery SE, Forno E, Canino G, Celedón JC. Asthma in Puerto Ricans: Lessons from a high-risk population. J Allergy Clin Immunol. 2016 Dec;138(6):1556-1558. doi: 10.1016/j.jaci.2016.08.047. Epub 2016 Oct 15. PMID: 27751794; PMCID: PMC5189666.
10. Miller GF, Coffield E, Leroy Z, Wallin R. Prevalence and Costs of Five Chronic Conditions in Children. J Sch Nurs. 2016 Oct;32(5):357-64. doi: 10.1177/1059840516641190. Epub 2016 Apr 4. PMID: 27044668; PMCID: PMC5010981.
11. Shrestha P, Chiarella S, Craig T. P212 Trends in hospitalization for serious infections in patients with asthma in the US. Ann Allergy Asthma Immunol. 2020;125(5):S30-S31. doi:10.1016/J.ANAI.2020.08.109
12. EPR—2. Expert panel report 2: guidelines for the diagnosis and management of asthma (EPR—2 1997). NIH Publication No. 97–4051. Bethesda, MD: U.S. Department of Health and Human Services; National Institutes of Health; National Heart, Lung, and Blood Institute; National Asthma Education and Prevention Program, 1997.
13. Sasaki, M., Yoshida, K., Adachi, Y., Furukawa, M., Itazawa, T., Odajima, H., ... & Akasawa, A. (2014). Factors associated with asthma control in children: findings from a national Web-based survey. Pediatric Allergy and Immunology, 25(8), 804-809.
14. Tmirah Haselkorn, Hubert Chen, Dave P. Miller, Stephen P. Peters, Scott T. Weiss, Craig A. Jones. Asthma control and activity limitations: insights from the Real-world Evaluation of Asthma Control and Treatment (REACT). Study Annals of Allergy, Asthma and Immunology, Volume 104, ISSUE 6, P471-477. June 01, 2010

15. Yaghoubi M, Adibi A, Safari A, FitzGerald JM, Sadatsafavi M. The Projected Economic and Health Burden of Uncontrolled Asthma in the United States. Am J Respir Crit Care Med. 2019 Nov 1;200(9):1102-1112. doi: 10.1164/rccm.201901-0016OC. PMID: 31166782; PMCID: PMC6888652.
16. Nurmagambetov T, Kuwahara R, Garbe P. The Economic Burden of Asthma in the United States, 2008-2013. Ann Am Thorac Soc. 2018 Mar;15(3):348-356. doi: 10.1513/AnnalsATS.201703-259OC. PMID: 29323930.
17. Song HJ, Blake KV, Wilson DL, Winterstein AG, Park H. Medical Costs and Productivity Loss Due to Mild, Moderate, and Severe Asthma in the United States. J Asthma Allergy. 2020 Oct 29;13:545-555. doi: 10.2147/JAA.S272681. PMID: 33149626; PMCID: PMC7605920.
18. Perry R, Braileanu G, Palmer T, Stevens P. The Economic Burden of Pediatric Asthma in the United States: Literature Review of Current Evidence. Pharmacoeconomics. 2019 Feb;37(2):155-167. doi: 10.1007/s40273-018-0726-2. PMID: 30315512; PMCID: PMC6386052.
19. Coffman, J. M., Cabana, M. D., & Yelin, E. H. Do school-based asthma education programs improve self-management and health outcomes?. Pediatrics, 124(2), 729-742. 2009.
20. Gibson, Peter G., Felix SF Ram, and Heather Powell. "Asthma education." Respiratory medicine 97.9 (2003): 1036-1044.
21. Butz, Arlene, Luu Pham, LaPricia Lewis, Cassis Lewis, Kim Hill, Jennifer Walker, and Marilyn Winkelstein. "Rural children with asthma: impact of a parent and child asthma education program." Journal of Asthma 42, no. 10 (2005): 813-821.
22. Charlotte A. Kenreigh, PharmD, and Linda Timm Wagner, PharmD. Medication Adherence: A Literature Review. October 12, 2005.
23. Dobbels F, Van Damme-Lombaert R, Vanhaecke J, De Geest S. Growing pains: Non-adherence with immunosuppressive regimen in adolescent transplant recipients. Pediatr Transplantation. 2005;9:381-390.
24. Brown MT, Bussell JK. Medication adherence: WHO cares? Mayo Clin Proc. 2011 Apr;86(4):304-14. doi: 10.4065/mcp.2010.0575. Epub 2011 Mar 9. PMID: 21389250; PMCID: PMC3068890.
25. Sabaté E, ed. Adherence to Long-Term Therapies: Evidence for Action. Geneva, Switzerland: World Health Organization; 2003.
26. Jimmy B, Jose J. Patient medication adherence: measures in daily practice. Oman Med J. 2011 May;26(3):155-9. doi: 10.5001/omj.2011.38. PMID: 22043406; PMCID: PMC3191684.
27. Osterberg L, Blaschke T. Adherence to medication. N Engl J Med. 2005 Aug 4;353(5):487-97. doi: 10.1056/NEJMra050100. PMID: 16079372.
28. DiMatteo MR. Variations in patients' adherence to medical recommendations: a quantitative review of 50 years of research. Med Care. 2004 Mar;42(3):200-9. doi: 10.1097/01.mlr.0000114908.90348.f9. PMID: 15076819.
29. MEDICATION ADHERENCE IN ASTHMA PATIENTS: A REVIEW International Journal of Current Research Vol. 9, Issue, 12, pp.62684-62689, December, 2017.

30. Llor C, Hernández S, Bayona C, Moragas A, Sierra N, Hernández M, Miravitlles M. A study of adherence to antibiotic treatment in ambulatory respiratory infections. Int J Infect Dis. 2013 Mar;17(3):e168-72. doi: 10.1016/j.ijid.2012.09.012. Epub 2012 Oct 29. PMID: 23116609.
31. Sasaki, M., Yoshida, K., Adachi, Y., Furukawa, M., Itazawa, T., Odajima, H., ... & Akasawa, A. (2014). Factors associated with asthma control in children: findings from a national Web-based survey. Pediatric Allergy and Immunology, 25(8), 804-809.
32. Toskala, E., & Kennedy, D. W. (2015, September). Asthma risk factors. In International forum of allergy & rhinology (Vol. 5, No. S1, pp. S11-S16).
33. Burke, W., Fesinmeyer, M., Reed, K., Hampson, L., & Carlsten, C. (2003). Family history as a predictor of asthma risk. American journal of preventive medicine, 24(2), 160–169. https://doi.org/10.1016/s0749-3797(02)00589-5
34. Chen, Edith PhD; Fisher, Edwin B. PhD; Bacharier, Leonard B. MD, and; Strunk, Robert C. MD Socioeconomic Status, Stress, and Immune Markers in Adolescents With Asthma, Psychosomatic Medicine: November 2003 - Volume 65 - Issue 6 - p 984-992 doi: 10.1097/01.PSY.0000097340.54195.3C
35. Federico, M. J., McFarlane II, A. E., Szefler, S. J., & Abrams, E. M. (2020). The impact of social determinants of health on children with asthma. The Journal of Allergy and Clinical Immunology: In Practice, 8(6), 1808-1814.
36. Huss et al. 2001;
37. Sporik et al. 1990;
38. Wahn et al. 1997
39. Gruchalla, R. S., Pongracic, J., Plaut, M., Evans III, R., Visness, C. M., Walter, M., ... & Mitchell, H. (2005). Inner City Asthma Study: relationships among sensitivity, allergen exposure, and asthma morbidity. Journal of Allergy and Clinical Immunology, 115(3), 478-485.
40. Gern and Busse 2002;
41. Sigurs et al. 2000;
42. Illi et al. 2001;
43. Shaheen et al. 1996
44. Eder et al. 2006;
45. Strachan and Cook 1998a;
46. Strachan and Cook 1998b;
47. McConnell et al. 2002
48. Mirabelli, M. C., Beavers, S. F., Chatterjee, A. B., & Moorman, J. E. (2013). Age at asthma onset and subsequent asthma outcomes among adults with active asthma. Respiratory medicine, 107(12), 1829–1836. https://doi.org/10.1016/j.rmed.2013.09.022
49. Cleveland Clinic. Asthma Testing and Diagnosis. 2021.
50. P Montnémery, L Hansson, J Lanke, L-H Lindholm, P Nyberg, C-G Löfdahl, E Ädelroth Family Practice, Volume 19, Issue 4, August 2002, Pages 365–368
51. Montnémery P, Hansson L, Lanke J, Lindholm LH, Nyberg P, Löfdahl CG, Adelroth E. Accuracy of a first diagnosis of asthma in primary health care. Fam Pract. 2002 Aug;19(4):365-8. doi: 10.1093/fampra/19.4.365. PMID: 12110556
52. National Health Interview Survey. User Notes. 2021.

53. National Health Interview Survey. Survey Description. 2018.
54. Rao-Scott Test

CHARTS, TABLES and FIGURES

Current Asthma Prevalence (2018)

https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm

National Current Asthma Prevalence (2018)		
Characteristic[2]	**Weighted Number with Current Asthma[1]**	**Percent (SE)**
Total	**24,753,379**	**7.7 (0.20)**
Child (Age <18 years)	5,530,131	7.5 (0.37)
Adult (Age 18+ years)	19,223,248	7.7 (0.22)
All Age Groups		
0–4 years	744,172	3.8 (0.49)
5–14 years	3,552,191	8.6 (0.56)
15–19 years	2,204,217	11.0 (0.93)
20–24 years	1,741,490	8.1 (0.93)
25–34 years	2,895,111	6.5 (0.49)
35–64 years	9,587,682	7.7 (0.30)
65+ years	4,028,516	7.8 (0.40)
Child Age Group		
0–4 years	744,172	3.8 (0.49)
5–11 years	2,349,889	8.1 (0.60)
12–17 years	2,436,070	9.9 (0.73)
Young Teens (12–14 years)	1,202,302	9.8 (1.15)
Teenagers (15–17 years)	1,233,768	10.0 (0.91)
Adolescents (11–21 years)	4,601,301	10.3 (0.65)
Young Adults (22–39 years)	5,102,853	6.5 (0.36)

National Current Asthma Prevalence (2018)		
Characteristic[2]	**Weighted Number with Current Asthma[1]**	**Percent (SE)**
Sex		
Males	9,786,413	6.2 (0.25)
Boys (Age <18 years)	3,121,842	8.3 (0.54)
Men (Age 18+ years)	6,664,571	5.5 (0.27)
Females	14,966,966	9.1 (0.29)
Girls (Age <18 years)	2,408,289	6.7 (0.52)
Women (Age 18+ years)	12,558,677	9.8 (0.33)
Poverty Level[3]		
Below 100% of the poverty threshold	4,432,695	10.8 (0.60)
100% to less than 250% of the poverty threshold	7,069,790	8.1 (0.40)
250% to less than 450% of the poverty threshold	6,028,021	7.3 (0.40)
450% of poverty threshold or higher	7,222,873	6.5 (0.32)

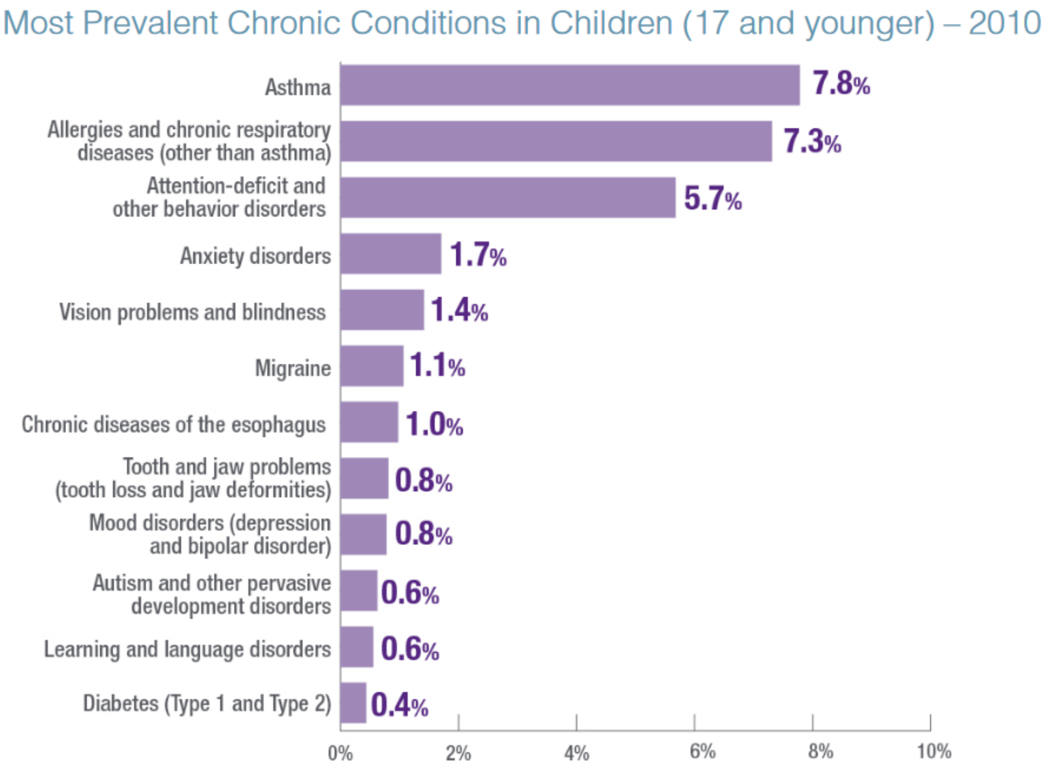
Note: NH = Non-Hispanic, SE = Standard Error
[1]Includes persons who answered "yes" to the questions: "Have you EVER been told by a doctor or other health professional that you had asthma?" and "Do you still have asthma?"
[2]Numbers within selected characteristics may not sum to total due to rounding
[3]Poverty level is based on family income and family size using the U.S. Census Bureau's poverty thresholds.
Source: 2018 National Health Interview Survey (NHIS) Data, Table 3-1 and Table 4-1 (Note: Some Child Age Group data analyzed separately)

Current Asthma[1] Prevalence by Race and Ethnicity (2016-2018)

Race/Ethnicity	Total		Child		Adult	
	Weighted Number with Current Asthma[1]	Percent (SE)	Weighted Number with Current Asthma[1]	Percent (SE)	Weighted Number with Current Asthma[1]	Percent (SE)
White NH	15,496,008	8.0 (0.13)	2,560,627	6.8 (0.27)	12,935,381	8.2 (0.14)
Black NH	4,159,143	10.7 (0.35)	1,391,780	14.2 (0.75)	2,767,363	9.6 (0.39)
AIAN NH	252,177	10.4 (1.42)	64,276	10.2 (2.96)	187,901	10.5 (1.53)
Asian NH	829,238	4.5 (0.36)	142,508	3.8 (0.50)	686,730	4.7 (0.42)
Multiple NH	952,212	13.1 (0.96)	398,771	13.0 (1.17)	553,441	13.3 (1.33)
Hispanic	3,746,988	6.5 (0.30)	1,380,782	7.5 (0.46)	2,366,206	6.0 (0.35)
Puerto Rican[2]	780,533	14.0 (1.17)	228,118	13.6 (1.89)	552,414	14.2 (1.40)
Mexican[2]	1,916,450	5.4 (0.31)	782,776	6.6 (0.49)	1,133,674	4.8 (0.39)
Other Hispanic[2]	1,050,005	6.3 (0.52)	369,888	7.6 (0.87)	680,117	5.7 (0.57)

Note: NH = Non-Hispanic, AIAN = American Indian/ Alaska Native, SE = Standard Error
[1]Includes persons who answered "yes" to the questions: "Have you EVER been told by a doctor or other health professional that you had asthma?" and "Do you still have asthma?"
[2]As a subset of Hispanic
Source: 2016–2018 National Health Interview Survey (NHIS)

Figure [1A] Multiple Chronic Conditions Chartbook 2010 MEDICAL EXPENDITURE PANEL SURVEY DATA (APRIL 2014 AHRQ Pub. No. 14-0038)



Most Prevalent Chronic Diseases in Children

Order	Condition Label	Prevalence	CCS Codes Included in Label Grouping
1	Asthma	7.77943	CCS 128 Asthma
2	Allergies and chronic respiratory diseases (other than asthma)	7.31036	CCS 133 Other lower respiratory disease CCS 134 Other upper respiratory disease
3	Attention-deficit and other behavior disorders	5.676	CCS 652 Attention-deficit, conduct, and disruptive behavior disorders
4	Anxiety disorders	1.70561	CCS 651 Anxiety Disorders
5	Vision problems and blindness	1.41309	CCS 89 Blindness and vision defects
6	Migraine	1.06402	CCS 84 Headache; including migraine
7	Chronic diseases of the esophagus	0.97672	CCS 138 Esophageal disorders
8	Tooth and jaw problems (tooth loss and jaw deformities)	0.80876	CCS 136 Disorders of teeth and jaw
9	Mood disorders (depression and bipolar disorder)	0.77891	CCS 657 Mood disorders
10	Autism and other pervasive development disorders	0.62148	CCS 655 Disorders usually diagnosed in infancy, childhood, or adolescence
11	Learning and language disorders	0.55338	CCS 654 Developmental disorders
12	"Diabetes (Type 1 and Type 2)	0.43835	CCS 49 Diabetes without complication CCS 50 Diabetes with complications

Figure [1B] from “New insights to improve treatment adherence in asthma and COPD” (George M, Bender B. New insights to improve treatment adherence in asthma and COPD. Patient Prefer Adherence. 2019 Jul 31;13:1325-1334. doi: 10.2147/PPA.S209532. PMID: 31534319; PMCID: PMC6681064.)

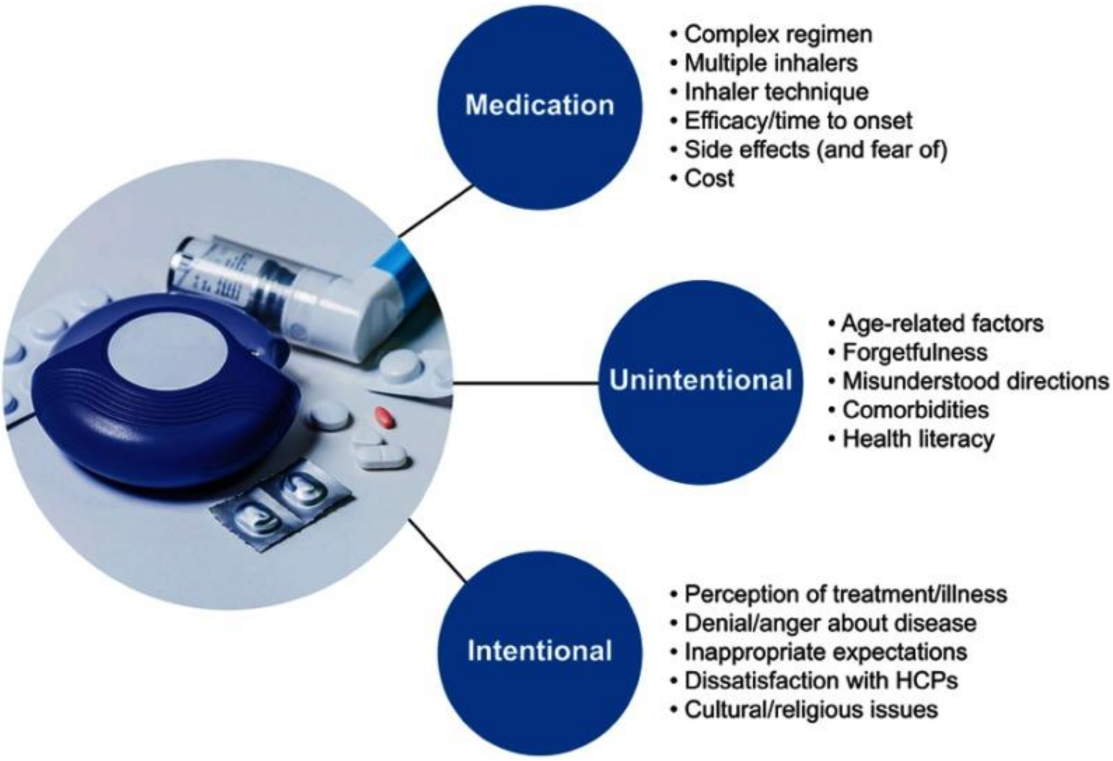


Figure [1C] “Stepwise Approach for Managing Asthma Long Term” (From Asthma Care Quick Reference, P.7)
https://www.nhlbi.nih.gov/files/docs/guidelines/asthma_qrg.pdf

STEPWISE APPROACH FOR MANAGING ASTHMA LONG TERM

The stepwise approach tailors the selection of medication to the level of asthma severity (see page 5) or asthma control (see page 6). The stepwise approach is meant to help, not replace, the clinical decisionmaking needed to meet individual patient needs.

ASSESS CONTROL:

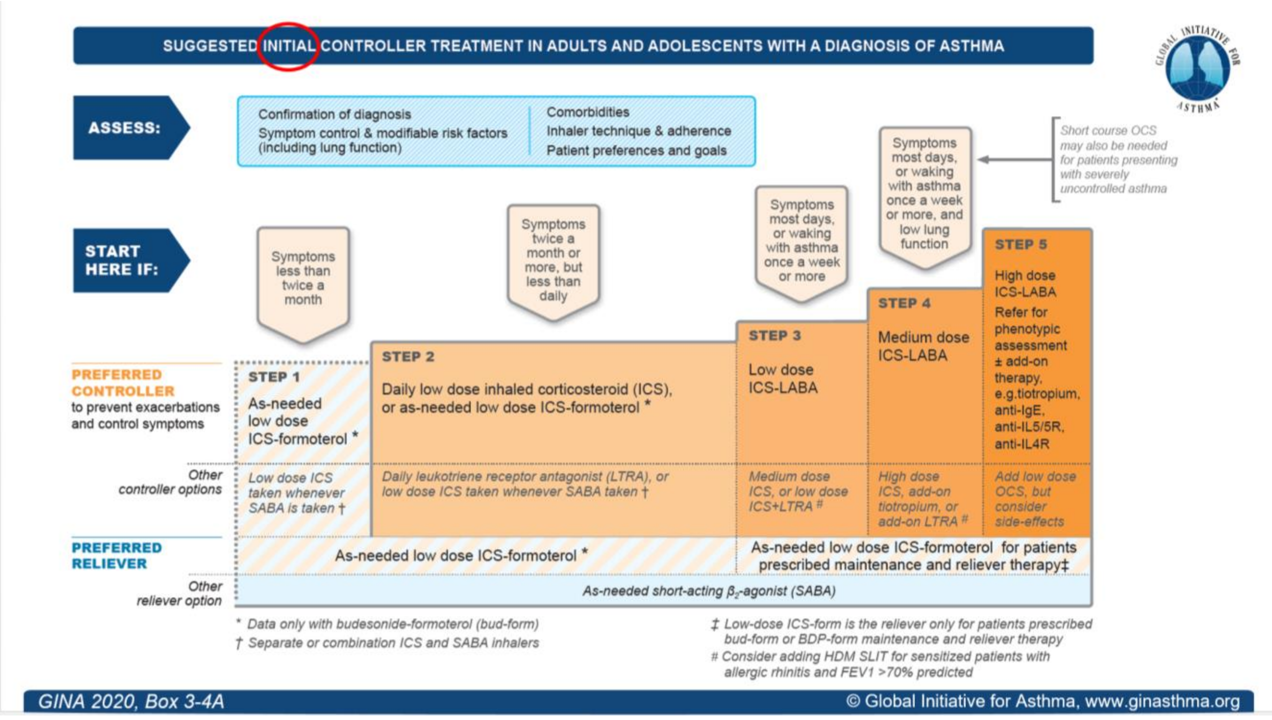
STEP UP IF NEEDED (first, check medication adherence, inhaler technique, environmental control, and comorbidities) →

← **STEP DOWN IF POSSIBLE** (and asthma is well controlled for at least 3 months)

Age		STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
	At each step: Patient education, environmental control, and management of comorbidities						
0–4 years of age		**Intermittent Asthma**	**Persistent Asthma: Daily Medication** Consult with asthma specialist if step 3 care or higher is required. Consider consultation at step 2.				
0–4 years of age	Preferred Treatment†	SABA* as needed	low-dose ICS*	medium-dose ICS*	medium-dose ICS* + either LABA* or montelukast	high-dose ICS* + either LABA* or montelukast	high-dose ICS* + either LABA* or montelukast + oral corticosteroids
0–4 years of age	Alternative Treatment†,‡		cromolyn or montelukast				
0–4 years of age		*If clear benefit is not observed in 4–6 weeks, and medication technique and adherence are satisfactory, consider adjusting therapy or alternate diagnoses.*					
0–4 years of age	Quick-Relief Medication	▪ SABA* as needed for symptoms; intensity of treatment depends on severity of symptoms. ▪ With viral respiratory symptoms: SABA every 4–6 hours up to 24 hours (longer with physician consult). Consider short course of oral systemic corticosteroids if asthma exacerbation is severe or patient has history of severe exacerbations. ▪ Caution: Frequent use of SABA may indicate the need to step up treatment.					
5–11 years of age		**Intermittent Asthma**	**Persistent Asthma: Daily Medication** Consult with asthma specialist if step 4 care or higher is required. Consider consultation at step 3.				
5–11 years of age	Preferred Treatment†	SABA* as needed	low-dose ICS*	low-dose ICS* + either LABA,* LTRA,* or theophylline(b) **OR** medium-dose ICS	medium-dose ICS* + LABA*	high-dose ICS* + LABA*	high-dose ICS* + LABA* + oral corticosteroids
5–11 years of age	Alternative Treatment†,‡		cromolyn, LTRA,* or theophylline§		medium-dose ICS* + either LTRA* or theophylline§	high-dose ICS* + either LTRA* or theophylline§	high-dose ICS* + either LTRA* or theophylline§ + oral corticosteroids
5–11 years of age			Consider subcutaneous allergen immunotherapy for patients who have persistent, allergic asthma.**				
5–11 years of age	Quick-Relief Medication	▪ SABA* as needed for symptoms. The intensity of treatment depends on severity of symptoms: up to 3 treatments every 20 minutes as needed. Short course of oral systemic corticosteroids may be needed. ▪ Caution: Increasing use of SABA or use >2 days/week for symptom relief (not to prevent EIB*) generally indicates inadequate control and the need to step up treatment.					
≥12 years of age		**Intermittent Asthma**	**Persistent Asthma: Daily Medication** Consult with asthma specialist if step 4 care or higher is required. Consider consultation at step 3.				
≥12 years of age	Preferred Treatment†	SABA* as needed	low-dose ICS*	low-dose ICS* + LABA* **OR** medium-dose ICS*	medium-dose ICS* + LABA*	high-dose ICS* + LABA* **AND** consider omalizumab for patients who have allergies††	high-dose ICS* + LABA* + oral corticosteroid§§ **AND** consider omalizumab for patients who have allergies††
≥12 years of age	Alternative Treatment†,‡		cromolyn, LTRA,* or theophylline§	low-dose ICS* + either LTRA,* theophylline,§ or zileuton‡‡	medium-dose ICS* + either LTRA,* theophylline,§ or zileuton‡‡		
≥12 years of age			Consider subcutaneous allergen immunotherapy for patients who have persistent, allergic asthma.**				
≥12 years of age	Quick-Relief Medication	▪ SABA* as needed for symptoms. The intensity of treatment depends on severity of symptoms: up to 3 treatments every 20 minutes as needed. Short course of oral systemic corticosteroids may be needed. ▪ Caution: Use of SABA >2 days/week for symptom relief (not to prevent EIB*) generally indicates inadequate control and the need to step up treatment.					

* **Abbreviations:** EIB, exercise-induced bronchospasm; ICS, inhaled corticosteroid; LABA, inhaled long-acting $beta_2$-agonist; LTRA, leukotriene receptor antagonist; SABA, inhaled short-acting $beta_2$-agonist.
† Treatment options are listed in alphabetical order, if more than one.
‡ If alternative treatment is used and response is inadequate, discontinue and use preferred treatment before stepping up.
§ Theophylline is a less desirable alternative because of the need to monitor serum concentration levels.
** Based on evidence for dust mites, animal dander, and pollen; evidence is weak or lacking for molds and cockroaches. Evidence is strongest for immunotherapy with single allergens. The role of allergy in asthma is greater in children than in adults.
†† Clinicians who administer immunotherapy or omalizumab should be prepared to treat anaphylaxis that may occur.

Figure [1D] GINA 2020, Box 3-4A Global Initiative for Asthma, www.ginasthma.org



(Permission to use image requested on 27 July 2021 and granted.)

Figure [1E] Utah Asthma Action Plan

ASTHMA ACTION PLAN

For: ______________________ Doctor: ______________________ Date: __________

Doctor's Phone Number: ______________ Hospital/Emergency Department Phone Number: ______________

GREEN ZONE

DOING WELL

- No cough, wheeze, chest tightness, or shortness of breath during the day or night
- Can do usual activities

And, if a peak flow meter is used,

Peak flow: more than __________
(80 percent or more of my best peak flow)

My best peak flow is: __________

Daily Medications

Medicine	How much to take	When to take it

Before exercise ☐ __________ ☐2 or ☐4 puffs 5 minutes before exercise

YELLOW ZONE

ASTHMA IS GETTING WORSE

- Cough, wheeze, chest tightness, or shortness of breath, or
- Waking at night due to asthma, or
- Can do some, but not all, usual activities

-Or-

Peak flow: __________ to __________
(50 to 79 percent of my best peak flow)

1st **Add: quick-relief medicine—and keep taking your GREEN ZONE medicine.**

__________ (quick-relief medicine) ______ Number of puffs **or** ☐Nebulizer, once — Can repeat every ____ minutes up to maximum of ____ doses

2nd **If your symptoms (and peak flow, if used) return to GREEN ZONE after 1 hour of above treatment:**

☐Continue monitoring to be sure you stay in the green zone.

-Or-

If your symptoms (and peak flow, if used) do not return to GREEN ZONE after 1 hour of above treatment:

☐Take: __________ (quick-relief medicine) ______ Number of puffs **or** ☐Nebulizer

☐Add: __________ (oral steroid) mg per day For ______ (3-10) days

☐Call the doctor ☐before/ ☐within______ hours after taking the oral steroid.

RED ZONE

MEDICAL ALERT!

- Very short of breath, or
- Quick-relief medicines have not helped,
- Cannot do usual activities, or
- Symptoms are same or get worse after 24 hours in Yellow Zone

-Or-

Peak flow: less than __________
(50 percent of my best peak flow)

Take this medicine:

☐ __________ (quick-relief medicine) ______ Number of puffs **or** ☐Nebulizer

☐ __________ (oral steroid) mg

Then call your doctor NOW. Go to the hospital or call an ambulance if:

- You are still in the red zone after 15 minutes AND
- You have not reached your doctor.

DANGER SIGNS

- **Trouble walking and talking due to shortness of breath**
- **Lips or fingernails are blue**

- **Take ______ puffs of __________ (quick relief medicine) AND**
- **Go to the hospital or call for an ambulance __________ (phone) NOW!**

See the reverse side for things you can do to avoid your asthma triggers.

Figure [1E] Utah Asthma Action Plan (cont.)

HOW TO CONTROL THINGS THAT MAKE YOUR ASTHMA WORSE

This guide suggests things you can do to avoid your asthma triggers. Put a check next to the triggers that you know make your asthma worse and ask your doctor to help you find out if you have other triggers as well. Keep in mind that controlling any allergen usually requires a combination of approaches, and reducing allergens is just one part of a comprehensive asthma management plan. Here are some tips to get started. These tips tend to work better when you use several of them together. Your health care provider can help you decide which ones may be right for you.

ALLERGENS

☐ Dust Mites

These tiny bugs, too small to see, can be found in every home—in dust, mattresses, pillows, carpets, cloth furniture, sheets and blankets, clothes, stuffed toys, and other cloth-covered items. If you are sensitive:

- Mattress and pillow covers that prevent dust mites from going through them should not be used alone; consider using them along with air filtration or carpet removal.
- Consider reducing indoor humidity to below 60 percent. Dehumidifiers or central air conditioning systems can do this.

☐ Cockroaches and Rodents

Pests like these leave droppings that may trigger your asthma. If you are sensitive:

- Consider an integrated pest management plan.
- Keep food and garbage in closed containers to decrease the chances for attracting roaches and rodents.
- Use poison baits, powders, gels, or paste (for example, boric acid) or traps to catch and kill the pests.
- If you use a spray to kill roaches, stay out of the room until the odor goes away.

☐ Animal Dander

Some people are allergic to the flakes of skin or dried saliva from animals with fur or hair. If you are sensitive and have a pet:

- Consider keeping the pet outdoors.
- Try limiting to your pet to commonly used areas indoors.

☐ Indoor Mold

If mold is a trigger for you, you may want to:

- Explore professional mold removal or cleaning to support complete removal.
- Wear gloves to avoid touching mold with your bare hands if you must remove it yourself.
- Always ventilate the area if you use a cleaner with bleach or a strong smell.

☐ Pollen and Outdoor Mold

When pollen or mold spore counts are high you should try to:

- Keep your windows closed.
- If you can, stay indoors with windows closed from late morning to afternoon, when pollen and some mold spore counts are at their highest.
- If you do go outside, change your clothes as soon as you get inside, and put dirty clothes in a covered hamper or container to avoid spreading allergens inside your home.
- Ask your health care provider if you need to take or increase your anti-inflammatory medicine before the allergy season starts.

IRRITANTS

☐ Tobacco Smoke

- If you smoke, visit smokefree.gov or ask your health care provider for ways to help you quit.
- Ask family members to quit smoking.
- Do not allow smoking in your home or car.

☐ Smoke, Strong Odors, and Sprays

- If possible, avoid using a wood-burning stove, kerosene heater, or fireplace. Vent gas stoves to outside the house.
- Try to stay away from strong odors and sprays, such as perfume, talcum powder, hair spray, and paints.

☐ Vacuum Cleaning

- Try to get someone else to vacuum for you once or twice a week, if you can. Stay out of rooms while they are being vacuumed and for a short while afterward.
- If you must vacuum yourself, using high efficiency participate air-filtration (HEPA) filter vacuum cleaners may be helpful.

☐ Other Things That Can Make Asthma Worse

- Sulfites in foods and beverages: Do not drink beer or wine or eat dried fruit, processed potatoes, or shrimp if they cause asthma symptoms.
- Cold air: Cover your nose and mouth with a scarf on cold or windy days.
- Other medicines: Tell your doctor about all the medicines you take. Include cold medicines, aspirin, vitamins and other supplements, and nonselective beta-blockers (including those in eye drops).

U.S. Department of Health and Human Services
National Institutes of Health
NIH National Heart, Lung, and Blood Institute
NIH Publication No. 20-HL-5251
December 2020

For more information and resources on asthma, visit *nhlbi.nih.gov/BreatheBetter*.

LEARN MORE BREATHE BETTER®