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Asthma-Related Health Outcomes in New Jersey After a Natural Disaster Event

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ASTHMA-RELATED HEALTH OUTCOMES

IN NEW JERSEY AFTER A NATURAL DISASTER EVENT

by

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ABSTRACT

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The occurrence of a natural disaster event such as a hurricane may further hinder the asthma management of asthmatic individuals. Unmanaged asthma has led to increased work absenteeism, preventable emergency department visits, costly hospitalizations and possibly death in severe cases. To improve asthma management in asthmatic adults in New Jersey (NJ) following a natural disaster event, this study examined whether predisposing, enabling and need factors are predictors for asthma exacerbation and asthma-related health care utilization in New Jersey. A retrospective secondary analysis of New Jersey Behavioral Risk Factor Surveillance System (NJBRFSS) data and New Jersey Asthma Call Back Survey (NJACBS) data was conducted on 2011 and 2013 data, which correspond to the pre and post Hurricane Sandy time frame. The Behavioral Model for Vulnerable Populations was used to guide the selection of the disaster-related predisposing, enabling and need risk factors in the study. The data was further stratified into two county comparison groups using the Sandy Community Hardship Index and the Federal Emergency Management Agency (FEMA) Flooding Map to examine the differences in predictors for asthma exacerbation or attacks and asthma-related health care utilization in high impact and low impact county groups. Descriptive statistics, Univariate analyses and Binomial Logistic Regressions were ran using a p-value of 0.05 to determine if there were any statistically

significant relationships between the identified risk factors from the conceptual framework and the outcome variables. The study found that at the state level, there are different significant predictors before and after Hurricane Sandy. Perceived cost barrier to medication, being given an asthma management plan and seeing or smelling mold were significant predictors at the state level. Seeing or smelling mold was the only significant predictor for the high impact county group. Overall, this study provided a new conceptual framework and supporting evidence regarding determinants related to asthma exacerbations and asthma-related health care utilization after a natural disaster event in asthmatic adults in NJ. The results of this study can inform public health practice in New Jersey and help improve health education interventions and health policies directed at asthmatic adults after a natural disaster event.

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CHAPTER I

INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways and is an increasingly prevalent chronic disease in the United States and around the world (World Health Organization, n.d.). This inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, coughing and an associated increase in the existing bronchial hyper responsiveness to a variety of stimuli (National Asthma Education and Prevention Program & National Heart, Lung, and Blood Institute, 2007). It affects 235 million people worldwide and 8% of Americans (World Health Organization, 2013). The occurrence of a natural disaster event such as a hurricane may further hinder the asthma management of asthmatic individuals. Some current studies show that the occurrence of a natural disaster may exacerbate respiratory conditions such as asthma by exposing these vulnerable individuals to more environmental triggers and creating barriers to effective asthma management (D'Amato & Cecchi, 2008; Diaz, 2007; Ryan et al., 2015; Saporta & Hurst, 2017) despite efforts by the local, state and federal government to provide immediate support. One natural disaster event that exemplifies these findings was when Hurricane Sandy made landfall in New Jersey in 2012. The hurricane brought massive wind, precipitation and storm surge to New Jersey. There was an increase in reported adverse respiratory health outcomes such as asthma after the natural disaster event, which puts the health of asthmatic adults in the state at higher risk since asthma is already a chronic condition of concern for the state. In 2013,

the New Jersey Department of Health identified asthma as a significant public health issue in the community and found that many adults in New Jersey still have unmanaged asthma. Unmanaged asthma has led to increased work absenteeism, preventable emergency department visits, costly hospitalizations and possibly death in severe cases in New Jersey (New Jersey Department of Health, 2013). To better inform future asthma-related public health policy and response efforts after a natural disaster event in New Jersey, which will contribute to overall improved asthma management in the state, there is a need to determine which disaster-related risk factors are most significantly associated with asthma exacerbations/attacks and asthma-related health care utilization in asthmatic adults following the occurrence of a natural disaster event.

This study provided a new conceptual framework specifically to study asthma exacerbation/attacks and asthma-related health care utilization after a natural disaster event and provided supporting evidence regarding the determinants of asthma exacerbation/attacks and asthma-related health services utilization in asthmatic adults after a natural disaster event. The results of this study added knowledge regarding risk factors specific to disaster impacted county groups in New Jersey. This new knowledge can inform public health practice in New Jersey and help improve health education interventions and health policies directed at asthmatic adults after a natural disaster event. Also, knowledge from this study can help the state of New Jersey address the state's Healthy People 2020 goals to reduce asthma deaths among adults, reduce asthma hospitalization rate among adults, reduce asthma emergency department visits among adults, increase adults with an asthma action plan, and increase adults with

asthma advised to make changes to indoor environment (New Jersey Department of Health, 2014).

This chapter will present background information regarding the asthma prevalence in the United States and in New Jersey as well as the impact of natural disasters such as hurricanes on this asthma prevalence. This chapter will identify the overall problem addressed in the study as well as the purpose and significance of the study to New Jersey and to the overall research community. The conceptual definitions, research questions and hypotheses, theoretical and conceptual framework and limitations of the study will also be included in this chapter.

Background of the Study

Asthma epidemiology in the United States and New Jersey. Asthma is one of the most common and costly diseases in the United States (US). The total cost to society from unmanaged asthma is more than $56 billion. Most of this cost is due to medical costs. The total medical expense is $50 billion annually. Missed work/school days accounts for $4 billion annually and premature death accounts for $2 billion annually. Asthma triggers vary from person to person but include sources such as dust mites, pollen, mold, secondhand smoke, air pollution, stress, strenuous exercise, cockroaches and pets (New Jersey Department of Health, 2018).

More people have asthma now than ever before in the United States (Asthma and Allergy Foundation, 2018). Nearly 25 million Americans currently have asthma, which means that 1 in 13 people have asthma (Centers for Disease Control and Prevention, 2018). Adults account for 7.6% of the total number of people with asthma. Adults within the age range of 35-64 have the highest rate of current asthma at 8.0%.

Based on gender, 9.7% (12,151) of women age 18 and older have current asthma while only 6.5% (6,293) of men age 18 and older currently have asthma. Based on race/ethnicity, black non-Hispanics age 18 and older have the highest rate of current asthma at 9.1% (2,595) compared to white non-Hispanics at 7.9% (12,435) and Hispanics at 5.9% (2,227) (Centers for Disease Control and Prevention, 2017). In 2015, 46.6% of adults who are 18 and older and have current asthma reported having one or more asthma attacks (Centers for Disease Control and Prevention, 2017). Overall, 6.2% of people in the US had a physician office visit with asthma indicated on the medical record. There were 2 million visits to the emergency department with asthma as the primary diagnosis and 3,615 deaths attributed to asthma in 2015 nationally (National Center for Health Statistics, 2017).

According to the New Jersey Department of Health, asthma is a public health issue of great significance in the state. There are currently, 167,000 children (8.7%) and 600,000 adults (9.0%) who have asthma in New Jersey. Adults are seven times more likely to die from asthma than children in New Jersey (New Jersey Asthma Awareness and Education Program, n.d.; New Jersey Department of Health, 2013). Regarding gender, the number of women who has asthma in New Jersey is double the number of men who have asthma. Hispanic and Black residents are more likely to have asthma compared to Caucasians. Also, the Healthy New Jersey 2020 target for asthma emergency department visits have not been met and is still an issue among all ethnic groups besides Asians (New Jersey Department of Health, 2017).

The occurrence of natural disasters in New Jersey can further hinder the asthma management of asthmatic adults and can possible lead to more asthma exacerbations

and asthma-related health care utilization. Therefore, it is essential to understand how natural disasters impact population health/healthcare systems and how natural disasters such as hurricanes can impact the prevalence of asthma in New Jersey.

Natural disasters and health. According to the World Health Organization, natural disasters can be defined as an act of nature that creates a catastrophic situation in which every day life is disrupted, and people become in need of shelter, food clothing and most importantly medical care. Natural disasters include wildfires, earthquakes, tsunamis, volcanic eruptions, landslides, heat waves, drought, volcanic eruptions and hurricanes. Nearly 160 million people are affected by natural disasters a year with more than 90,000 people who are killed every year (World Health Organization, 2018). Natural disasters can be extremely detrimental to individual health, especially vulnerable populations. Vulnerable populations often experience issues with utilizing health services before a disaster and even more so after a disaster (Disaster Preparedness Advisory Council & Committee on Pediatric Emergency Medicine, 2015). A vulnerable population can be defined as any individual, group or community whose circumstances create barriers to obtaining proper health care services (Iowa public health preparedness program, n.d.). This includes individuals who are considered children, low-income, elderly, chronically or terminally ill, uninsured, disabled, homeless, non-English speakers, and racial/ethnic minorities (Iowa public health preparedness program, n.d.; Runkle, Brock-Martin, et al., 2012). Since natural disasters may make it more difficult for chronically ill individuals, such as asthmatic adults, to manage their health conditions, it is important to understand the health care utilization within this group of people because health care utilization has been shown to be a key metric for

their effective disease management (“Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions - pqiguide.pdf,” n.d.; Runkle, Brock-Martin, et al., 2012; Runkle, Zhang, et al., 2012).

Impact of hurricanes on health systems and respiratory health. Natural disasters like hurricanes have a significant impact on health care systems and on individual health. Hazards associated with hurricanes include high winds, rip currents, storm surge and flooding. High winds from hurricanes causes an increase in blown debris, pollen and injuries. Rip currents increase the risk of drowning from swimming in the ocean. Elevated storm surges cause roadways to be flooded which restricts access to care and causes massive damage to private and commercial property. Most of the flooding from hurricanes comes directly from storm surge and excessive precipitation.

Due to flooding from hurricanes, health systems have been shown to struggle with secondary surge capacity. Secondary surge capacity is the ability of the health care system to respond to an increased demand for medical care in the long-term post disaster recovery phase (Iowa public health preparedness program, n.d.; Runkle, Brock-Martin, Karmaus, & Svendsen, 2012; Runkle, Zhang, Karmaus, Martin, & Svendsen, 2012). Secondary surge capacity is often described as hospital resources such as number of beds within a hospital, and number of health care providers per hospital or living area (Runkle, Brock-Martin, et al., 2012). When hospitals struggle with secondary surge capacity, providers are not able to effectively care for all patients leaving vulnerable populations such as chronically ill asthmatic adults more at risk for serious complications.

Flooding from hurricanes also has a detrimental impact on respiratory health of the population. Due to the presence of floodwaters in homes, homes quickly become a breeding ground for mold endotoxins that are found to exacerbate respiratory conditions such as asthma. States that are near the coast such as New Jersey are extremely vulnerable to the impacts of Hurricanes. This vulnerability is a result of New Jersey being below sea level and having an increase in heat as well as ocean temperatures. The geographic location of New Jersey puts the state at risk for hurricanes and the rising global temperatures makes the occurrence of Hurricanes much more intense.

Hurricane Sandy. Hurricane Sandy was one of the deadliest hurricanes that impacted the United States. The hurricane caused damage in 24 states and caused approximately 73 deaths in the United States alone (Federal Emergency Management Agency, 2013). The Centers for Disease Control and Prevention found that drowning was the most common cause of death related to Hurricane Sandy from October 28 to November 20, 2012 in the United States (Centers for Disease Control and Prevention (CDC), 2013). Carbon monoxide exposure, gas exposure, injuries, dehydration, mental illnesses, cardiovascular illnesses and adverse respiratory health illnesses (Centers for Disease Control and Prevention (CDC), 2012; Chen et al., 2013; Kim et al., 2013; Lauper, Pantea, Chen, Chang, & Lin, 2015; Manuel, 2013) were adverse health outcomes resulting from hurricane Sandy which subsequently contributed to the huge influx of patients into the health care system. A similar strain on the health care system was also seen with hurricane Katrina where there was an exacerbation of chronic health conditions including respiratory illnesses such as asthma and COPD (Arrieta, Foreman, Crook, & Icenogle, 2009; Lane et al., 2013).

Hurricane Sandy and asthma in New Jersey. New Jersey was one of the hardest hit states when the hurricane made landfall in October 2012 (Federal Emergency Management Agency, 2013). Hurricane Sandy caused the state over 35 billion dollars in economic damage. There was extreme flooding in roadways and within the homes of the residents of New Jersey. As a result of Hurricane Sandy, many homes in New Jersey experienced an overgrowth of mold. Mold contains endotoxins that are toxic to respiratory health and can lead to a rise in adverse respiratory health issues such as asthma and Chronic Obstructive Pulmonary Disorder (COPD) (Alderman et al., 2013; Fisher Wilson, 2006; Solomon et al., 2006; Terr, 2004). In New Jersey, Hospitalization and Emergency room visits for asthma increased 2 months after Hurricane Sandy. Also, there were more than 180 additional hospitalizations two months after the occurrence of the hurricane in adults in New Jersey. The greatest increase was seen in overall emergency department visits by adults in New Jersey (Thomas, Rajan, Tan, & Davidow, 2015). It was also found that following Hurricane Sandy, deaths from asthma increased by more than 8 % in the month following the hurricane and by more than 24 % four months after the hurricane (Kim et al., 2017). If left unaddressed, asthma will continue to remain unmanaged pre-disaster and post disaster and will result in great costs to the United States and the State of New Jersey.

Problem Statement

According to 2014 New Jersey State Health Assessment Data, asthma prevalence is at historically high levels in New Jersey. In 2014, 35.7% of adults with asthma reported missed workdays or limited usual activities because of asthma, which provides further evidence that asthma management is still an issue among New Jersey

Residents. This percentage is above the Healthy New Jersey 2020 target of 26.5% (New Jersey Department of Health, 2016). With the expected increase in the occurrence of natural disasters such as Hurricane Sandy in the state due to rising global temperatures and environmental sustainability concerns, New Jersey residents may be at an even higher risk of adverse respiratory health outcomes (Freedman, 2013). Of the many people who may be impacted by natural disasters in New Jersey, vulnerable populations such as asthmatic adults are at increased risk for serious exacerbation of their condition because prior research has shown that asthma management is more difficult during and after the occurrent of natural disasters (D'Amato & Cecchi, 2008; Diaz, 2007; Ryan et al., 2015; Saporta & Hurst, 2017). Failure to take into consideration the needs of asthmatic adults after a natural disaster event may result in poorer asthma management in that group of people and lead to greater overall morbidity and mortality within the population (Disaster Preparedness Advisory Council & Committee on Pediatric Emergency Medicine, 2015). Therefore, it is essential to understand the various factors that may impact the occurrence of asthma exacerbations or attacks and asthma-related health care utilization in asthmatic adults in the state and in impacted county groups after the occurrence of a natural disaster event such as a hurricane.

Purpose of the Study

The purpose of this study was to improve understanding of factors that may impact asthma exacerbations/attacks and asthma-related health care utilization in NJ after a natural disaster event such as Hurricane Sandy to help improve asthma management in asthmatic adults and to inform asthma-related programs or policies after a natural disaster event in NJ. This will help the development of more tailored

asthma related policies and interventions following the occurrence of a natural disaster event such as Hurricane Sandy. To accomplish this purpose, a modified version of Gelberg's Behavioral Model for Vulnerable Populations was employed to examine the impact of predisposing, enabling, and need factors on asthma exacerbation/attacks, emergency room visits, and hospitalization among a sample of asthmatic adults in New Jersey before and after the occurrence of Hurricane Sandy. This model was also used to examine how predisposing, enabling, and need factors affected asthma exacerbation/attacks and asthma-related health care utilization at the county level based on high impact and low impact areas in New Jersey after Hurricane Sandy. Additionally, the relationship between the construct factors and asthma exacerbation and asthma health care utilization was investigated in this study.

Theoretical Framework

Behavioral Model for Vulnerable Populations. Gelberg's Behavioral Model for Vulnerable Populations was used for this study and is an adaptation of Andersen's Behavioral Model of Health Services Use. The Behavioral Model for Vulnerable Populations has constructs that include predisposing factors, enabling factors, need, health behavior and outcomes. This framework has been applied to study elderly, homeless, and Medicare beneficiaries. However, this framework has not been used to study individuals in New Jersey, or asthmatic individuals ("Applying the Gelberg-Andersen Behavioral Model for Vulnerable Populations to Health Services Utilization in Homeless W.pdf," n.d.; Gelberg, Andersen, & Leake, 2000; Stein, Andersen, & Gelberg, 2007).

Conceptual framework for study. This study utilized four of the same constructs as Gelberg's Behavioral Model for Vulnerable Populations but a different set of variables. The major constructs that was analyzed are predisposing factors, enabling factors, need factors and health behavior. The conceptual model can be seen in Figure 1.

Research Questions and Hypotheses

Gelberg's Behavioral Model for Vulnerable Populations guided the research questions for this study. This study addressed the following research questions:

- Research question 1: Are predisposing, enabling and need factors from the conceptual framework strong predictors of asthma exacerbations or attacks in asthmatic individuals in NJ before compared to after a natural disaster event?

  H_{01}: Predisposing factors are not significantly associated with asthma exacerbations or attacks in the study sample after a natural disaster event compared to before.

  H_{a1}: Predisposing factors are significantly associated with asthma exacerbations or attacks in the study sample after a natural disaster event compared to before.

- Research question 2: Are predisposing, enabling and need factors from the conceptual framework strong predictors of asthma-related healthcare utilization in asthmatic individuals in NJ before compared to after a natural disaster event?

  H_{02}: Predisposing factors are not significantly associated with asthma-related health care utilization (emergency room visits, hospital admissions) in the study sample after a natural disaster event compared to before.

H_{a2}: Predisposing factors are significantly associated with asthma-related health care utilization (emergency room visits, hospitalization admissions) in the study sample after a natural disaster event compared to before.

- Research question 3: How do predictors of asthma exacerbation and asthma-related healthcare utilization in asthmatic individuals in NJ differ at the county level based on high impact and low impact areas after a natural disaster event?

  H_{03}: Predisposing factors are not significantly associated with asthma exacerbation and asthma-related health care utilization in the high impact county group compared to the low impact county group in NJ after a natural disaster event.

  H_{a3}: Predisposing factors are significantly associated with asthma exacerbation and asthma-related health care utilization in the high impact county group compared to the low impact county group in NJ after a natural disaster event.

Significance of the Study

Results from this study can help the New Jersey Health Department achieve its objective, according to the NJ 2008-2013 Asthma Strategic Plan, of reducing asthma attacks and preventable emergency room and hospitalization in the state after a natural disaster event. This study added new knowledge to the literature regarding the impact of mold inside the home, perceived general health and perceived cost barriers on asthma exacerbations or attacks and asthma-related healthcare utilization after the occurrence of a natural disaster event. Current research literature on asthma exacerbations and asthma-related healthcare utilization predominately examined

health-related quality of life as an outcome measure of asthma instead of a predictor, mostly involved children, and was performed using a national dataset or based on asthma questionnaires (Blumenschein & Johannesson, 1998; Carranza Rosenzweig, Edwards, Lincourt, Dorinsky, & ZuWallack, 2004; Chen et al., 2007; Dean et al., 2010; Georgiou et al., 2003; Saleem et al., 2012; Sawyer et al., 2004; Vollmer et al., 1999). There are few studies that examine asthma health outcomes that are theory driven, that investigate asthma health care utilization at the county level and considers the impact of a natural disaster event such as Hurricane Sandy. This study addressed these gaps in the literature and provided an adapted conceptual framework to examine if predisposing, enabling or need factors best predict asthma exacerbation/attacks and asthma-related health care utilization in asthmatic adults following a natural disaster event. Findings from this study can assist policy makers and health educators within NJ improve the current asthma health education programs and develop better -tailored asthma health education programs and health policies for the future.

CHAPTER II

REVIEW OF LITERATURE

Chapter II provides a review of the literature on the impact of Hurricane Sandy on New Jersey. This information will be followed by a review of different theoretical frameworks that can be utilized to examine health care utilization and outcomes in adults pre and post disasters and to develop a conceptual model to predict asthma exacerbations and asthma-related health care utilization among asthmatic adults after a natural disaster event. Evidence will be provided from the literature to support the inclusion of various constructs within the conceptual model that includes predisposing factors, enabling factors and need factors. The overall goal of this chapter is to critically analyze previous research findings to identify gaps in the literature to support the need to improve asthma management in New Jersey, to study asthma-related health care utilization in asthmatic adults in New Jersey and to support the development of a new conceptual framework for the study of asthma following a natural disaster event in New Jersey.

Impact of Hurricane Sandy in New Jersey

Since New Jersey was severely impacted by Hurricane Sandy, many journal articles have examined how Hurricane Sandy impacted the state. These articles vary in scope and touch upon different health conditions and target populations. Most of the literature articles focused on adults age 65 or older within the state. Although this subset of the population is very important to analyze, asthma impacts adults of all ages in New Jersey. This study examined the health care needs of asthmatic adults of a wider age range including young adults 18 years of age and older because the New Jersey State

Health Assessment Data showed that the age group 18-24 had higher current asthma crude rates compared to age group 65+in 2011, 2012, 2013 and 2016.

A majority of the literature focused on the impact of Hurricane Sandy on mental health or mental health care utilization (Boscarino, Hoffman, Adams, Figley, & Solhkhah, 2014; Boscarino et al., 2013; Heid, Christman, Pruchno, Cartwright, & Wilson-Genderson, 2016; Lowe, Sampson, Gruebner, & Galea, 2015; Schwartz, Gillezeau, Liu, Lieberman-Cribbin, & Taioli, 2017; Schwartz et al., 2018; Schwartz, Rothenberg, Kerath, Liu, & Taioli, 2016; Schwartz et al., 2015). Heid et al. (2017) conducted semi-structured interviews of older adults in New Jersey who had high levels of damage due to Hurricane Sandy. Results of the interviews showed that older adults experienced social, financial and emotional challenges before, during and after the hurricane but these challenges were mitigated by having a strong family and community social support network (Heid, Schug, Cartwright, & Pruchno, 2017). Boscarino et. al (2014) conducted a cross-sectional survey of 200 adults who resided in Monmouth County, NJ to evaluate the mental health outcomes of these residents following Hurricane Sandy. The study found that having physical impairments and health conditions were not directly related to adverse mental health outcomes but having suicidal thoughts, sleep problems and pain were significant predictors (Boscarino et al., 2014). Another study by Boscarino et. al (2013) found that having higher hurricane exposure and having environmental health concerns were best predictors for mental health service use and poor mental health status such as PTSD or depression (Boscarino et al., 2013). These studies examined interpersonal or environmental factors related to Hurricane Sandy individually but not collectively. This study will consider the

impact of behavioral, physical and environmental factors collectively on asthma outcomes following Hurricane Sandy. Also, these studies only examined mental health outcomes of individuals after the occurrence of Hurricane Sandy. Many studies on natural disasters have shown that natural disasters may have a detrimental impact not only on mental health but on respiratory health as well, especially of chronically ill populations (Barbeau, Grimsley, White, El-Dahr, & Lichtveld, 2010; D'Amato & Cecchi, 2008; Mirsaeidi et al., 2016; Shea, Truckner, Weber, & Peden, 2008; Takaro, Knowlton, & Balmes, 2013).

Impact of Hurricane Sandy on Respiratory Health and Asthma in New Jersey

There were limited studies on respiratory health in New Jersey following Hurricane Sandy. A study by Gargano et al. (2018) examined the relationship between inhalation exposures and lower respiratory symptoms (LRS) in individuals impacted by Hurricane Sandy. The study found that individuals who were involved in the post disaster cleanup or reconstruction efforts may be at an increased risk of LRS (Gargano, Locke, Jordan, & Brackbill, 2018). Tsai et al. (2016) analyzed severe weather indicators in New Jersey by creating graphs comparing 1 month, 3 months, and 12-month periods of 8 severe weather event indicators related to Hurricane Sandy and the year following the hurricane. Results of the study showed spikes in overall emergency department use immediately after the hurricane for asthma, carbon monoxide poisoning and methadone-related substance use. The study concluded that there is an increased need for medicine refills particularly during the two weeks following the hurricane (Tsai et al., 2016). These studies considered occupational and environmental risk factors for LRS and asthma but did not consider the simultaneous impact of many risk factors on the

occurrence of asthma exacerbations and asthma-related health care utilization. This study addressed this gap in literature on asthma exacerbations and asthma-related health care utilization of asthmatic individuals in New Jersey before and after Hurricane Sandy.

There was a lack of studies that utilized the Behavioral Risk Factor Surveillance Survey and Asthma Call Back Survey to analyze asthma health outcome and asthma-related health care utilization in New Jersey after a natural disaster time frame. There was a lack of literature on predictors of asthma exacerbations and asthma-related health care utilization at the county using high impact and low impact county group stratification based on the Sandy Community Hardship Index. This study addressed these gaps in the literature.

Theoretical Frameworks to Study Health Care Outcomes

Selecting and utilizing a theoretical framework is one of the most important tasks within a research study. A theoretical framework provides a structure for the paper as well as support for the study's problem statement, rationale, research questions and significance (Grant & Osanloo, 2015). This study examined the various factors that may predict health care utilization among asthmatic adults after a natural disaster at the state and impacted county level. To select a theory that assisted in understanding predictors for asthma exacerbations or attacks and asthma-related health care utilization in asthmatic adults, it was necessary to examine existing theoretical frameworks that can be used to study health behavior. Two of the theoretical frameworks that were influential in this study were the Anderson's Behavioral Model for Health Services Use and the Gelberg's Behavioral Model for Vulnerable Populations.

Anderson's Behavioral Model for Health Services Use. The Behavioral Model for Health Services Use was developed in 1968 and is one of the most widely recognized frameworks to study health care utilization (R. M. Andersen, 1995; Babitsch, Gohl, & von Lengerke, 2012). The model has been through many modifications since it's development and currently has three main constructs: predisposing factors, enabling factors, and need factors. Predisposing factors include demographic characteristics, social factors, and mental factors. Common predisposing factors include age, sex, education, occupation, ethnicity, social relationships, attitudes, values and knowledge related to health/ health services, and cultural norms. Enabling factors are conditions that enable service utilization and include individual financing factors and organizational factors. Examples of enabling factors include income, health insurance status, regular source of care, transportation, resources available within the community for health services, amount and distribution of health services facilities and personnel, health policies, and outreach/education programs. Need factors include perceived need and evaluated need. Examples of need factors include perceived general health, perceived functional state, perceived illness symptoms, and professional assessments and objective measurements of patient's health status (R. M. Andersen, 1995; R. Andersen & Newman, 1973; Babitsch et al., 2012).

Andersen's Behavioral Model for Health Service Use has been used in a variety of studies. A systematic review by Babitsh et al. (2012) assessed studies that employed the behavioral model as a theoretical framework up to 2011. This systematic review identified 16 studies that used the behavioral model to examine health service utilization in general, on outpatient care, primary care, tertiary care, community center care, and

mental health services. Most of these studies utilized the 1995 version of the model and focused predominately on need factors such as health status, self-reported health, diabetes, depression, hypertension, cancer, heart disease, and daily activities. Limited studies utilized Andersen's behavioral model to study asthma (Babitsch et al., 2012). A cross-sectional study by Unni & Farris (2011) utilized Andersen's behavioral model to compare determinants of asthma maintenance medication adherence. The study found that need factors such as illness perceptions and disease severity were significant predictors of asthma maintenance medications (Unni & Farris, 2011). The most recent study that utilized the Andersen's behavioral model to study asthma was by Ortiz-Rivera (2016) and examined asthma determinants, health care utilization and control among women in Puerto Rico. This study found that being self-employed and being in the $15,000 to $25,000 income bracket significantly predicted the frequency of emergency room visits (Ortiz-Rivera, 2016). Overall, these studies did not study asthma-related health care utilization following a natural disaster and did not look at any county level impacts. Also, these studies did not consider the specific needs of asthmatic individuals. This study utilized Gelberg's Behavioral Model for Vulnerable Populations to fill this gap in the literature.

Gelberg's Behavioral Model for Vulnerable Populations. Gelberg's Behavioral Model for Vulnerable Populations was created in 2000 and was an adaptation of Andersen's Behavioral Model of Health Services Use. Gelberg's Behavioral Model for Vulnerable Populations includes the same constructs as the Anderson's behavioral model, which is predisposing factors, enabling factors, need factors and health behavior. However, Gelberg added vulnerability domains to specifically address the

health and health-seeking behavior of vulnerable populations (Gelberg et al., 2000). The vulnerability domains focus predominately on enabling resources and social structure. Gelberg's behavioral model also extends Andersen's original model to include the impact of health care utilization on health status outcomes (Gelberg, Andersen, & Leake, 2000a; Stein, Andersen, & Gelberg, 2007a).

Gelberg's behavioral model has been applied in various research studies to examine the health care utilization and health outcomes of the elderly, homeless, and Medicare beneficiaries (Bethel, Foreman, & Burke, 2011; Doran et al., 2014; Gelberg, Andersen, & Leake, 2000b; Stein, Andersen, & Gelberg, 2007b; Stein, Andersen, Robertson, & Gelberg, 2012). Recent applications of the model has been used to examine the health service use of other vulnerable populations such as previously incarcerated woman (Oser, Bunting, Pullen, & Stevens-Watkins, 2016), people living with HIV (Tsuyuki & Surratt, 2015), people with low socioeconomic status (Baughman et al., 2015), patients suffering from dental disease or need dental services (Azarpazhooh, Dao, Figueiredo, Krahn, & Friedman, 2013; Azarpazhooh et al., 2014; Azarpazhooh & Quiñonez, 2015; Muirhead, Quiñonez, Figueiredo, & Locker, 2009), and people who are currently deployed (Wooten et al., 2017, 2013). However, Gelberg's Behavioral Model for Vulnerable Populations has not been used to examine asthma exacerbations/attacks or asthma healthcare utilization in asthmatic adults before of after a natural disaster event.

Development of Conceptual Framework to Study Asthma after Natural Disaster Event

To examine asthma exacerbations/attacks and asthma-related health care utilization, a new conceptual framework was created from Gelberg's Behavioral Model for Vulnerable Populations (Gelberg et al., 2000). Incorporating constructs from the behavioral model produced a conceptual framework that provided a more comprehensive examination of the traditional and vulnerable risk factors that may predict the asthma-related health care utilization of asthmatic adults. Studies have shown that considering vulnerable domains such as living conditions play a major role on health care utilization of vulnerable populations after a natural disaster event (Bethel et al., 2011; Disaster Preparedness Advisory Council & Committee on Pediatric Emergency Medicine, 2015; Runkle, Zhang, et al., 2012). This conceptual model included constructs such as predisposing characteristics, enabling factors, need factors and health behavior. The conceptual model for the study is shown in Figure 1.

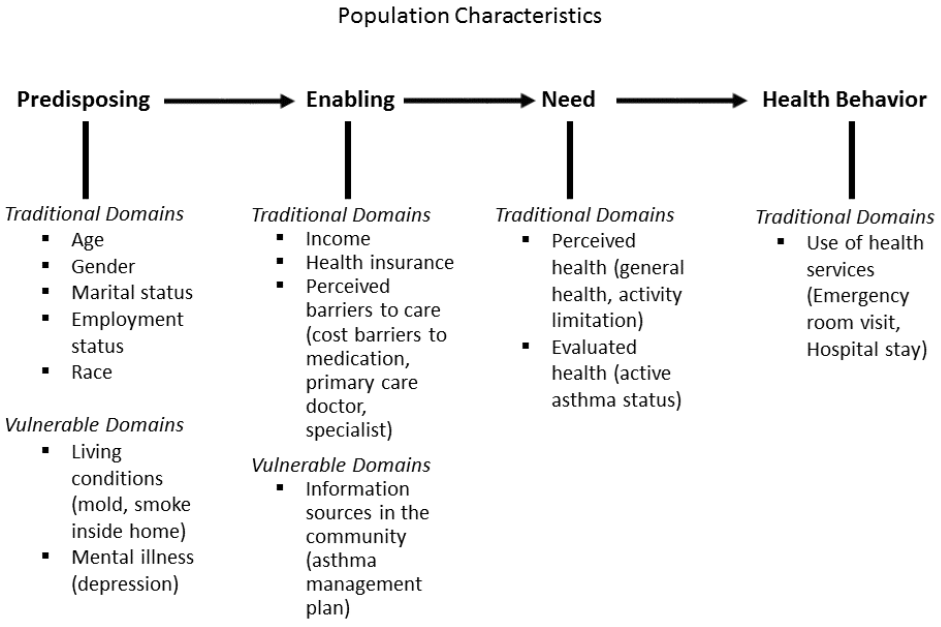

Figure 1. Conceptual Framework for the Study. This figure illustrates the framework that was modified from the Behavioral Model for Vulnerable Population

The components of the conceptual framework. To improve asthma management in asthmatic adults in NJ, the conceptual framework considered risk factors that impact asthma exacerbation/attacks and asthma health care utilization within the population after a natural disaster event such as Hurricane Sandy. Specifically, the conceptual framework was comprised of predisposing, enabling, and need factors that impact asthma exacerbation/attacks and asthma health care utilization.

Predisposing characteristics. Predisposing characteristics included traditional factors such as age, gender, marital status, employment status, and race. Age was important to examine because according to a study by Blackwell et al. (2009), there is a great disparity in odds of being hospitalized based on age (Blackwell, Martinez, Gentleman, Sanmartin, & Berthelot, 2009). Gender has also been shown to be a contributing factor to health disparities for vulnerable populations post disaster (Aldrich & Benson, 2008; Bethel et al., 2011; Nick et al., 2009; Runkle, Brock-Martin, et al., 2012; Runkle, Zhang, et al., 2012; Uscher-Pines et al., 2009). Also, women were more likely to visit a physician than men (Babitsch et al., 2012). Predisposing characteristics also included vulnerability factors such as living conditions (seeing or smelling mold inside home, smoke inside home) and mental illnesses such as depression. Seeing or smelling mold after a natural disaster event has been linked to increase healthcare utilization in several studies (Barbeau et al., 2010; Bloom, Grimsley, Pehrson, Lewis, & Larsson, 2009; Johanning, Auger, Morey, Yang, & Olmsted, 2014; Ryan et al., 2015; Saporta & Hurst, 2017).

Enabling characteristics. Enabling characteristics included traditional factors such as health insurance status, income, perceived barriers to care (cost barrier to medication), and information sources in the community (given an asthma management plan). Health insurance status was important to examine because it is considered a direct metric to measure health utilization for both vulnerable and non-vulnerable populations. Income was one of the major variables to examine because income has been shown to be directly related to health care utilization in vulnerable populations such as the chronically ill (Bethel et al., 2011; Disaster Preparedness Advisory Council & Committee on Pediatric Emergency Medicine, 2015; Dostal, 2015; Nick et al., 2009; Runkle, Zhang, et al., 2012). Regarding costs, most of the current research literature only examine costs as it is associated with treatment options and regarding the impact of real medical costs on health care utilization (García-Ruiz et al., 2015; Rysiak et al., 2016; Sadatsafavi et al., 2016; Zeiger et al., 2016). There are limited studies that examine how perceived costs barriers may impact adherence to a regular asthma treatment plan.

Enabling characteristics included vulnerability factors like information sources in the community. Information sources in this study include being given an asthma management plan. Having asthma information resources are particularly important in the management of asthma in adults because the research literature states that less than 70% of adults are taught how to recognize symptoms associated with asthma. Additionally, adults are more likely compared to children to not have an asthma action plan. Less than 33% of adults are given an asthma action plan from their doctors compared to 50% of children (Centers for Disease Control and Prevention, n.d.).

Need. The need construct included the vulnerability domains of perceived health and evaluated health. Perceived health included perceived health related quality of life factors such as general health and activity limitation. Evaluated health included active asthma status. Numerous studies in the literature have found that there is an association between increased health care utilization and poorer physical and mental health. Also, individuals who reported having restriction of activity, a health status of poor or fair, or a depressive disorder were significantly more likely to seek a doctor or go to the hospital (R. J. Adams, Smith, & Ruffin, 2000; Becerra, 2016; Mroczek, Parzuchowska, Jasińska-Starczewska, Grodzki, & Kurpas, 2017; Ross, Yang, Song, Clark, & Baptist, 2013; Wisnivesky, Leventhal, & Halm, 2005). It is important to note that a study by Afilalo et al. (2004) found that perceived need was the main reason given by patients for going to the emergency room instead of their primary care providers. The study participants believed that their perceived condition was severe enough to utilize the emergency room (Afilalo et al., 2004).

Health care behaviors. Health care behaviors included emergency room visits, hospital visits and asthma exacerbations or attacks. According to the New Jersey Department of Public Health, examining emergency department utilization and hospitalization is a strong indicator of asthma management within the population. Preventable use of the hospital for asthma care or treatment shows a serious exacerbation of the asthma condition in the individual and overall poor asthma management. High frequencies of asthma attacks and preventable emergency department visits is an indicator of unmanaged asthma (New Jersey Department of Health, 2016, 2017).

Summary

This study utilized Gelberg's Behavioral Model for Vulnerable Populations to better understand the factors that may impact the asthma exacerbation/attacks and asthma-related health care utilization of asthmatic adults in New Jersey before and after the occurrence of Hurricane Sandy. The application of this modified theory to examine health care utilization of asthmatic adults post disaster was tested using statistical methods that will be described in chapter three. Additionally, predictive models were created to help inform decision-making regarding preparedness planning for asthmatic adults in the future.

CHAPTER III

RESEARCH METHOD

This chapter describes the research methods utilized within the study including the research design, data collection, and data analysis. Survey data from the New Jersey Behavioral Risk Factor Surveillance System (NJBRFSS) and the New Jersey Asthma Call Back Survey (NJACBS) were utilized for this current study.

Goal of the Study

This study examined the asthma exacerbation and asthma-related health care utilization of asthmatic adults using data from before and after hurricane Sandy.

Rationale for the Study

In 2012, Hurricane Sandy struck New Jersey and caused massive storm surges as well as wind damage. This caused extensive damage to homes, leaving homes full of mold and other hazardous exposures that adversely impacted health of vulnerable populations such as the chronically ill (“Health-Systems-and-Services-Resilience.pdf,” n.d.; Lane et al., 2013; Manuel, 2013; Park et al., 2013; Swerdel, Janevic, Cosgrove, Kostis, & Group, 2014). The current study utilized survey data from the New Jersey Behavioral Risk Factor Surveillance System (NJBRFSS) and New Jersey Asthma Call Back (NJACBS) in 2011 and 2013. Analysis of this time frame allowed researchers to see how asthma management may be impacted before and after Hurricane Sandy, one of the most devastating storms to make landfall in New Jersey (Burger & Gochfeld, 2014). Additionally, New Jersey collects BRFSS data most months within the year and has extra state added questions that allow for closer examination of health-related quality of care and cost perceptions of care. For this study, only data from 2011 to 2013

was utilized because these years have the same weighting methodology, which means that the data was collected and cleaned using the same weighting adjustment method.

Protection of Human Subjects

The Institutional Review Board (IRB) of Old Dominion University reviewed the current study. The study was classified as exempt because there was no direct contact with survey respondents, data is publicly available, data is de-identified, and survey respondents were given informed consent over the phone by the interviewer from the New Jersey Health Department.

Study Population

The study population for the state model included asthmatic adults who lived in New Jersey in 2011 and 2013. In this study, an individual is considered asthmatic if they answered yes to the survey question, “do you have asthma?” in the BRFSS and the ACBS survey. Adults are defined as individuals who are 18 and older. To be included in this study, respondents must have asthma, must agree and participate in both the NJBRFSS survey and the NJACBS survey, must be 18 years and older and must live in New Jersey in a residential home and not in a dormitory, nursing home, or penitentiary. Additionally, respondents must pass all eligibility requirements. The eligibility requirements include agreeing to have their responses linked to their previous BRFSS response, to still have asthma and to fully complete the follow-up survey. Figure 2 shows the NJACBS Eligibility Chart with details regarding how participants were included or excluded from the research study. The total sample size for the state model was 462 in 2011 and 335 in 2013.

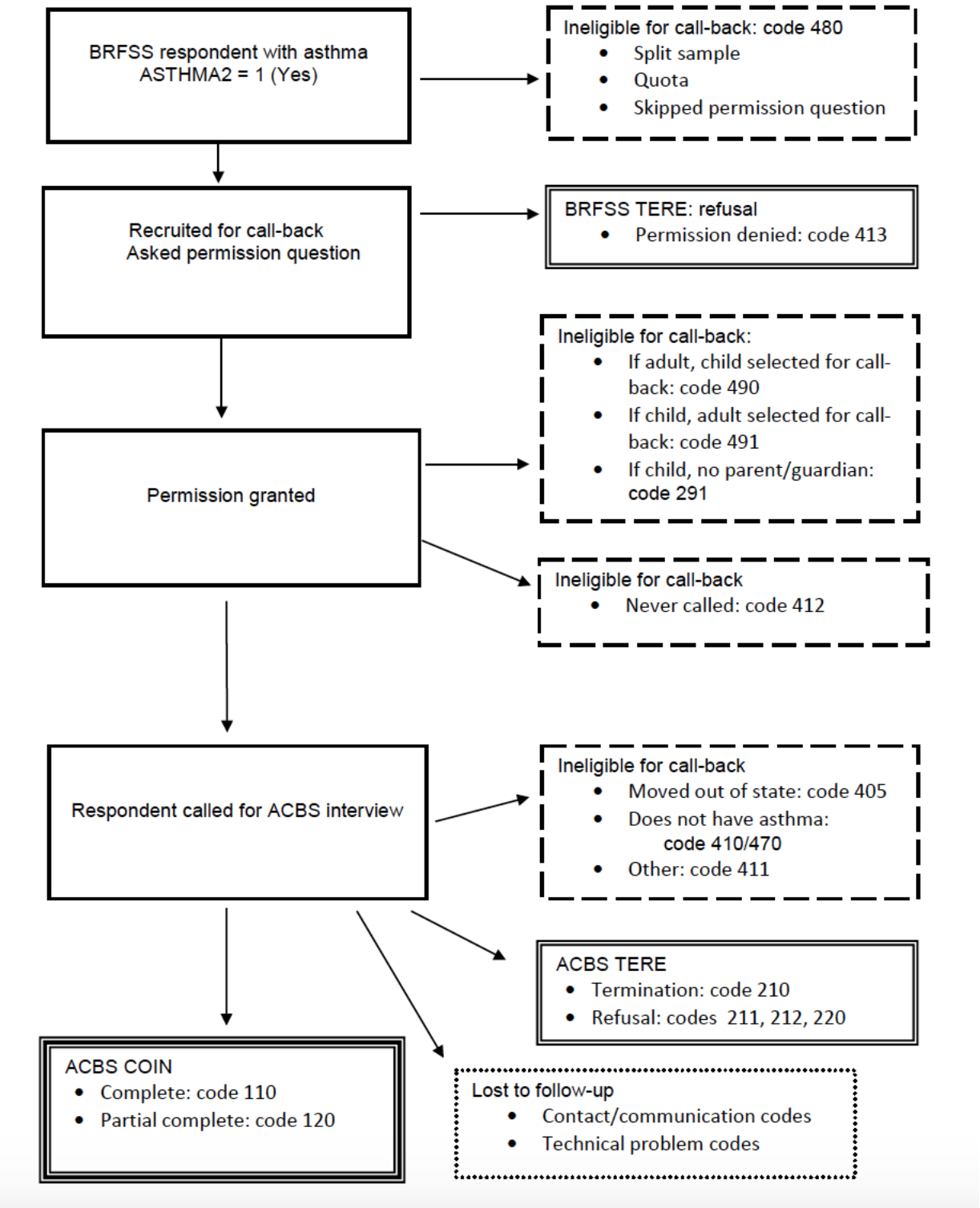

Figure 2. NJACBS Eligibility Chart. Reprinted from Asthma Call-Back Survey Summary Data Quality Report, by Center for Disease Control and Prevention, August 15, 2013, retrieved from Center for Disease Control and Prevention.

The study population for the county model included asthmatic adults who lived in New Jersey in 2013. For this population, an individual was considered asthmatic if they answered yes to the survey question, “do you have asthma?” in the BRFSS and the ACBS survey. Adults were defined as individuals who were18 and older. To be included in this county model, respondents must have asthma, must agree and participate in both the NJBRFSS survey and the NJACBS survey, be 18 years and older and live in New Jersey in a residential home and not in a dormitory, nursing home, or penitentiary. Additionally, respondents must pass all eligibility requirements to agree to have their responses linked to their previous BRFSS response, to still have asthma and to fully complete the follow-up survey. The eligibility for the county model study population was shown in Figure 2. It is important to note that the study population in the county model did not include all counties in New Jersey. The counties that were selected in the study population was identified as high impact or low impact based on the Hurricane Sandy Community Hardship Index.

The Hurricane Sandy Community Hardship Index was utilized in this study to determine the selection of the high impact and low impact county group because it is identified by the Federal Emergency Management Agency and Rutgers University as a standardized way to assess the true extent of economic and physical damage caused by Hurricane Sandy. The index controls for population differences at the county and municipal level so makes comparison regarding extent and severity of damage across different geographical locations within the state feasible. The Hurricane Sandy Community Hardship Index includes indicators such as days without power; residential claims reported as percent of total housing unit; residential paid loss per housing unit;

commercial paid loss per non-residential parcels; commercial claims reported as a percentage of non-residential parcels; FEMA Municipal assistance per capita; people served at shelters per 1,000; and gas calls per 10,000 (Halpin, 2013).

Based on the FEMA Sandy Community Hardship Index, the counties that were included in the high impact country groups in the study had a score between 66 and 88. These counties in New Jersey were shaded black in the map. The counties that were included in the low impact country groups in the study had a score between 30 and 35. These counties in New Jersey were shaded in white in the map. The sample size for the final county groups include 62 for the Low Impact County Group and 39 for the High Impact County Group (Halpin, 2013).

Data Sources Used in Study

New Jersey Behavioral Risk Factor Surveillance System (NJBRFSS).

BRFSS coordinators and Center for Disease Control and Prevention (CDC) staff developed the NJBRFSS with input by the New Jersey Department of Health. It is made of three main parts: required core component, optional modules and state-added questions. The required core component consists of a fixed set of questions, rotating questions and questions on emerging health topics. The optional modules have health questions that are asked on alternating years. The state-added questions are state specific health questions. To collect the NJBRFSS data, the New Jersey Health Department conducted random sampling of the population. Phone numbers were randomly selected from all working phone numbers, both listed and unlisted. Although only landlines were contacted in the BRFSS, the sample size of the participants in the BRFSS file was over 11,000 respondents, which include both asthmatic and non-

asthmatic individuals. The initial BRFSS Survey takes 20 minutes to complete and is completely voluntary. Only adults 18 and over who live at home and not in dormitories, jails, hospitals, nursing homes were eligible to participate. The NJ Health Department made calls 7 days per week, during both daytime and evening hours. Once the data was collected, CDC staff generated data quality reports and shared them with state coordinators. These data quality reports provided in-depth information regarding the data. The collected data was validated, cleaned-up if necessary, and assigned weights. Calculated variables were created if necessary. Once the data was processed, the data was made available for download from the CDC website and was available in ASCII and SAS format.

Table 1 shows the response rates for the NJBRFSS 2011 and 2013 survey. The interview completion rate is the rate of completed interviews from all respondents who BRFSS determines to be eligible and selects for an interview. The BRFSS Cooperation Rate is the number of complete/partial complete interviews over the number of contacted and eligible interview respondents. The BRFSS Cooperation should be above 65 %. The BRFSS Refusal Rate is the proportion of all eligible respondents who refused to complete an interview or terminated an interview prior to the necessary threshold to be considered a partial interview. The BRFSS Refusal Rate should be below 35 %. The Council of American Survey Research Organization (CASRO) Rate is an outcome rate that examines the number of complete and partial interviews over an estimate of the number of eligible units in the sample. The CASRO Rate should be above 40% (US Center for Disease Control and Prevention, 2014).

Table 1

NJBRFSS Calculated Response Rates for 2011 and 2013

BRFSS Response Rate Categories	2011	2013
Completion Rate	82.9	77.3
Cooperation Rate	79.7	60.9
Refusal Rate	9.84	13.6
CASRO Rate	47.8	46.5

Note. Rates are from the 2011 and 2013 NJBRFSS Data Quality Report

The New Jersey Asthma Call Back Survey (NJACBS). The asthma call back survey was given to respondents who answered yes to having asthma on the NJBRFSS survey and showed a willingness to participate in the 2-week follow-up NJACBS survey. The NJACBS survey was linked to the NJBRFSS since 2011. Many questions are taken from established national surveys such as the National Health Survey. The response rates for the 2011 and 2013 NJACBS survey is shown in Table 2. The ACBS Interview Completion Rate is the proportion of completed interviews among eligible respondents who are contacted and who started the ACBS interview. The ACBS Cooperation Rate is the proportion of completed interviews among all eligible respondents who are recruited and contacted for the ACBS interview. The ACBS Cooperation Rate should be above 65%. The ACBS Refusal Rate is the percentage of all eligible respondents that refuse to be interviewed or terminate an interview early in the survey. The ACBS Refusal Rate should be below 35%. The ACBS CASRO rate is a measure of respondent cooperation and is generally defined as the proportion of all eligible respondents in the sample for whom an interview has been completed. The ACBS CASRO rate should be above 40 % (Ortiz-Rivera, 2016).

Table 2

NJACBS Response Rates for 2011 and 2013

ACBS Response Rate Categories	2011	2013
Completion Rate	94.3 %	95.9 %
Cooperation Rate	50.0 %	50.5 %
Refusal Rate	32.4%	34.6 %
CASRO Rate	32.4%	35.3 %

Note. Rates are from the 2011 and 2013 ACBS Data Quality Report

To collect the sample for the study, the NJACBS survey data was downloaded from the CDC website. The NJACBS data file contained both the NJBRFSS survey data and NJACBS survey data. There were 462 participants in the 2011 NJACBS file and 335 participants in the 2013 NJACBS file.

Data Management

The BRFSS and ACBS survey was validated and tested for reliability prior to being uploaded to the CDC website for download. It has over 200 questions of which, only 20 were selected and used in the data analysis. To obtain data for the state model, the ACBS public file was downloaded and cleaned using the Variable “STATE”. New Jersey was coded 34 and all other states were deleted from the data set. To ensure that the 2011 and 2013 datasets only had cases for each year, the date of the survey was verified using the “IDATE” variable that lists the date the survey was taken. Any cases that did not belong in that specific year file was deleted or exported to the proper year. To obtain data for the county model, the “CITYCODE” variable was used to identify the individual county codes. The “CITYCODE” variable corresponded to the CENSUS codes so county names were determined by matching the city code number to the census code names. For the county model, the cases were further stratified into a high

impact county group and a low impact county group based on the Federal Emergency Management Agency (FEMA) Hurricane Sandy Community Hardship Index and FEMA flood surge maps. These two maps showed areas within New Jersey that were impacted by the hurricane based on a color-coding scale, with darker colors showing higher impacts for the Hardship Index Map and red showing high surge for the surge maps. The Sandy Community Hardship Index can be seen in Appendix B and the FEMA Surge Map can be seen in Appendix C. NJBRFSS and NJACBS survey data from the affected counties groups was analyzed using 2013, post-disaster, data. Statistical tests were conducted to see if the proposed variables from the conceptual models were strong predictors for asthma exacerbation and asthma-related health care utilization within asthmatic adults before and after Hurricane Sandy.

Study Variables

The independent variables included predisposing factors (age, marital status, employment status, race, respondent sex, mold inside home, smoke inside home, depression), enabling factors (health insurance, income, perceived cost barrier to medication, asthma health management plan), and need factors (active asthma, general health) from the conceptual framework. The dependent variables were asthma exacerbation or attacks, and asthma-related health care utilization (emergency room visits and hospital admissions).

Measurement of variables. The variables within the study, which correspond to the constructs within the conceptual framework, were measured using NJBRFSS and NJACBS survey questions. A summary of the variables measured in the study is

described below. The survey questions that correspond to each identified disaster-related risk factors can be viewed in Appendix A.

Predisposing factors. Predisposing factors are factors that predispose individuals to a health behavior. These factors included age, gender, race, marital status, employment status, mental illness and living conditions such as seeing or smelling mold inside the home and smoking inside the home.

Enabling factors. Enabling factors are conditions that enable a health behavior and included factors such as health insurance status, income, perceived barriers to care such as cost barrier to medication, and information sources such as being given an asthma health management plan.

Need. Need factors are evaluated and perceived health conditions. Need factors included perceived health related quality of life factors like general health. Active asthma status was also examined.

Health behavior. Health behavior is the actions an individual take concerning their health. For this study, the health behavior of interest was asthma exacerbation, emergency room visits and hospital admissions (Gelberg et al., 2000).

Statistical Analysis

Statistical significance refers to whether any differences observed between groups are due to chance or some factor of interest. If the p value is less than 0.05, then the null hypothesis can be rejected, and it can be assumed that there is a difference between the two groups. Assumptions of parametric tests were evaluated for binomial logistic regressions as part of the data analysis. The assumptions that were evaluated were linearity, independence of errors and multicollinearity. Other assumptions that

were considered included incomplete information from the predictors, overdispersion and whether there was complete separation. The dataset was then cleaned to check for proper variable coding and variable categorization. Refused to answer/Don't Know responses were recoded to missing values based on prior research studies.

Once the dataset was cleaned, descriptive statistics was conducted for the 2011 state group, 2013 state group, and high impact and low impact county groups. Most survey question did not have missing data. Next, Chi-square analyses were conducted to test if the identified categorical risk factors from the conceptual framework were significantly associated with the categorical dependent variables of asthma exacerbations/attacks, emergency department visits and hospital visit. All associations with significance of less than 0.25 (*Logistic Regression: Univariate and Multivariate*, n.d.; Sperandei, 2014) and were identified by the literature as having an impact on asthma attacks and asthma related health care utilizations were carried over to the binomial logistic regression. Also, factors that were found to be confounders according to prior research were carried over to the binomial logistic regression models. Binomial logistic regression models were run to test research question 1 and 2 to see if predisposing, enabling and need factors impact asthma exacerbation/attacks, emergency room visits and hospital admissions. The enter, forward conditional and backward conditional methods were used to test the stability of the binomial logistic regression model outputs. Any associations with a p-value <0.05 was considered statistically significant.

A power analysis was conducted using G*Power 3.1.9.2 software. For the chi-square analyses, an A priori power analysis was conducted using an effect size of 0.3,

alpha level of 0.05 and 1 degree of freedom. To obtain 80%, 95% and 99%, the estimated sample size needed was 88, 145 and 205. Therefore, the 2011 state sample (N=462) and 2013 state sample (N=335) had 99% power in the univariate analyses. For the logistic regression analyses, an A priori power analysis was conducted using an effect size of 0.15, alpha level of 0.05, and 5 predictors. To obtain 80%, 95% and 99% power, the estimated sample size needed was 92, 138, 184. Therefore, the 2011 state sample (N=462) and 2013 state sample (N=335) had 99% power in the logistic regression analyses.

Methodology Limitations and Strengths

Although careful thought was given to the design of this study, this study had some limitations. The literature identified many important factors that impacted asthma management in asthmatic adults in New Jersey but not all these factors can be considered in the study due to the study being a secondary data analysis. The impact of current regulations and social reforms are also important to consider when examining asthma management within the population but were not studied and tested in the study. Self-reported data poses a limitation since it makes the data results vulnerable to recall bias or social desirability effect. The results from this study may only be generalizable to adult in New Jersey due to the specific geographic characteristics of the population and due to the addition of the state-added questions. Plus, the survey data from the NJACBS was collected only from landlines and not cellphones, which reduces the sample size.

The study had several strengths. For one, this study is one of the very few that examines asthma exacerbations/attacks and asthma-related health care utilization

using a behavioral based theoretical framework. Although many studies have been conducted regarding Hurricane Sandy, there are limited studies that look at both the environmental and behavioral factors that predict asthma exacerbation and asthma-related health care utilization in the United States. The most recent study that examined these similar outcomes was in Puerto Rico. Statistical methods were used in supplement to the conceptual framework to guide all analyses conducted within the study.

CHAPTER IV

RESULTS

This chapter presents the results of the study. The descriptive analyses performed on the state and county level data are presented. The findings from the binomial logistic regression analyses for the 2011 and 2013 data are presented. A summary of the main findings of the study is discussed in this chapter as well.

Descriptive Analysis

Descriptive analysis was run on respondents in 2011 and in 2013. Descriptive analysis was also run on respondents in a Low Impact County Group and a High Impact Country Group in 2013. A summary of the findings from the descriptive analyses is summarized below.

Characteristics of sample population in 2011. The sample was composed of 462 asthmatic adults in New Jersey. Sixty-eight percent of the respondents were female. Over 49% of the respondents were married and 40% graduated from college. Over 74% of respondents were not given an asthma action pan. Thirty-percent of respondents had an income of $75,000 or more. Over 90% of the respondents had health insurance coverage. Regarding personal habits, over 46% of respondents reported having never smoked a cigarette and over 98% never used smokeless tobacco products. Sixty-eight percent of respondents did not use an air cleaner or humidifier inside their home. However, 13% of respondents self-reported seeing or smelling mold in their homes and had someone smoked inside their home. Over 52% of participants had indoor pets. Over 45% of respondents did not ever have a pneumonia shot and over 43% did not have a flu shot/spray in the past 12 months. Regarding their personal

health, over 80% of respondents had active asthma and over 36% were categorized as obese. Twenty-eight percent of the respondents were told by a physician that they were depressed and 10% reported having poor perceived general health. The characteristics of the 2011 population will be used as a baseline to compare with the characteristics of the 2013 population. According to the US Census Bureau, the demographics for the 2011 sample population is fairly representative for New Jersey adults ("U.S. Census Bureau QuickFacts," 2018). The frequencies and percentages of the sample characteristics can be seen in Table 3.

Table 3

Characteristics of Asthmatic in New Jersey Before and After Hurricane Sandy

Variables	2011		2013	
	n	%	*n*	%
Female	318	68.8	242	72.2
Married	228	49.4	151	45.1
Four years of college or more	186	40.3	139	41.5
Income $75,000 or more	141	30.5	111	33.1
Given an asthma action plan	108	23.4	88	26.3
Never smoked	216	46.8	162	48.4
Never use smokeless tobacco products	456	98.7	332	99.1
Air cleaner used	141	30.5	88	26.3
Dehumidifier used	143	31.0	106	31.6
Saw or smelled mold past 30 days	63	13.6	43	12.8
Indoor pets	243	52.6	176	52.5
Anyone smoked inside your home	61	13.2	48	14.3
Have cost barrier to medication	38	8.2	34	10.1
Have health insurance	419	90.7	309	92.2
Active asthma status	372	80.5	283	84.5
Obese	170	36.8	143	42.7
Ever told depressed	132	28.6	101	30.1
Poor perceived general health	46	10.0	43	12.8
Ever received pneumonia shot ever	204	44.2	175	52.2

Table 3 (continued)

Variables	2011		2013	
	n	%	*n*	%
Received adult flu shot/vaccine past 12 months	263	56.9	179	53.4

Characteristics of sample population in 2013. The sample was composed of 335 asthmatic adults in New Jersey. Seventy-two percent of the respondents were female. Over 45% of the respondents were married and 41% graduated from college. Over 72% of respondents were not given an asthma action pan. Thirty-three percent of respondents had an income of $75,000 or more. Over 92% of the respondents had health insurance coverage. Regarding personal habits, over 48% of respondents reported having never smoked a cigarette and over 99% never used smokeless tobacco products. Seventy-three percent of respondents did not use an air cleaner in their home and 68% did not use a humidifier inside their home. However, nearly 13% of respondents self-reported seeing or smelling mold in the homes and had someone smoked inside their home. Over 52% of participants had indoor pets. Over 39% of respondents did not ever have a pneumonia shot and over 46% did not have a flu shot/spray in the past 12 months. Regarding their personal health, over 84% of respondents had active asthma and over 42% were categorized as obese. Thirty percent of the respondents wee told by a physician that they were depressed and 12% reported having poor perceived general health. The frequencies and percentages of the sample characteristics was shown in Table 3.

Characteristics of sample population in low impact county group in 2013.

The low impact county group sample was composed of 62 asthmatic adults in New Jersey. Seventy-six percent of the respondents were female. Over 42% of the respondents were married and 28% graduated from college. Over 23% of respondents were given an asthma action pan. Thirty-one percent of respondents had an income of $75,000 or more. Over 96% of the respondents had health insurance coverage. Regarding personal habits, over 44% of respondents reported having never smoked a cigarette and over 96% never used smokeless tobacco products. Sixty-nine percent of respondents did not use an air cleaner and 66% did not use a humidifier inside their home. However, over 25% of respondents self-reported seeing or smelling mold in their homes in the past 30 days and 14% had someone smoked inside their home. Over 57% of participants had indoor pets. Over 63% of respondents reported ever having pneumonia shot and over 65% reported having a flu shot/vaccine in the past 12 months. Regarding their personal health, over 82% of respondents had active asthma and over 44% were categorized as obese. Thirty-six percent of the respondents were told by a physician that they were depressed and 12% reported having poor perceived general health. The characteristics of the low impact county group population in NJ was used as a baseline to compare with the characteristics of the high impact county group population in NJ. The frequencies and percentages of the low impact and high impact sample characteristics can be seen in Table 4.

Table 4

Characteristics of Asthmatic in Impacted County Groups in New Jersey in 2013

Variables	Low Impact County Group		High Impact County Group	
	n	%	*n*	%
Female	48	76.2	28	71.8
Married	27	42.9	17	43.6
Four years of college or more	18	28.6	14	35.9
Income $75,000 or more	20	31.7	12	30.8
Given an asthma action plan	15	23.8	12	30.8
Never smoked	28	44.4	23	59.0
Never used smokeless tobacco products	61	96.8	39	100
Air cleaner used	19	30.2	9	23.1
Dehumidifier used	21	33.3	12	30.8
Saw or smelled mold past 30 days	16	25.4	4	10.3
Have indoor pets	36	57.1	21	53.8
Anyone smoked inside your home	9	14.3	2	5.1
Have cost barrier to medication	5	7.9	6	15.4
Have insurance	61	96.8	34	87.2
Active asthma status	52	82.5	34	87.2
Obese	28	44.4	21	53.8
Ever told depressed	23	36.5	11	28.2
Poor perceived general health	8	12.7	4	10.3
Ever received pneumonia shot	40	63.5	22	56.4
Received adult flu shot/vaccine past 12 months	41	65.1	18	46.2

Characteristics of sample population in high impact country group in 2013.

The sample was composed of 39 asthmatic adults in New Jersey. Seventy-one percent of the respondents were female. Over 43% of the respondents were married and 35% graduated from college. Over 30% of respondents were given an asthma action pan. Thirty percent of respondents had an income of $75,000 or more. Over 86% of the respondents had health insurance coverage. Regarding personal habits, over 59% of

respondents reported having never smoked a cigarette and 100% never used smokeless tobacco products. Seventy-six percent of respondents did not use an air cleaner and 69% did not use a humidifier inside their home. However, over 10% of respondents self-reported seeing or smelling mold in their homes in the past 30 days and 5% had someone smoked inside their home. Over 53% of participants had indoor pets. Over 56% of respondents reported ever having a pneumonia shot and over 46% reported having a flu shot/spray in the past 12 months. Regarding their personal health, over 87% of respondents had active asthma and over 53% were categorized as Obese. Twenty-eight percent of the respondents were told by a physician that they were depressed and 10% reported having poor perceived general health. The frequencies and percentages of the sample characteristics was shown in Table 4.

In comparison, the two county groups are similar in demographics regarding gender, income, and education. Both groups are non-smokers and have health insurance coverage. The two groups do differ slightly in the frequency of individuals who were given an action plan, individuals who saw or smelled mold, and individuals who had cost barrier to medication.

Univariate Analyses

A chi-square test for independence was conducted to see if there is a significant association between the categorical predictors and the categorical dependent outcome of asthma exacerbation or attacks and asthma-related health care utilization. This step is necessary to assess which categorical predictors will be included in the logistic regression models. All cells were checked for expected values that fall below five because this means that the data violates the assumptions for univariate analyses. If

any cells had expected values below five, the value from the Fisher's exact test was utilized.

Univariate analyses in 2011. In 2011, there was a statistically significant association between having a cost barrier to medication and having an emergency room visit in the past 12 months, Pearson $\chi 2$ (2) = 21.512, p =0.000 There was a statistically significant association between perceived general health and emergency room visits in the past 12 months, Pearson $\chi 2$ (2) = 19.762, p =0.000.

Regarding having an overnight stay in the hospital in the past 12 months, perceived cost barrier to medication was found to be statistically significant, Pearson $\chi 2$ (2) = 15.539, p =0.002. Also, there was a statistically significant association between perceived general health and having an overnight stay in the hospital in the past 12 months, Pearson $\chi 2$ (2) = 22.740, p =0.000.

Regarding asthma exacerbation or attacks, there was a statistically significant association between having a cost barrier to medication and having an asthma exacerbation or attack in the past 12 months, Pearson $\chi 2$ (2) = 20.058, p =0.000. Additionally, there was a statistically significant association between being given an asthma management plan and having an asthma exacerbation or attack in the past12 months, Pearson $\chi 2$ (2) = 17.358, p =0.000. Finally, there was a statistically significant association between perceived general health and having an asthma exacerbation or attack in the past 12 months, Pearson $\chi 2$ (2) = 18.668 p =0.000. Results for the univariate analyses of the 2011 data is shown in Tables 5, 6 and 7.

Table 5

Descriptive Analysis for Predisposing, Enabling and Need Risk Factors for Emergency Room Visit Among Asthmatic in New Jersey

Variables	2011 *p* (X^2)	2013 *p* (X^2)	High Impact County Group *p* (X^2)	Low Impact County Group *p* (X^2)
Mold Inside Home	0.444 (0.104)	**0.026** (5.546)	**0.045** (7.649)	0.414 (0.547)
Cost Barrier to Medication	**0.000** (21.512)	**0.002** (13.357)	0.104 (4.103)	0.457 (0.434)
Asthma Management Plan	0.088 (2.418)	**0.016** (5.984)	0.078 (4.093)	0.545 (0.082)
Income	0.081 (2.426)	0.544 (0.015)	0.690 (0.025)	0.513 (0.178)
Insurance	0.231 (0.954)		0.687 (0.023)	
General Health	**0.000** (19.762)	0.075 (2.274)	0.455 (0.385)	0.545 (0.082)

Note. Boldface highlights significant predictors

Table 6

Descriptive Analysis for Predisposing, Enabling and Need Risk Factors for Hospital Visit Among Asthmatic in New Jersey

Variables	2011 *p* (X^2)	2013 *p* (X^2)	High Impact County Group *p* (X^2)	Low Impact County Group *p* (X^2)
Mold Inside Home	0.542 (0.106)	**0.011** (9.152)	0.197(3.618)	0.547 (0.719)
Cost Barrier to Medication	**0.002** (15.539)	**0.022** (7.689)	0.287 (1.940)	0.846 (0.178)
Asthma Management Plan	0.245 (0.895)	**0.001** (14.799)	0.089 (4.743)	0.056 (6.476)
Income	0.143 (1.872)	0.114 (2.24)	0.617 (0.142)	0.409 (1.152)
Insurance	0.071 (3.870)		0.757 (0.310)	0.937 (0.068)
General Health	**0.000** (22.740)	**0.022** (5.600)	0.405 (1.181)	0.130 (3.592)

Note. Boldface highlights significant predictors

Table 7

Descriptive Analysis for Predisposing, Enabling and Need Risk Factors for Asthma Exacerbation Among Asthmatic in New Jersey

Variables	2011 *p* (X^2)	2013 *p* (X^2)	High Impact County Group *p* (X^2)	Low Impact County Group *p* (X^2)
Mold Inside Home	0.342 (0.158)	0.286 (0.531)	**0.037** (5.20)	0.515 (0.071)
Cost Barrier to Medication	**0.000** (20.058)	**0.002** (9.747)	0.258 (1.201)	0.666 (0.004)

Table 7 (continued)

Variables	2011 *p* (X^2)	2013 *p* (X^2)	High Impact County Group *p* (X^2)	Low Impact County Group *p* (X^2)
Asthma Management Plan	**0.000** (17.358)	**0.000** (14.909)	0.252 (1.035)	0.093 (2.652)
Income	0.456 (0.047)	0.264 (1.390)	0.206 (1.414)	0.121 (2.100)
Insurance	0.402 (0.166)	0.179 (1.284)	**0.035** (4.916)	0.341 (1.451)
General Health	**0.000** (18.668)	0.067 (2.621)	0.511 (0.096)	0.143 (1.78)

Note. Boldface highlights significant predictors

Univariate analyses in 2013. In 2013, there was a statistically significant association between seeing or smelling mold inside the home and emergency room visits in the past 12 months, Pearson χ2 (2) = 5.546, p =0.026. There was a statistically significant association between having a cost barrier to medication and emergency room visits in the past 12 months, Pearson χ2 (2) = 13.357, p =0.002. Finally, there was a statistically significant association between being given an asthma management plan and emergency room visits in the past 12 months, Pearson χ2 (2) = 5.984, p =0.016.

In 2013, there was a statistically significant association between seeing or smelling mold inside the home and having an overnight stay in the hospital in the past 12 months, Pearson χ2 (2) = 9.152 p =0.011. There was a statistically significant association between having a cost barrier to medication and having an overnight stay in the hospital in the past 12 months, Pearson χ2 (2) = 7.689, p =0.022. Additionally, there was a statistically significant association between being given an asthma management plan and having an overnight stay in the hospital in the past 12 months, Pearson χ2 (2) = 14.799 p =0.001. Finally, there was a statistically significant association between perceived general health and having an overnight stay in the hospital in the past 12 months, Pearson χ2 (2) = 5.600 p =0.022.

In 2013, there was a statistically significant association between having a cost

barrier to medication and having an asthma exacerbation or attack in the past 12 months, Pearson $\chi 2$ (2) = 9.747, p =0.002. Additionally, there was also a statistically significant association between being given an asthma management plan and having an asthma exacerbation or attack in the past 12 months, Pearson $\chi 2$ (2) = 14.90 p =0.000. Finally, there was a statistically significant association between sex and having an asthma exacerbation or attack in the past 12 months, Pearson $\chi 2$ (2) = 6.76 p =0.006. Results for the univariate analyses of the 2013 data was shown in Tables 5, 6 and 7.

Univariate analyses for high impact county group and low impact county group in 2013. In the high impact county group, there was a statistically significant association between seeing or smelling mold inside the home and emergency room visits in the past 12 months, Pearson $\chi 2$ (2) = 7.649, p =0.045. No other risk factor was a significant predictor for emergency room visits in the high impact county group. Regarding having an overnight stay in the hospital, no predictor was found to be significant for the high impact county group. There was a statistically significant association between seeing or smelling mold inside the home and having an asthma exacerbation or attack in the past 12 months, Pearson $\chi 2$ (2) = 5.200 p =0.037. No predictor was statistically significant for the low impact county group. Results of the chi-square test for predisposing, enabling and need characteristic of asthmatic adults in New Jersey at the High Impact and Low Impact County Level was shown in Tables 5, 6 and 7.

Binomial Logistic Regression

To answer research question 1, 2 and 3 in the study, various binomial logistic regression models were run for the time period of 2011 and 2013. Tables 8, 9, and 10 summarized the results of the binomial logistic regressions for 2011 and 2013.

Binomial logistic regression analysis in 2011. To assess whether predisposing, enabling and need factors from the conceptual framework predict asthma -related emergency room visits in the last 12 months in 2011, a binomial logistic regression was conducted using the enter method. The dependent variable was emergency room visits in the last 12 months (yes/no) and the independent variables were predisposing (respondent sex, depression), enabling (perceived cost barrier to medication), and need (general health). The Wald test was used to demonstrate statistical significance between the binary dependent variable of emergency room visits and the Gelberg-Andersen's model predictors. Nagelkerke R^2 method was used to explain the variation in the dependent variable. In 2011, the logistic regression model was statistically significant, $\chi 2$ (4) = 35.189, p = 0.000. The model had a weak relationship as shown by the Nagelkerke R^2= 0.156 and explained only 15.6% of the variance in emergency room visits in the last 12 months. The *Hosmer-Lemeshow* statistic was not statistically significant (0.916) which mean the model was a good fit. The model correctly classified 89.9% of cases, which was close to the constant model. Individual coefficients were examined further by using the Wald criterion. The Exp (B) was used to determine all predicted probabilities of ER visits in the last 12 months. The model showed that having a perceived cost barrier to medication was a significant predictor, *OR* = 3.8, indicating that respondents who had perceived cost barrier to

medication were 3.8 times more likely to have a visit to the ER in the last 12 months than respondents who did not report perceived cost barrier to medication. The model showed that perceived general health was a significant predictor, *OR* = 0.4, indicating that respondents who reported excellent or good health were 2.5 times more likely to not have a visit to the ER in the last 12 months than respondents who reported having fair or poor health. Lastly, the model showed that depression was a significant predictor, *OR* = 2.2, indicating that respondents who reported having depression were 2.2 times more likely to have a visit to the ER in the last 12 months than respondents who did not report depression. The rest of the predisposing, enabling, and need factors were not significant. Results of the logistic regression are presented in Table 8.

Table 8

Predisposing, Enabling, and Need Factors to Predict an Asthma-Related Emergency Room Visit in the Last 12 months

	2011	2013
Logistic Regression Model Information	Model 1: Sex, Cost Barrier to Medication, General Health, Depression	Model 1: Sex, Mold, Cost Barrier to Medication, Asthma Management Plan
Significant Predictors*	*Enabling Factors* Cost Barrier to Medication (Reference No): OR = 3.8 (95% CI 1.7 – 8.6) *Need Factors* General Health (Reference fair or poor health): OR = 0.4 (95% CI 0.2 – 0.8) Depression (Reference No): OR = 2.2 (95% CI 1.1 – 4.3)	*Enabling Factors* Cost Barrier to Medication (Reference No): OR = 3.1 (95% CI 1.2 – 8.1) Asthma Management Plan (Reference No): OR = 2.7 (95% CI 1.2 – 6.0)

*Note. *p* <0.05

To assess whether predisposing, enabling and need factors predict asthma-related hospital visits in the last 12 months in 2011, a binomial logistic regression was conducted using the enter method. The dependent variable was hospital visits in the last 12 months (yes/no) and the independent variables were predisposing (respondent sex, depression), enabling (perceived cost barrier to medication), and need (general health). The Wald test was used to demonstrate statistical significance between the binary dependent variable of hospital visits and the Gelberg-Andersen's model predictors. Nagelkerke R^2 method was used to explain the variation in the dependent variable. In 2011, the logistic regression model was statistically significant, $\chi 2$ (4) = 26.930, p = 0.000. The model had a weak relationship as shown by the Nagelkerke R^2=.0.203 and explained only 20.3% of the variance in emergency room visits in the last 12 months. The *Hosmer-Lemeshow* statistic was not statistically significant (0.257) which mean the model was a good fit. The model correctly classified 96.1% of cases, which was the same as the constant model. Individual coefficients were examined further by using the Wald criterion. The Exp (B) was used to determine all predicted probabilities of hospital visits in the last 12 months. The model showed having perceived cost barrier to medication was a significant predictor, *OR* = 3.6, indicating that respondents who reported perceived cost barrier to medication were 3.6 times more likely to have a visit to hospital in the last 12 months than respondents who did not report perceived cost barrier to medication. The model showed that having excellent or good health was a significant predictor, *OR* = 0.1 indicating that respondents who reported having excellent or good health were 10 times more likely to not have a visit to hospital in the last 12 months than respondents who reported fair or poor health.

Results of the logistic regression are presented in Table 9.

Table 9

Predisposing, Enabling, and Need Factors to Predict an Asthma-Related Hospital Admission in the Last 12 months

	2011	2013
Logistic Regression Model Information	Model 1: Sex, Cost Barrier to Medication, General Health, Depression	Model 1: Sex, Mold, Asthma Management Plan, General Health
Significant Predictors *	Enabling Factor Cost Barrier to Medication (Reference No): OR = 3.6 (95% CI 1.2 - 10.8) Need Factor General Health (Reference fair or poor health): OR = 0.1 (95% CI 0.03 - 0.4)	Predisposing Factor Saw or Smelled Mold (Reference No): OR = 9.8 (95% CI 2.3 – 41.8) Enabling Factor Asthma Management Plan (Reference No): OR = 14.9 (95% CI 3.2 – 69.9) Need Factor General Health (Reference fair or poor health): OR = 0.2 (95% CI 0.05 – 0.8)

*Note. *p* <0.05

To assess whether predisposing, enabling and need factors predict asthma exacerbations or attacks in the last 12 months in 2011, a binomial logistic regression was conducted using the enter method. The dependent variable was asthma attacks or episodes in the last 12 months (yes/no) and the independent variables were predisposing (respondent sex, depression), enabling (perceived cost barrier to medication), and need (general health) factors. The Wald test was used to demonstrate statistical significance between the binary dependent variable of asthma exacerbations

or attacks and the Gelberg-Andersen's model predictors. Nagelkerke R^2 method was used to explain the variation in the dependent variable. In 2011, the logistic regression model was statistically significant, $\chi 2$ (4) = 36.879, p = 0.000. The model had a weak relationship as shown by the Nagelkerke R^2= 0.107 and explained only 10.7% of the variance in asthma exacerbation or attacks in the last 12 months. The *Hosmer-Lemeshow* statistic was not statistically significant (0.990) which mean the model was a good fit. The model correctly classified 67.2% of cases, which was the same as the constant model. Individual coefficients were examined further by using the Wald criterion. The Exp (B) was used to determine all predicted probabilities of asthma exacerbation or attacks in the last 12 months. The model showed having perceived cost barrier to medication was a significant predictor, *OR* = 1.3, indicating that respondents who reported perceived cost barrier to medication were 1.3 times more likely to have an asthma exacerbation or attack in the last 12 months than respondents who did not report perceived cost barrier to medication. The model showed that having excellent or good health was a significant predictor, *OR* = 0.5 indicating that respondents who reported having excellent or good health were 2.0 times more likely to not have an asthma exacerbation or attack in the last 12 months than respondents who reported fair or poor health. The rest of the predisposing, enabling, and need factors were not significant predictors. Results of the logistic regression are presented in Table 10.

Table 10

Results of Binomial Logistic Regression of Predisposing, Enabling, and Need Factors to Predict an Asthma Exacerbation or Attack in the Last 12 months

	2011	2013
Logistic Regression Model Information	Model 1: Sex, Cost Barrier to Medication, General Health, Depression	Model 1: Sex, Cost Barrier to Medication, Asthma Management Plan, General Health
Significant Predictors *	Enabling Factor Cost Barrier to Medication (Reference No): OR = 1.3 (95% CI 1.8 - 8.0) Need Factor General Health (Reference Fair or poor health): OR = 0.5 (95% CI 0.3 - 0.8)	Enabling Factors Cost Barrier to Medication (Reference No): OR = 2.9 (95% CI 1.4 – 6.1) Asthma Management Plan (Reference No): OR = 2.6 (95% CI 1.6 – 4.4) Predisposing Factor Sex (Reference Male): OR = 1.8 (95% CI 1.0 - 3.1)

Note. $*p < 0.05$

Binomial logistic regression analysis in 2013. To assess whether predisposing, enabling and need factors predict asthma-related emergency room visits in the last 12 months in 2013, a binomial logistic regression was conducted using the enter method. The dependent variable was emergency room visits in the last 12 months (yes/no) and the independent variables were predisposing (respondent sex, presence of mold), enabling (income), and need (general health). The Wald test was used to demonstrate statistical significance between the binary dependent variable of emergency room visits and the Gelberg-Andersen's model predictors. Nagelkerke R^2 method was used to explain the variation in the dependent variable. In 2013, the logistic regression model was not statistically significant, $\chi 2\ (4) = 7.644$, $p = 0.106$. The model had a weak relationship as shown by the Nagelkerke $R^2 = 0.058$ and explained only

5.8% of the variance in emergency room visits in the last 12 months. The *Hosmer-Lemeshow* statistic was not statistically significant (0.187) which mean the model was a good fit. The model correctly classified 91.6% of cases, which was the same as the constant model. Individual coefficients were examined further by using the Wald criterion. The Exp (B) was used to determine all predicted probabilities of ER visits in the last 12 months. The model showed that having a perceived cost barrier to medication was a significant predictor, *OR* = 3.1, indicating that respondents who had cost barrier to medication were 3.1 times more likely to have a visit to the ER in the last 12 months than respondents who did not report perceived cost barrier to medication. The model showed that being given an asthma management plan was a significant predictor, *OR* = 2.7, indicating that respondents who were given an asthma management plan were 2.7 times more likely to have a visit to the ER in the last 12 months than respondents who were not given an asthma management plan. The rest of the predisposing, enabling, and need factors were not significant. Results of the logistic regression was presented in Table 8.

To assess whether predisposing, enabling and need factors predict asthma related hospital visits in the last 12 months in 2013, a binomial logistic regression was conducted using the enter method. The dependent variable was hospital visits in the last 12 months (yes/no) and the independent variables were predisposing (respondent sex, presence of mold), enabling (income), and need (general health). The Wald test was used to demonstrate statistical significance between the binary dependent variable of hospital visits and the Gelberg-Andersen's model predictors. Nagelkerke R^2 method was used to explain the variation in the dependent variable. In 2013, the logistic

regression model was statistically significant, χ2 (4) = 12.706, *p* = 0.013. The model had a weak relationship as shown by the Nagelkerke R^2= 0.146 and explained only 14.6% of the variance in emergency room visits in the last 12 months. The *Hosmer-Lemeshow* statistic was not statistically significant (0.204) which mean the model was a good fit. The model correctly classified 96% of cases, which was the same as the constant model. Individual coefficients were examined further by using the Wald criterion. The Exp (B) was used to determine all predicted probabilities of hospital visits in the last 12 months. The model showed that seeing or smelling mold inside the home was a significant predictor, *OR* = 9.8, indicating that respondents who saw or smelled mold inside their home were 9.8 times more likely to have a visit to hospital in the last 12 months than respondents who did not see or smell mold inside their home. The model showed that being given an asthma management plan was a significant predictor, *OR* = 14.9, indicating that respondents who were given an asthma management plan were 14.9 times more likely to have a visit to hospital in the last 12 months than respondents who were not given an asthma management plan. The model showed that having excellent or good health was a significant predictor, *OR* = 0.2, indicating that respondents who had excellent or good health were 5.0 times more likely to not have a visit to hospital in the last 12 months than respondents who reported fair or poor health. The rest of the predisposing, enabling, and need factors were not significant. Results of the logistic regression was presented in Table 9.

To assess whether predisposing, enabling and need factors predict asthma exacerbations or attacks in the last 12 months in 2013, a binomial logistic regression was conducted using the enter method. The dependent variable was asthma

exacerbations or attacks in the last 12 months (yes/no) and the independent variables were predisposing (respondent sex), enabling (asthma management plan, perceived cost barrier to medication), and need (general health). The Wald test was used to demonstrate statistical significance between the binary dependent variable of asthma attacks or episodes and the Gelberg-Andersen's model predictors. Nagelkerke R^2 method was used to explain the variation in the dependent variable. In 2013, the logistic regression model was not statistically significant, $\chi 2$ (4) = 6.372, p = 0.173. The model had a weak relationship as shown by the Nagelkerke R^2= 0.029 and explained only 2.9% of the variance in asthma exacerbations or episodes in the last 12 months. The *Hosmer-Lemeshow* statistic was not statistically significant (0.204) which mean the model was a good fit. The model correctly classified 63.5% of cases, which was the same as the constant model. Individual coefficients were examined further by using the Wald criterion. The Exp (B) will be used to determine all predicted probabilities of asthma exacerbation or attacks in the last 12 months. The model showed that having a perceived cost barrier to medication was a significant predictor, *OR* = 2.9, indicating that respondents who had perceived cost barrier to medication were 2.9 times more likely to have an asthma exacerbation or attack in the last 12 months than respondents who did not report perceived cost barrier to medication. The model showed that being given an asthma management plan was a significant predictor, *OR* = 2.6, indicating that respondents who were given an asthma management plan were 2.6 times more likely to have an asthma exacerbation or attack in the last 12 months than respondents who were not given an asthma management plan. Lastly, the model showed that respondent sex was a significant predictor, OR = 1.8, indicating that respondents who were female

were 1.8 times more likely to have an asthma exacerbation or attack compared to respondents who were male. The rest of the predisposing, enabling, and need factors were not significant. Results of the logistic regression was presented in Table 10.

CHAPTER V

DISCUSSION AND CONCLUSIONS

In this study, determinants of asthma exacerbation and asthma-related health care utilization before and after a natural disaster event was identified using the Gelberg-Andersen Behavioral Model for Vulnerable Populations as a guiding framework. This chapter discusses the findings from the study and how these findings relate to the current research literature and impact public health practice or policy.

Main Findings and Interpretations

Application of theoretical framework in study. The major finding from applying an adapted version of the Behavioral Model for Vulnerable Populations to the study of asthma health outcomes in New Jersey was that it was essential to include variables from the "vulnerable" domains in the Gelberg-Andersen Behavioral Model for Vulnerable Populations. Many of the significant predictors from the study such as Mold and General Health came from the vulnerable domains listed in the theoretical framework. The original Anderson Model for Healthcare Utilization does not specifically have these vulnerable domains so these significant variables could have been overlooked. Also, it was found from the study that applying the theoretical framework helped guide the data analysis process. Since there were numerous variables that impacted asthma exacerbations/attacks and asthma-related health care utilization, measuring the impact of all the possible factors that impacted asthma exacerbations and asthma-related health care utilization was not feasible. The Gelberg-Anderson Behavioral model helped identify predictors for asthma exacerbation and asthma-related health care utilization for the univariate, bivariate and multivariate analyses.

However, application of the model alone was not enough to identify key predictors of asthma exacerbation and asthma-related health care utilization for the primary main effects model. It was necessary to put the variables that were identified as significant from bivariate analyses in a multivariate model and then test for multicollinearity and interaction effects. Therefore, the theoretical framework can be used as a guide to identify the factors that may impact asthma exacerbation and asthma-related health care utilization. However, the framework cannot be used alone without further statistical analysis methods because some of the theoretical constructs can be closely related such as income and perceived cost barrier. Also, utilizing the theoretical framework alone will result in having too many variables in the final multivariate model which can lead to issues with multiple comparison bias (Coppock, 2016).

Asthma health outcomes before and after Hurricane Sandy in NJ. There was a total of 462 people in NJ in the 2011 state dataset and 335 people in NJ in the 2013 state dataset. From comparing the sample characteristics of the 2011 and 2013 state data, it was found that both years are parsimonious in terms of demographics, smoking status and health insurance. However, these two groups differed in their frequencies related to perceived general health, being given an asthma management plan, and cost barrier to medication. The 2013 group showed higher percentages of people who reported poor perceived general health (12.8% in 2013 vs 10.0% in 2011), higher percentages of people who were given an asthma action plan (26.3% in 2013 vs. 23.4% in 2011), and higher percentages of people who reported perceived cost barrier to medication (10.1% in 2013 vs. 8.2% in 2011). The sample characteristic for the study population supports what is in the current literature that many New Jersey residents

identified poorer mental and physical following Hurricane Sandy and many residents identified having financial issues following the hurricane (Boscarino et al., 2014; Gargano et al., 2018; Marshall et al., 2016; Pizzi, 2015; Swerdel, Janevic, Cosgrove, Kostis, & Myocardial Infarction Data Acquisition System (MIDAS 24) Study Group, 2014).

Results from the binomial logistic regression for asthma exacerbation or attacks in the last 12 months shows that the null hypothesis for research question 1 can be rejected. Predisposing factor such as gender was found to be a significant predictor of asthma exacerbation or attacks in the last 12 months. Specifically, it was found that compared to men, women were 1.8 times more likely to have an asthma exacerbation or attack in the last 12 months. This finding supports the current literature that shows that asthma is more prevalent as well as severe in woman compared to men (Zein & Erzurum, 2015). Enabling factors such as having a perceived cost barrier to medication and being given an asthma management plan was found to be significant predictors of asthma exacerbation or attacks in the last 12 months. Having a perceived cost barrier to medication is found in the literature to be associated with poorer asthma management in adults so supports the current literature (Briesacher, Gurwitz, & Soumerai, 2007; McQuaid, 2018; The American College of Allergy, Asthma and Immunology, 2008). An unexpected finding from the binomial logistic regression was that asthmatic adults who were given an asthma management plan was more likely to have an asthma exacerbation or attack compared to people who were not given a plan. One possible explanation for this increase in likelihood to have an asthma exacerbation or attack is that having an asthma management plan may make an asthmatic individual less likely

to visit a general practitioner for regular check-ups until the person's condition worsens greatly to the point where they have an exacerbation (Kelso, 2016).

Results from the binomial logistic regression for asthma-related emergency room visit in the last 12 months shows that the null hypothesis for research question 2 can be accepted. Predisposing factors are not significantly associated with asthma-related emergency room visit in the last 12 months. The only significant predictors were enabling factors of perceived cost barrier to medication and being given an asthma management plan. The finding that perceived cost barrier to medication is associated with more asthma-related emergency room visits in asthmatic adults supports the current literature. Research shows that cost barriers are a leading cause of nonadherence to treatment plan. In the case of asthma, non-adherence to asthma medication treatment is associated with poor asthma control and asthma management which can lead to an increase in asthma-related health service utilization (Briesacher et al., 2007; Knoeller, Mazurek, & Moorman, 2011; McQuaid, 2018; Patel, Brown, & Clark, 2013). An unexpected finding was that compared to people who were not given an asthma management plan, people who were given an asthma management plan were 2.7 times more likely to report an asthma-related emergency room visit in the last 12 months. This is unusual because having an asthma management plan is supposed to instruct an asthmatic individual on when to change the amount or type of medicine, when to call the doctor for advice and when to go to the emergency room. Therefore, an asthmatic adult who is given and adheres to an asthma management plan should have better managed asthma and less likelihood to have an asthma-related emergency room visit. A study by Oraka et al. found similar findings. This could allude to a possibility that

the patients received the asthma management plan after their visit to the emergency room (Oraka, Iqbal, Flanders, Brinker, & Garbe, 2013).

Findings from the binomial logistic regression for asthma-related hospital admission in the last 12 months shows that the null hypothesis for research question 2 can be rejected. The predisposing factor of seeing or smelling mold inside the home was significantly associated with asthma-related hospital admission in the last 12 months. Specifically, asthmatic adults who reported seeing or smelling mold inside their home were 9.8 time more likely to have a hospital admission in the last 12 months compared to asthmatic adults who did not report seeing or smelling mold inside their home. This finding support the current literature that having mold inside disaster impacted homes can lead to a rise in hospital admission (Barbeau et al., 2010; Gargano et al., 2018; Malik et al., 2017; Sharp et al., 2016). The need factor of perceived general health was also a significant predictor for asthma-related hospital admission in the last 12 months. People who reported having excellent or good health were 5.0 times more likely to not report an asthma-related hospital admission in the last 12 months compared to people who reported having fair or poor health. This finding supports the current literature that good health related quality of life is associated with better asthma management and asthma outcomes (Guilbert et al., 2011; Jansson et al., 2016; Mroczek et al., 2017; Ross et al., 2013; Wisnivesky et al., 2005). An unexpected finding was that compared to people who were not given an asthma management plan, people who were given an asthma management plan were 14.9 times more likely to report a hospital admission in the last 12 months. This finding was supported by the current literature, which states that this association may indicate that asthmatic adults are

receiving the asthma management plan at the hospital instead of at their primary care physician office (Oraka et al., 2013).

Asthma health outcomes after Hurricane Sandy in County Groups in NJ. From comparing the sample characteristics of the high impact county group and low impact county group, it was found that the two groups are similar in terms of demographics, smoking status and health insurance. However, these groups differ in their frequencies related to seeing or smelling mold inside their home, depression status and perceived general health. An unexpected finding was that the low impact county group had a higher percentage of people who reported seeing or smelling mold inside their home (25.4% in low impact county group vs. 10.3% in high impact county group), a higher percentage of people who reported being diagnosed with depression (36.5% in low impact county group vs. 28.2% in high impact county group), and a higher percentage of people who reported have poor perceived general health (12.7% in low impact county group vs. 10.3% in high impact county group). These results support the finding that some areas that were identified as having low impact based on the Community Hardship Index experienced some hardship due to Hurricane Sandy. Since the index was used as method to provide quick assistance to areas that were most vulnerable to impacts of the storm, being identified as low impact may have left those areas without quick access to disaster assistance (Halpin, 2013).

Findings from the descriptive analysis of asthma-related emergency room visits in the past 12 months for the high impact and low impact county groups in NJ show that the null hypothesis for Research Question 3 can be rejected. The predisposing factor of seeing or smelling mold was a significant predictor for asthma-related emergency room

visits in the past 12 months in the high impact county group compared to the low impact county group. This finding supports the current literature, which states that high impact counties such as Monmouth County and Ocean County experienced extreme flooding which led to excessive mold growth within the homes (Halpin, 2013). Results from the descriptive analysis of asthma-related hospital admissions in the past 12 months for the high impact and low impact county groups in NJ show that the null hypothesis for Research Question 3 can be accepted. Predisposing factors were not significantly associated with asthma-related health care utilization in the high impact county group compared to the low impact county group. Findings from the descriptive analysis of asthma exacerbation or attacks in the past 12 months for the high impact and low impact county groups in NJ show that the null hypothesis for Research Question 3 can be rejected. The predisposing factor of seeing or smelling mold was a significant predictor for asthma exacerbation or attacks in the past 12 months in the high impact county group compared to the low impact county group. This finding supports the current literature which shows that exposure to mold can be an asthma trigger for asthmatic adults (Barbeau et al., 2010; Bloom et al., 2009; D'Amato & Cecchi, 2008; "Department of Health | Environmental Health | Mold," n.d.; Mirsaeidi et al., 2016; Saporta & Hurst, 2017; Shea et al., 2008; Takaro et al., 2013).

Limitations and Strengths of Study

One of the limitations of the study is that the survey data was self-reported, so it is vulnerable to recall bias and social desirability bias. Although the literature has identified many important factors that impact asthma health management and asthma health care utilization in asthmatic adults, all these factors could not be considered in

the study as a result of this study being a secondary data analysis. The impact of current regulations and social reforms are also important to consider when examining asthma management but were not studied and tested so direct implications regarding the impact of these factors cannot be discussed. In addition, the study time period post disaster was only a year because according to the NJACBS codebook, the data is only comparable for analysis from 2011 to 2013. Before 2011 and after 2013, the CDC employed different weighting methodologies for the raw data. This is a limitation because the long-term impacts of the natural disaster on asthma attacks and asthma related health care utilization cannot be assessed pass the acute response and recovery phase of the natural disaster. Regarding the data analysis, only the relationship between the variables can be examined so no cause and effect conclusions can be made. Some of the questions on the NJACBS survey is ambiguous and can be interpreted differently. One of these questions is “Have you seen or smelled mold in your home in the past month?” It may be difficult to quantify the “smell” of mold as well as have an individual who is not trained in mold identification to positively identify what they are seeing as mold and not some other substance such as mildew or stains. Only landline data was used so the cellphone population was not considered. Since cellphone use is increasingly popular among many users, this may have reduced the sample size of the study population for the state and county model, but this decision was necessary in order to compare the two years. The county model had limited statistical power because the sample size was too low based on stratifying by the Community Hardship index.

The study had several strengths. For one, this study is one of the very few that

examines asthma exacerbations/attacks and asthma-related health care utilization using a behavioral based theoretical framework. Although many studies have been conducted regarding Hurricane Sandy, there are limited studies that look at both the environmental and behavioral factors that predict asthma exacerbation and asthma-related health care utilization in the United States. The most recent study that examined these similar outcomes was in Puerto Rico. Statistical methods were used in supplement to the conceptual framework to guide all analyses conducted within the study. The data sets utilized in the study is validated and tested for reliability by the Center for Disease Control and Prevention.

Implications

Disaster preparedness and asthma management during and after a hurricane. Hurricane Sandy placed great strain on healthcare systems and healthcare providers to provide adequate pre-disaster level quality of care to chronically ill individuals. Many studies showed that health care systems in New Jersey were overwhelmed during and immediately after Hurricane Sandy (Donohue, 2013; “Hurricane Sandy puts NJ hospital under extreme stress, highlighting vulnerabilities, areas requiring improvement,” 2013; King et al., 2016; McQuade et al., 2018; Traynor, 2012; Whiteside, n.d.; Young, 2012). Health care systems struggled the most with power loss and coordination with care. To ensure that healthcare providers are ready to provide care for chronically ill patients such as asthmatic adults, during and after the occurrence of a natural disaster such as Hurricane Sandy, it is essential to include disaster preparedness into the training of healthcare providers. One study identified healthcare preparedness as a national security priority that can help the nation reduce

the long-term health consequences of natural disasters (Toner, 2017). The American College of Emergency Physicians recommends that trainings that simulate a disaster situation where there are multiple system failures are offered to all healthcare providers, especially the providers who are charged with providing care to chronically ill patients (Whiteside, n.d.). Hospital administrators should provide more training for health care professionals in hurricane impacted areas so that they know how to manage chronic conditions with power outages and multi-system failures. In addition, medical conferences should offer special workshops or training that will provide health care providers with best practices and recommendations on how effectively provide care during and after a natural disaster event such as a hurricane.

Besides health care providers, asthmatic adults should also take actions to ensure that they can properly manage their asthma during and after a hurricane. **I**t is essential to get all medications refilled before natural disaster event occurs and have medications accessible, especially for people with poor perceived health quality of life. Asthmatic adults should continue to take all prescribed medications and follow their asthma management plan (State of New Jersey Health Department, 2017). In addition, it is essential that asthmatic adults see their primary care physician doctor following the occurrence of a natural disaster if they feel that their asthma is getting worse due to the extra environmental triggers that may result from the disaster.

Environmental and public health implications. Mold was a major public health issue in New Jersey as a result of the Hurricane Sandy. Asthmatic adults in NJ affected by hurricanes have increased health risk from mold exposure. Immediate repair of flooded or water damaged homes is needed to reduce presence of Mold and to reduce

hazardous long-term exposure to the mold. However, before engaging in cleanup after hurricane, asthmatic adults should review available state and local resources regarding how to protect their health. They can assess these local resources from the Official NJ website, Federal Emergency Management Agency Website. Renters can contact local building office for assistance with Mold remediation. To help prevent emergency room visits and hospital stay after a hurricane event, asthmatic adults should take preventative actions. If possible, asthmatic adults should avoid prolonged exposure to areas with excessive mold and other indoor irritants. These individuals should Wear N95 dust mask when doing cleanup, isolate moldy work areas from living areas, do not try to remediate a large mold problem and consider getting professional help (State of New Jersey Department of Health, 2017).

Policy implications. Findings from the study show that asthma management plans may be given to asthmatic adults more often in the emergency room than in the primary care setting which is the opposite of what is recommended by the Healthy New Jersey initiative. New Jersey recommends that patients are given an asthma management plan when they visit the doctors to help them recognize the symptoms of an asthma attack, know what medicine and dosage to use and know when to seek medical attention. Having an asthma management plan is even more important after a natural disaster event such as Hurricane Sandy because there may be more asthma triggers from the high winds, flooding, and storm surge. Policy makers should increase the number of asthma management plans that are given to asthmatic adults after a natural disaster in a primary care setting. Also, it is essential to train health care professionals to be more effective at giving asthma management plan at each office or

urgent care visit. This will ensure that the patient not only receive the asthma management plan but truly understand how to effectively use it to manage their asthma. Asthma management plans should also be given at the free clinics and at the aid offices where medical assistance is provided. This will ensure that these asthmatic individuals have access to the asthma management plans if they decide not to visit their own medical provider.

To improve NJ department of Health understanding of the effectiveness of being given an asthma management plan, it is recommended that additional questions regarding adherence and understanding of the asthma management plan are added to the NJACBS questionnaire. The BRFSS state coordinator for New Jersey or NJBRFSS designated data personnel should be contacted regarding the process of adding state-specific questions (Center for Disease Control and Prevention, 2019). This deeper insight into whether asthmatic individuals who are given an asthma management comprehend the content or use the plan in their daily management of asthma will help policy makers implement better laws or regulations regarding how the plan is given to asthmatic individuals. Better understanding of the effectiveness of current asthma management plan efforts will also help New Jersey accomplish the Healthy New Jersey 2020 objective to increase adults with an asthma action plan (New Jersey Department of Health, 2014).

Federal and State emergency response officials and emergency management planners should consider both the Community Hardship Index and FEMA flooding maps when assessing health impacts from the occurrence of a hurricane. Although the Community Hardship Index helps provide a measure to compare the damage across

New Jersey counties, utilizing the Community Hardship Index alone can underestimate the true extent of the damage from the Hurricane. For example, certain counties that were identified as low impact according to the Community Hardship Index experienced extreme storm surge according to the FEMA flooding maps (Halpin, 2013). Failure to identify the true damage and environmental vulnerability of these identified low impact county areas can impact those areas ability to effectively mitigate and recover from damage from the disaster.

Conclusions

Primary contributions of this study. This study, to our knowledge, was the first application of the Gelberg-Anderson Behavioral Model for Vulnerable Populations to study asthma exacerbations/attacks and asthma-related health care utilization in a pre-disaster setting and after a natural disaster event. The theoretical model has been used previously to study the elderly, or homeless (Gelberg et al., 2000b; Stein et al., 2007b, 2012). In addition, there are few studies that investigate asthma-related health care utilization at the county level using the Hurricane Sandy Community Index and FEMA flooding surge maps together as tools for county group stratification. This study presents a possible methodology to examine predictors of asthma-related health care utilization at the county level.

Results from this study can provide new knowledge to the literature regarding the impact of perceived health related quality of life, perceived cost barriers and being given an asthma management plan on asthma management and asthma-related healthcare utilization after the occurrence of a natural disaster event in New Jersey. Findings from this study can help disaster planners, policy makers and public health professionals in

NJ improve their current approach to addressing the needs of asthmatic adults in New Jersey in the event of a future natural disaster such as a hurricane.

Widening the scope of the conceptual model. The Behavioral Model for Vulnerable Population was useful in analyzing asthma-related health care utilization among asthmatic adults before and after a natural disaster event such as Hurricane Sandy. To further understand the impact of population characteristics like predisposing factors, enabling factors and need factors on asthma-related health care utilization and asthma exacerbation within a pre and post disaster impacted population, future applications of the conceptual model should consider the outcome construct. Asthma exacerbations or attacks can also be considered an evaluated outcome in future use of the model. Examining the outcome construct will provide more insight into the health status of asthmatic adults who use health services as well as their satisfaction with the care that they receive. It is found that for asthmatic adults, improved symptoms and quality of life is better obtained from effective regular interactions with a healthcare provider compared to just receiving an educational intervention alone (Robert John Adams, 2010). Future application of the conceptual framework should consider other vulnerable domains such as transportation and literacy. Transportation to primary care physicians and pharmacies were identified as issues related to extreme flooding in the roadways in New Jersey (Arya, Medina, Scaccia, Mathew, & Starr, 2016; Whiteside, n.d.). Inadequate literacy was found to be strongly associated with poor management of asthma in asthmatic patients.

Future directions. This research study has created many future research opportunities to pursue. To better understand what happened to asthmatic adults in

New Jersey in long-term recovery, it will be necessary to examine asthma-related health care utilization and asthma attacks in New Jersey from 2014 and onward. This will be possible when the CDC releases newer datasets on their official ACBS website. Further examination into methods to stratify county groups using different indexes and methods is necessary to see if the findings from the county group analyses will differ substantially. Also, a different county stratification method can help to increase the statistical power of the county group analysis. It would be informative to compare asthma-related health care utilization findings from the ACBS with the New Jersey State Health Assessment Data (NJSHAD) to see the accuracy of the asthma-related health care utilization reporting. NJSHAD is a new tool that allows researchers to analyze inpatient and emergency department discharge records online. Typically, this hospital reported data is not readily obtained online so analysis using the data is more difficult. However, since NJSHAD provides the data online and free of charge, it is now possible to compare the two datasets easily.

The impact of new policies and regulations on the asthma management of the pre and post disaster population at the state and county level was not examined in this study but would be an interesting research topic to examine further. It was found that implementing health care reform or new health care regulations can have profound effects on health care systems, health care providers and patient's health (Larrat, Marcoux, & Vogenberg, 2012). Specifically, the impact of disaster-related response and mitigation regulations/policies on the asthma-related health care utilization and asthma exacerbation of asthmatic adults in New Jersey since the occurrence of Hurricane Sandy would provide a good indicator of state's response to the disaster event.

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APPENDIX A

Survey Questions from NJBRFSS AND NJACBS

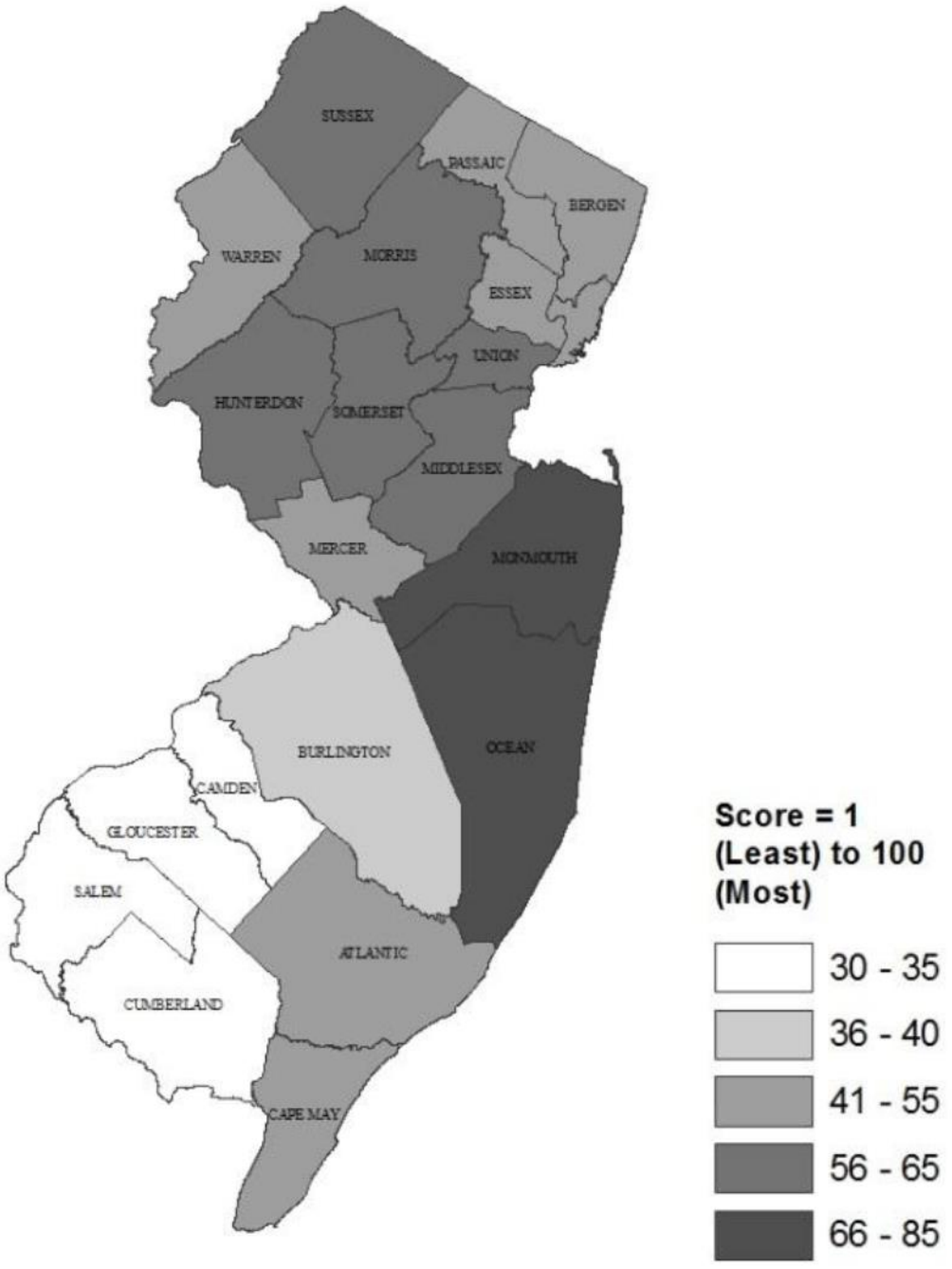
Conceptual Framework Construct	Disaster-Related Risk Factors	Survey Question
Predisposing Factors	Age	Respondents age
	Gender	Indicate sex of respondent. Ask only if necessary.
	Marital Status	Are you (married, divorce widowed, separated, never married)?
	Employment Status	Next, we are interested in things that affect asthma in the workplace. However, first I'd like to ask how you would describe your current employment status. Would you say?
	Race/Ethnicity	How do other people usually classify you in this country? Would you say: White, Black or African American, Hispanic or Latino, Asian, Native Hawaiian or Other Pacific Islander, American Indian or Alaska Native, or some other group?
	Mold	In the past 30 days, has anyone seen or smelled mold or musty odor inside your house? Do not include mold on food.
	Diagnosed Depression	Have you ever been told by a doctor or health professional that you were depressed?
Enabling Factors	Health Insurance Status	Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such Medicare or Medicaid?
	Income	Is your annual household income from all sources?
	Perceived Cost Barriers to Primary Care Physician	Was there a time in the past 12 months when you needed to see your primary care doctor for your asthma but could not because of the cost?
	Perceived Cost Barriers to Specialist	Was there a time in the past 12 months when you were referred to a specialist for asthma care but not could go because of cost?
	Perceived Cost Barriers to Medication	Was there a time in the past 12 months when you needed to buy medication for your asthma but could not because of the cost?
	Asthma Management Plan	An asthma action plan, or management plan, is a form with instructions about when to change the amount or type of medicine, when to call the doctor for advice, and when to go to the emergency room. Has a doctor or other health professional ever given you an asthma action plan?

APPENDIX A (continued)

Conceptual Framework Construct	Disaster-Related Risk Factors	Survey Question
Need Factor	Perceived General Health	Would you say in general your health is-
	Perceived Activity Limitation	During the past 12 months, would you say you limited your usual activities due to asthma not at all, al little, a moderate amount, or a lot?
	Active Asthma Status	Active asthma status
Health Behavior	Asthma Exacerbation or Attack	During the past 12 months, have you had an episode of asthma or an asthma attack?
	Emergency Room Visit	An urgent care center treats people with illnesses or injuries that must be addressed immediately and cannot wait for a regular medical appointment. During the past 12 months, have you had to visit an emergency room or urgent care center because of your asthma?
	Hospital Visit	During the past 12 months, that is since (1 year ago today), have you had to stay overnight in a hospital because of your asthma? Do not include an overnight stay in the emergency room

APPENDIX B

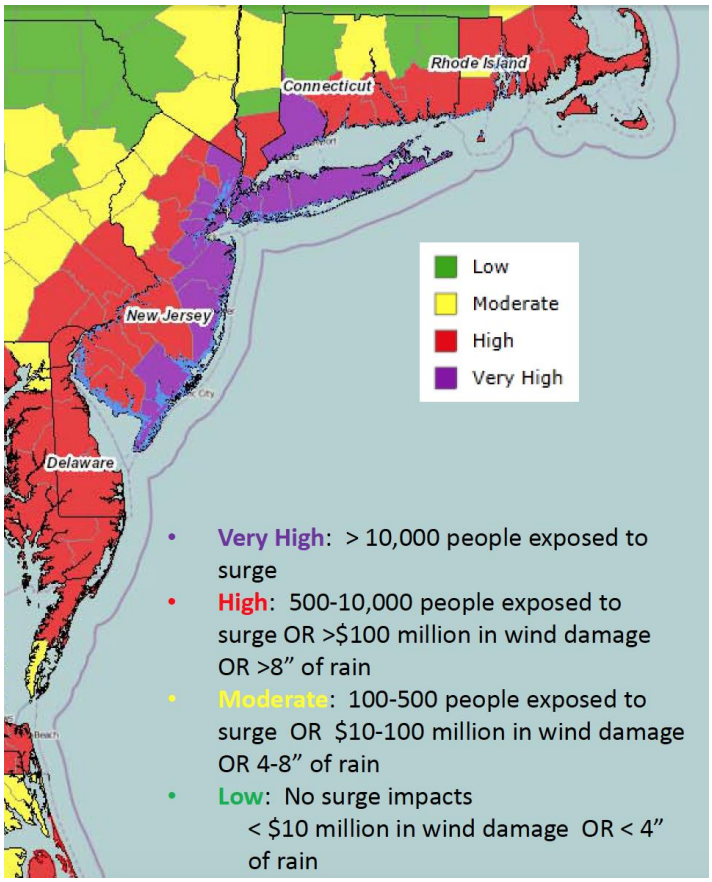
Sandy Community Hardship Index for New Jersey Counties



Note. Image of the Sandy Community Hardship Index for New Jersey Counties. Reprinted from The impact of Superstorm Sandy on New Jersey towns and households, by Stephanie Halpin, retrieved from New Jersey Environmental Digital Library Copyright 2013 by School of Public Affairs and Administration, Rutgers-Newark

APPENDIX C

Federal Emergency Management Agency Hurricane Sandy Impact Analysis Map



Note. Image of the Federal Emergency Management Agency Hurricane Sandy Impact Analysis Map. Adapted from Hurricane Sandy, by Eric Blake, March 28, 2013, retrieved from National Hurricane Center

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May, 2019: Ph.D. in Health Services Research, Old Dominion University
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December, 2008: B.S in Environmental Health (Dean's List), Old Dominion University

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May 2011-August 2011: Industrial Hygiene Contractor, ALTRIA Inc. Center of Research and Technology
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MOST RELEVANT OF EIGHT PUBLISHED PAPERS

Akpinar-Elci M, Bidaisee S, Nguyen MT, Elci OC. (2017). Occupational exposure and respiratory health problems among nutmeg production workers in Grenada, the Caribbean. *International Journal of Occupational and Environmental Health, 23(1),* 1–5.

Blando J, Nguyen MT, Sheth-Chandra M, Akpinar-Elci M. (2016). Virginia air quality: trends, exposure, and respiratory health impacts. *Virginia Journal of Science, 66(3),* 371-388.

Akpinar-Elci M, Nguyen MT, Bidaisee S, Elci OC. (2016). Pesticide exposure in the Caribbean: A case from nutmeg processing. *Journal of Environmental Health, 78(6),* 62–4.

Nguyen MT, LaPointe S, Jennings B, Zoumplis A. (2011). Gulf of Mexico air quality: CALIPSO decision support for Gulf of Mexico air quality relating to the deepwater horizon oil spill. *IEEE Oceanic Engineering Society Earthzine Online Journal.*

MOST RELEVANT OF SIXTEEN RESEARCH STUDY PRESENTATIONS

Nguyen MT, Blando J, Kekeh M, Olayinka O, Akpinar-Elci. (2018, November). *Predictors of Asthma Attacks and Asthma Health Care Utilization in Asthmatic Adults in New Jersey After a Natural Disaster Event.* Poster presented at American Public Health Association Annual Meeting and Expo. San Diego, CA

Nguyen MT, Blando J. (2018, October). *Predictors of Asthma Attacks and Asthma Health Care Utilization in Asthmatic Adults in New Jersey After Hurricane Sandy. Oral presentation given at* MASS Workshop. New Brunswick, NJ

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