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Asthma Determinants, Health Care Utilization, and Control Among Women in Puerto Rico

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This is to certify that the doctoral dissertation by

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has been found to be complete and satisfactory in all respects,
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Walden University
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Abstract

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MSEM, Metropolitan University, 2000

BS, University of Puerto Rico, 1983

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Active asthma and asthma-related health care utilization are higher among adult females than they are among adult males in Puerto Rico. The purpose of this study was to examine the determinants of the risk of active asthma and associated health care utilization and asthma control among women in Puerto Rico. Guided by the Andersen behavioral model, the study included data from the Asthma Call-Back Survey (ACBS) during 2011 and 2012 in Puerto Rico. The associations between active asthma and behavioral, demographic, and environmental factors were assessed using logistic regression. The relationship between asthma-related health care utilization and predisposing, enabling, and need factors was examined using multiple linear regression. The association between achieved level of asthma control and asthma-related healthcare utilization was investigated using multinomial logistic regression. Results of the logistic regression indicated that being out of work, being in a middle income category, and being obese significantly increased the odds of active asthma. Being self-employed and being in the income category of $15,000-$25,000 significantly predicted the frequency of emergency room visits (ERVs). Results of the multinomial logistic regression indicated that physician urgent visit and ERV were significantly associated with poorly controlled asthma symptoms. The positive social change implication of these findings is that the identified risk factors can be used to develop asthma management plans to prevent and control asthma attacks in at-risk populations and reduce asthma-related health care utilization cost.

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Dedication

I dedicate this dissertation to every woman in the world who overcomes risk factors and manages her asthma condition effectively.

Acknowledgments

I am grateful to the universe's driven actions for placing in my life those whom I could count on. Nobody came to my life by accident; each person was a blessing for my growth process. In 2009, an announcement on the Internet showed me the way to complete a PhD at Walden University. Although I had a master's degree, I had to complete a public health master's first and then the doctorate.

Thanks to all professors at Walden University, and especially to Dr. Mary Lescoe-Long for a year full of learning during my proposal phase. To Dr. Cheryl Cullen, who embraced me during a hard time when I thought all was lost. Dr. Cullen has guided me in the last and most important phase. To Dr. Laurence Fulton, who has taught me a lot by his patience. To Dr. Gudeta Fufaa, Walden URR, for refining the dissertation with accurate comments.

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I spent a lot of hours away from my family; to them, my biggest appreciation. To begin and finish a doctorate, one must be determined, constant, and resilient to overcome financial challenges, lack of time, and well-being difficulties.

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Chapter 1: Introduction to the Study

Asthma is a chronic disease that affects the respiratory system, but with different functional and pathological characteristics from chronic obstructive pulmonary disease (Fabbri et al., 2003). Investigating the relationships among social, behavioral, and environmental risk factors and relating those factors to the level of health care utilization and the control of asthma symptoms among adult females in Puerto Rico is an important public health endeavor. In Puerto Rico, adult females have higher asthma morbidity and lifetime risk of contracting the disease compared to adult males (Bartolomei-Díaz, Hernández, Amill-Rosario, 2009; Perez-Perdomo, Pérez-Cardona Disdier-Flores, & Cintrón, 2003). Additionally, adult females in Puerto Rico utilize health care more than adult males (Bartolomei-Díaz, 2007; Bartolomei-Díaz et al., 2009). Asthma-related health services in Puerto Rico cost millions of dollars every year on potentially preventable asthma care services (CDC's National Asthma Control Program, 2013a). Therefore, there is a need to determine which risk factors are associated with higher asthma prevalence rates and health care utilization among females in Puerto Rico and how this impacts the level of control in asthma among the study population.

The results of this study provide supporting evidence regarding the determinants of asthma and specific asthma-related services utilization and level of asthma control among women in Puerto Rico. Because women have nonmodifiable risk factors that challenge them to keep asthma under control, knowledge regarding modifiable risk factors for asthma control could inform clinical practitioners about additional considerations relevant to the medical management of this target population (Van den

Berge, Heijink, Van Oosterhout, & Postma, 2009). This knowledge could inform clinical specialists about additional considerations relevant to the medical management of asthma in this population. This evidence could further inform public health care practice in Puerto Rico and contribute to improved health education and health promotion interventions directed toward adult female asthmatics. This investigation has the potential to contribute to positive social change by improving both the self-management and clinical management of asthma in the study population, and reducing the incidence of uncontrolled asthma among women in Puerto Rico. As well, the results have the potential to contribute to the Healthy People's goal of reducing asthma-related health care costs (Federal Interagency Workgroup, 2014), particularly for public health administration in Puerto Rico.

In this chapter, I present a summary of this investigation. The background section includes the information related to asthma prevalence and risk factors establishing the current gap in the literature and justifying the need for this research. The problem statement section includes the evidence that demonstrates the significance and relevance of this study for public health in Puerto Rico. The chapter continues with the connection of the research problem with the purpose of the study, as well as the dependent and independent variables for the study. I also state the research questions and hypotheses, as well as the theoretical framework that guides this investigation. This chapter also includes sections presenting conceptual definitions, the nature of this study, assumptions, scope and delimitations, and limitations. The chapter concludes with the significance of the study and a summary.

Background

Researchers have linked nonmodifiable and modifiable factors with asthma outcomes considering asthma as a multifactorial disease (Subbarao, Mandhane, & Sears, 2009). The contribution of each of these factors has been examined relative to distinct populations within the United States and other countries; however, little literature exists in which researchers have characterized the relationship of risk factors to asthma control among adult asthmatics in Puerto Rico, and specifically for the adult female population. Some researchers suggested reasons for increased asthma prevalence among Puerto Ricans (Chen et al., 2013; Loyo-Berrios, Orengo, & Serrano-Rodríguez, 2006; Naqvi et al., 2007; Reibman & Liu, 2010) and among women generally (Real, Svanes, Macsali, & Omenaas, 2008; Real, 2007; Macsali et al., 2009), but did not establish links to the sociodemographic, behavioral, and environmental factors potentially unique to asthma control.

Investigators have determined that Puerto Ricans of both genders have a genetic susceptibility to asthma (Chen et al., 2013; Loyo-Berrios et al., 2006; Naqvi et al., 2007; Reibman & Liu, 2010) and are less responsive to bronchodilators than other Hispanic or ethnic groups (Gwynn, 2004; Naqvi et al., 2007). In addition, researchers have demonstrated that female hormone levels are associated with reduced lung function, increased asthma susceptibility, and increased incidence of asthma-related symptoms (Real et al., 2008; Real, 2007; Macsali et al., 2009). Although genetic factors and hormonal risk factors explain some measure of the general propensity for asthma among Puerto Rican women, minimal research exists that targets the distribution of modifiable

risk factors or examines the contribution of modifiable risk factors to uncontrolled asthma among adult females in Puerto Rico.

While researchers have associated social risk factors with higher asthma symptoms, especially those with lower socioeconomic status (Bacon, Bouchard, Loucks, & Lavoie, 2009; Corvalan et al., 2005; Curtis, Wolf, Weiss, & Grammer, 2012; Ekerljungl, Sundblad, Rönmark, Larsson, & Lundbäck, 2010; Johannesen, Eagan, Omenaas, Bakke, & Gulsvik, 2010; Shiue, 2013), the majority of studies have been done isolated from behavioral and environmental factors contributing to asthma outcomes. The relationship between income, unemployment, and asthma health services and control has not been examined among women with asthma in Puerto Rico. The percentage of the population with health insurance coverage is substantially higher in Puerto Rico than in the United States, and as coverage is not tied to employment status, an investigation into these relationships could better define asthma risks in the Commonwealth of Puerto Rico (Pérez-Perdomo, García-Rivera, & Serrano-Rodríguez, 2005; U.S. Department of Health and Human Services, Office of Minority Health, 2012; Vogt, Bersamin, Ellenberg, & Winkleby, 2008).

Behavioral risk factors for asthma that have been broadly studied in the United States and other countries, but not among adult females in Puerto Rico with asthma uncontrolled, include smoking, obesity, and lack of physical activity (Akerman, Calacanis, & Madsen, 2004; Benet et al., 2011; Ford, Heath, Mannino, & Reed, 2003; García-Aymerich, Varraso, Antó, & Camargo, 2009; Shavit et al., 2007; Strine, Balluz, & Ford, 2007; Vortmann & Eisner, 2008). Shavit et al. (2007) found that smokers are more

likely to have asthma nighttime symptoms and use more asthma health-related services. Akerman et al. (2004), Vortmann and Eisner (2008), and Strine et al. (2007) found that obese asthmatics reported more chronic symptoms than nonobese asthmatics. Physically inactive asthmatic adults were more likely to visit the emergency room than physically active asthmatics (Benet et al., 2011; Ford et al., 2003; García-Aymerich et al., 2009; Strine et al., 2007). In Puerto Rico, Perez-Perdomo et al. (2003) found an association between obesity and asthma, and secondhand smoke was associated with an increase in asthma among exposed children. However, no studies in Puerto Rico have addressed the impact of these risk factors on either asthma symptomology or service utilization, and no studies have targeted the adult female population.

Previous studies on environmental risk factors and asthma addressed indoor environmental allergens that breed organic asthma triggers such as mold, mites, and cockroaches, and chemical asthma triggers such as secondhand smoke (Jaakkola, Piipari, Jaakkola, & Jaakkola, 2003; Loyo-Berrios et al., 2006; Quintero, Rivera-Mariani, Bolaños-Rosero, 2010; Nazario et al., 2012; Nguyen et al., 2010; Nguyen, King, & Dube, 2014). Neither of these risks has been examined relative to Puerto Rican women, despite the fact that Puerto Rico has a very humid climate (Quintero et al., 2010). Furthermore, it is not known to what extent women with current asthma in Puerto Rico have environmental modifications in place in their homes to control these triggers (Lara, Ramos, González, & Morales, 2009).

The study of the contribution of modifiable risk factors associated with asthma-related health services and asthma control is in accordance with the specific objectives in

Healthy People to reduce asthma impact on people's health and the burden on the public health budget by 2020 (Federal Interagency Workgroup, 2014). Because uncontrolled asthma attacks account for the majority of asthma-related expenditures in the form of emergency room visits and hospitalizations (CDC's National Asthma Control Program, 2013b), there is a need to identify the factors that distinguish controlled from uncontrolled asthma among females in Puerto Rico, to plan effective and efficient health-prevention activities (Peat & Li, 1999; Subbarao et al., 2009), and to improve health care service distribution (Jandasek et al., 2011; Lara et al., 2009) for adult female asthma sufferers in Puerto Rico. This was the first study that addressed the relationship between social, behavioral, and environmental factors associated with asthma-related health care utilization and uncontrolled asthma among women in Puerto Rico.

Problem Statement

Although asthma affects millions of people of different races, genders, and ages around the world, Puerto Ricans are facing a significant disparity in asthma morbidity and mortality (Federal Interagency Workgroup, 2014). According to the Centers for Disease Control and Prevention (CDC, 2011a), the prevalence of adult lifetime asthma in the unincorporated territory of Puerto Rico is higher (15.2%) than in the continental United States and Hawaii combined (13.5%). The lifetime and current asthma prevalence in Puerto Rico is 14.6% and 7.5% respectively, showing no significant changes during the last 10 years (CDC, 2013b). Additionally, the incidence of asthma-related mortality was consistently higher in the commonwealth of Puerto Rico than in the rest of the

United States from 1999 through 2007 (Bartolomei-Díaz, Amill-Rosario, Claudio & Hernandez, 2011).

Among Puerto Ricans, active asthma is higher for adult females (9.2%) than for adult males (5.5%), a percentage that had remained constant in the last 10 years (Bartolomei-Díaz & Acevedo, 2013). Adult females are observed to have higher hospital admissions, higher emergency room visits, and higher drug claims for asthma-related symptoms and illnesses than any adult male population (Bartolomei-Díaz et al., 2009). Women have longer length of stay in hospitals than men (Scott, Woods, Brown, & Engel, 2010), thus increasing health care costs. Among females, the 40 to 54 age group is the most impacted by asthma hospitalizations (Lin & Lee, 2008; Melero-Moreno et al., 2012).

The determinants of uncontrolled asthma specifically among the adult female population of Puerto Rico remain unexplored. This review demonstrates a gap in the literature in which previous studies have addressed risk factors isolated from other factors and their influence on asthma control level. In addition, there have been no studies addressing the impact of asthma among adult females on health care service utilization in Puerto Rico. Research specifically targeting females is supported by McHugh, Smymaski, Pompeii, and Delclos (2009), who stated that research should explore asthma risk factors by gender and recommended disaggregating data by sex to better explain asthma prevalence, asthma-related health status, and health care use among women (Nowatski & Grant, 2011; Valerio et al., 2009). Therefore, in this study I address the gap in the literature by studying females with uncontrolled and controlled asthma symptoms

and their connections with social, behavioral, and environmental factors and patterns of asthma-related health care utilization and asthma control.

Purpose of the Study

Given the marked difference in the incidence and control of asthma symptoms among women relative to men in Puerto Rico, and the impact on health care utilization, I conducted a quantitative systematic examination of secondary databases to establish the relationships among the sociodemographic, behavioral, and environmental risk factors for current asthma status. I also compared those factors to asthma-related service utilization and the achieved control of asthma level among adult females in Puerto Rico. Initially, I assessed the relationship between sociodemographic, behavioral, and environmental determinants associated with a diagnosis of current asthma status in the study sample of the target population. The independent variables in this assessment were age group, education, marital status, employment, income, smoking, physical activity, obesity, secondhand smoke, pets, molds, and vectors, such as rodents and cockroach, and environmental modifications, such as air cleaner inside home and dehumidifier.

Second, I employed the Andersen model to examine the impact of predisposing, enabling, and need factors on asthma-related health care utilization among a sample of asthmatic women in Puerto Rico. Among predisposing factors, the independent variables were age group, education, marital status, employment; among enabling factors, the independent variables were health insurance and income. Among need factors, the independent variable was self-rated health status.

Finally, I applied the Andersen factors and asthma-related health services to explain achieved level of asthma control among a sample of adult female asthmatics in Puerto Rico. Among predisposing factors, the independent variables were age group, education, marital status, and employment; among enabling factors, the independent variables were health insurance and income. Among need factors, the independent variable was self-rated health status. To assess the relationships described before, I conducted logistic regression, multiple linear logistic regression, and multinomial logistic regression fully described in Chapter 3.

Research Questions and Hypotheses

The research questions for this investigation were guided by the Andersen model, which identifies determinants of health service utilization as predisposing, enabling, or need factors (Aday & Andersen, 1974; Andersen, 1968; Andersen, 1995; Andersen & Newman, 1973/2005). Predisposing characteristics are variables that prime individuals to use health care services and include demographic characteristics, social structure, and health beliefs (Aday & Andersen, 1974). Enabling resources facilitate or impede health care use and include personal, family, and community resources. Need is measured by perceived need, which is the individual's own assessment of the need for medical services, and clinically evaluated need, which is the health care provider's professional recommendation for service use (Aday & Andersen, 1974). Considering the general determinants for asthma and predictors for health care utilization in the Andersen model, I established the following three research questions:

RQ1: To what extent do sociodemographic, behavioral, and environmental variables differentiate between active and nonactive asthma status at the point of assessment in the sample of adult females living in Puerto Rico?

RQ2: To what extent do predisposing, enabling, and need factors explain health care utilization in the study sample of asthmatic adult females living in Puerto Rico?

RQ3: To what extent do predisposing, enabling, need, and health care utilization explain the level of asthma control in the study sample of asthmatic adult females in Puerto Rico?

To answer the first research question, I tested the following hypotheses regarding social risk factors as described by Aday (2001), behavioral risk factors as described by Traore (2010), and environmental risk factors as described by March, Sleiman, and Hakonarson (2011) and their relation to current asthma status among the study sample of adult females in Puerto Rico.

$H_0$1: Sociodemographic (age group, marital status, education, income, employment, health insurance coverage), behavioral (smoking, physical activity, meets aerobic, body mass index), and environmental (secondhand smoke, mold, pets, cockroach, dehumidifiers, and air cleaner use) variables are not significantly associated with the presence of active asthma in the study sample.

$H_1$1: Sociodemographic (age group, marital status, education, income, employment, health insurance coverage), behavioral (smoking, physical activity, meets aerobic, body mass index), and environmental (secondhand

smoke, mold, pets, cockroach, dehumidifiers, and air cleaner use) variables are significantly associated with the presence of active asthma in the study sample.

For the second research question, I tested hypotheses supported by the Andersen behavioral framework, which has been widely used for the assessment of chronic conditions and lifestyle behaviors and their relation to health service utilization at the individual level (Johnson, Carroll, Fulda, Cardarelli, &Cardarelli, 2010; Lo & Fulda, 2008; Parslow & Jorm, 2004; Piper, Elder, Glover, Baek, & Murph, 2010; Redondo-Sendino, Guallar-Castillón, Banegas, & Rodríguez-Artalejo, 2006; Xu, Patel, Vahratian, & Ransom, 2006). The following hypotheses include the Andersen factors and their relation to asthma-related health care utilization among a study sample of adult females in Puerto Rico.

$H_0$2: Predisposing (age group, marital status, education, employment), enabling (income, health insurance coverage), and need (self-rated health status) factors are not significantly associated with asthma-related health care utilization (physician urgent visits, emergency room visits, hospitalizations) in the study sample.

$H_1$2: Predisposing (age group, marital status, education, employment), enabling (income, health insurance coverage), and need (self-rated health status) factors are significantly associated with asthma-related health care utilization (physician urgent visits, emergency room visits, hospitalizations) in the study sample.

For the third research question, I tested hypotheses supported by the three sets of risk factors of the Andersen model and asthma-related health care utilization with the achieved asthma control level.

$H_0$3: Predisposing (age group, marital status, education, employment), enabling (income, health insurance coverage), and need (self-rated health status) factors are not significantly associated with achieved level of asthma control (well controlled, not well controlled, very poorly control) in the study sample.

$H_1$3: Predisposing (age group, marital status, education, employment), enabling (income, health insurance coverage), and need (self-rated health status) factors are significantly associated with achieved level of asthma control (well controlled, not well controlled, very poorly control) in the study sample.

$H_0$4: Asthma-related health care utilization (physician urgent visits, emergency room visits, hospitalizations) is not significantly associated with achieved level of asthma control (well controlled, not well controlled, very poorly control) in the study sample.

$H_1$4: Asthma-related health care utilization (physician urgent visits, emergency room visits, hospitalization) is significantly associated with achieved level of asthma control (well controlled, not well controlled, very poorly control) in the study sample.

Theoretical and Conceptual Framework for the Study

Theoretical Foundation

This study employed Andersen's framework of health services utilization (Andersen, 1995). The Andersen model elucidates health care utilization using three sets of factors (see Figure 1). The first set consists of those factors that encourage people to use health services (predisposing factors), and they are operationalized using sociodemographic variables such as age, marital status, employment, education, and employment (Aday & Andersen, 1974; Andersen, 1968; Andersen, 1995; Andersen & Newman, 1973/2005). The second set of factors includes variables that either facilitate or impede the use of services (enabling factors), and include variables such as the access to health care services, source of care, and income (Aday & Andersen, 1974; Andersen, 1968; Andersen, 1995; Andersen & Newman, 1973/2005). The final set is termed need factors and consists of variables related to how people perceive their general health (Aday & Andersen, 1974; Andersen, 1968; Andersen, 1995; Andersen & Newman, 1973/2005).

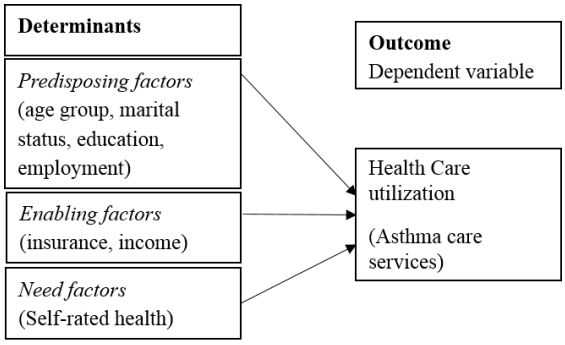

Figure 1. Andersen behavioral model for health care utilization on asthma. Adapted from "Revisiting the Behavioral Model and Access to Medical Care: Does it Matter?" by R. M. Andersen, 1995, *Journal of Health and Social Behavior*, *36*, p. 2. Reprinted with permission.

Researchers using the Andersen framework have demonstrated the robustness of the model in not only explaining health care utilization, but also in distinguishing between different levels of illness manifestation (Andersen, 1995; De Boer, Wijker, & De Haes, 1997; Jandasek et al., 2011; Jonhson et al., 2010; Piper et al., 2010; Redondo-Sendino et al., 2006). According to general findings from the Andersen model, researchers have concluded that in conditions of greater severity, the use of health services will be explained by predisposing and need factors rather than enabling factors. Perceived need explains care seeking and adherence, while evaluated need explains the kind and amount of treatment provided by medical care providers. I describe these findings in detail in Chapter 2.

The factors in the Andersen model are consistent with the variables available in the secondary data set used for the investigation, and statistical logic to operationalize the later versions of the Andersen framework. To make the appropriate links to the Andersen model, I assessed the relationship of the social, behavioral, and environmental risk factors with current asthma status in the target population. Then, I evaluated the influence of the independent variables on the dependent variables, the use of health care services and the resulting health status of the study population (see Figure 2). Finally, the target population suffers from a chronic illness state, a type of condition for which the Andersen model has been proven to be well suited.

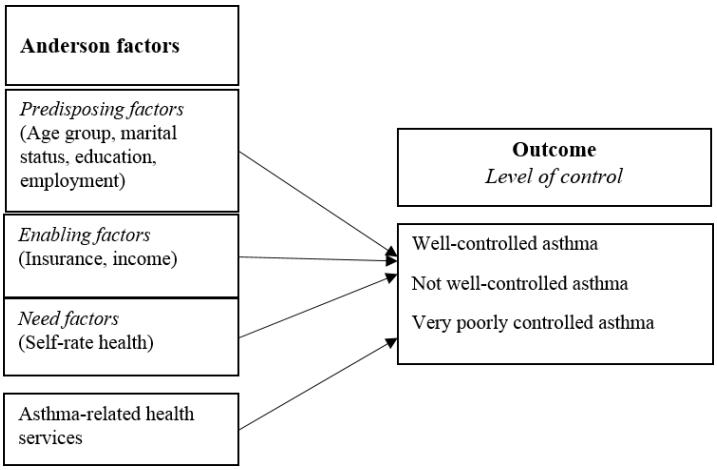

Figure 2. Andersen factors and health care utilization explaining asthma control level. Adapted from "Revisiting the Behavioral Model and Access to Medical Care: Does it Matter?" by R. M. Andersen, 1995, *Journal of Health and Social Behavior, 36*, p.8. Reprinted with permission.

Conceptual Framework

In this investigation, I incorporated the concepts of social, behavioral, and environmental health determinants generally, and those determinants that impact current asthma specifically. For social risk factors, I used the definitions according to Aday (2001), who considered both individual and community dimensions. For Aday, health determinants at the individual level are defined by their social status including nonmodifiable and modifiable risk factors. Among modifiable risk factors, Aday embraced how social capital and human capital factors provide opportunities at the individual and community level to develop people's skills and capabilities that influence health outcomes. Human capital factors provide access and opportunities to advantageous living and working environments and better health care services (Aday, 2001; Commission on Social Determinants of Health, 2007). As well, Aday conceived social

capital as those factors that promote social support networks at the individual and community level reducing individual vulnerability to illness.

Researchers have used Aday social risk factors to investigate their relationship with asthma outcomes among adults (Bacon et al., 2009; Corvalan et al., 2005; Curtis et al., 2012; Ekerjung, Sundblad, Rönmark, Larson, & Lunbäck, 2010; Shiue, 2013). Among different races and ethnicities, lower human capital has been related consistently with asthma incidence (Ekerjung et al., 2010), with asthma prevalence and severe asthma symptoms (Corvalan, 2005; Shiue, 2013), and with poorer asthma control and higher health care utilization (Bacon et al., 2009; Curtis et al., 2012). For researchers studying social capital and its relationships with adults with asthma, there are fewer consistent results. The influence of marital status on asthma outcomes varies across cultures (Hosseinpoor et al., 2012) or does not account for significant differences among adults (Johannesen et al., 2010; Shiue, 2013). However, Droga, Kuk, Baker, and Jamnik (2011) found that marital status was a protective factor for pulmonary function among married females. I describe these studies in Chapter 2.

For asthma behavioral risk factors, I used the characterization of Traore (2010), who described four personal lifestyle/behavioral factors that predispose to asthma: smoking, secondhand smoke, obesity, and physical activity. By its involuntary exposure, secondhand smoke is also considered an environmental risk factor (Traore, 2010). Researchers who support evidence that behavioral risk factors impact asthma are Akerman et al. (2004); Benet et al. (2007); Eisner (2008); Ford, Head, Mannino, and Reed (2003); García-Aymerich et al. (2009); Jaakkola, Piipari, Jaakkola, and Jaakkola

(2003); Nguyen, King, and Dube (2014); Shavit et al. (2007); Strine, Balluz, and Ford (2007); Vortmann and Eisner (2008); Weiss, Utell, and Samet (1999), and the World Health Organization (2014a). I describe these studies in Chapter 2.

For environmental risk factors that impact asthma, I included variables with scientific evidence related to exposures to environmental stimuli, such as climate variables, infectious organisms, allergens, and irritants that interact with genetic factors to increase risk of asthma attack exacerbations. Platts-Mills (2009) found that the exposure to outdoor or indoor triggers can induce contraction of the bronchioles or small airways, increase airway inflammation, and cause prolonged increases in contraction of the airways. Individual vulnerability is greater for women who have asthma and are pregnant or nursing, or are older than 50 years (United States Department of Health and Human Services, 2012). Studies from Arif and Declos (2012); Jie, Ismail, Jie, and Isa (2011); Quintero et al., (2010); Nazario et al. (2012); Nguyen et al. (2010); and Wen, Balluz and Mokdad (2009) are described in Chapter 2. As a more recent trend, researchers have demonstrated the need to assess mixed risk factors as a combination of social, behavioral, and environmental predictors for asthma outcomes (Jackson, Roberts, & Pearlman, 2011; Knoeller, Mazurek, & Moorman, 2013; Nguyen, Zahran, Iqbal, Peng, & Boulay, 2011; Slejko et al., 2013; Trupin et al., 2010; Trupin et al., 2013).

Nature of the Study

In this study, I used a quantitative methodology to analyze secondary cross-sectional data from the Centers for Disease Control's Surveys conducted in Puerto Rico during 2011 and 2012. I selected an observational design instead of an experimental or

quasi-experimental approach because the study was not intended to measure the impact of a specific treatment or intervention (Creswell, 2009). In addition, sociodemographic variables cannot be manipulated in experiments. Prospective cohort studies are appropriate when there is a short time interval of the exposure to produce the outcomes (Carlson & Morrison, 2009). Thus, an observational cross-sectional design was the most appropriate design to assess relationships within my variable set.

A subsample was taken from the Asthma Call-Back Survey (ACBS) from the Centers for Disease Control and Prevention composed for female adults (18 ≥ years) residing in Puerto Rico. The sample included adult females identified as current asthmatics according to their responses to the questions "Have you ever been told by a doctor or other health professional that you have asthma?" and "Do you still have asthma?" (CDC, 2013d, p. 4).

The three dependent variables in this study were current asthma status, asthma-related service utilization, and achieved level of asthma control. To assess asthma current status, I used three sets of independent dichotomous variables regarding sociodemographic, behavioral, and environmental risk factors. The independent variables to establish these relationships were age group, education, marital status, employment, income, smoking, physical activity, body mass index, secondhand smoke, pets, vectors, and environmental modifications.

The dependent variable asthma-related health services was composed of one continuous variable (number of urgent visits to physician) and two dichotomous categorical variables (emergency room visit and hospitalization). These dependent

variables were associated with three sets of independent variables grouped as predisposing, enabling, and need factors. Among predisposing factors, the independent variables were age group, education, marital status, employment. Among enabling factors, the independent variables were health insurance and income. Among need factors, the independent variable was self-rated health status.

Finally, I assessed the dependent achieved asthma level of control as an ordinal variable composed of three levels (well controlled, not well controlled, and very poorly controlled) and related these with four sets of independent variables: predisposing factors, enabling factors, need, and asthma-related health services. Among predisposing factors, the independent variables were age group, education, marital status, and employment. Among enabling factors, the independent variables were health insurance and income. Among need factors, the independent variable was self-rated health status. Among asthma-related health services, I used the continuous variable (number of urgent visits to physician) and two dichotomous categorical variables (emergency room visit and hospitalization).

ACBS has proven to be a powerful tool for analysis producing valid and reliable results through the years (Mokdad, 2009). ACBS maintains the highest quality standards for representative sampling in each state, ongoing data collection, recruitment, and participation year after year (Mokdad, 2009). I transferred to this investigation the standards of a well-designed survey that follows scientific standards and ethical procedures.

Operational Definitions

Current asthma status: Refers to asthma as an active condition at the point of assessment (Moorman et al., 2012).

Asthma-related health care utilization: Refers to the times that a person sees a doctor, visits an emergency room, or stays overnight in a hospital because of asthma over a year's time (Andersen, 1995).

Achieved level of asthma control: Refers to clinical control, or the frequency and intensity of asthma symptoms and the patient's physical limitations during day and night, and the number of times the participant required oral corticosteroids in the previous 12 months (Bousquet et al., 2010).

Age group: Refers to the age of the participant according to age by group as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Education: Refers to the level of education completed as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Income: Refers to the annual household income from all sources as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Marital status: Refers to whether or not a person is married, divorce, widowed, separated, never married, or a member of an unmarried couple as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Employment: Refers to the employment status, such as employed by wages, self-employed, out of work more than 1 year, out of work more than 2 years, homemaker,

student, retired, or unable to work as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d)

Health care insurance: Refers to having any type of health insurance at the time of assessment as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Body mass index (BMI): Refers to an index using weight to classify overweight and obesity in adults, where weight in kilograms is divided by the square of height in meters (WHO, 2014a).

Physical activity: Refers to the recommendation for U.S. adults as 30 minutes or more of moderate-intensity physical activity on all or most days of the week (Pate et al., 1995).

Smoking status: Refers to smoking cigarettes at the time of the assessment as defined in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Exposure to secondhand smoke: Refers to if anyone has smoked in the home, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Molds inside home: Refers to if anyone has seen or smelled mold or a musty odor inside the home as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Pets inside home: Refers to if anyone has pets, such as dogs, cats, hamsters, birds spending time indoors, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Cockroach inside home: Refers to if anyone has seen a cockroach inside home, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Rodent inside home: Refers to if anyone seen mice or rats inside home, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Air cleaner use: Refers to if anyone used an air cleaner or purifier filter to trap indoor air pollutants like dust, pollen, mold and chemicals inside home, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Dehumidifier use: Refers to if anyone used a dehumidifier to reduce moisture inside the home, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Self-rated health: Refers to the general health status (good, better, fair and poor, as asked in the Behavioral Risk Factor Surveillance System (CDC, 2013d).

Assumptions

For this study, there were assumptions derived from the theoretical foundation and the nature of the study. First, I assumed that the Andersen framework was an appropriate and reliable model to measure health care utilization and asthma control among the target population for the study. The independent variables coincided with the Andersen model's conceptualization of individual characteristics and health behaviors as the intermediate factors affecting outcomes. As well, the model has been proven to be well suited to measure chronic conditions at individual level, which is compatible with asthma outcomes.

Second, because the secondary data available for this study were from a cross-sectional survey, I assumed that self-reported information represented accurate responses from the target population. The cross-sectional data survey was designed using random sampling and stratification that controlled systematic differences across participant responses (Nelson, Holtzman, Waller, Leutzinger, & Condon, 1998), thereby increasing representativeness and generalizability of results.

Scope and Delimitations

First, the sample for this study was limited to adult females18 years or older living in Puerto Rico who participated in the Asthma Call-Back Survey during 2011 and 2012. Females were selected based on their disparity in asthma outcomes as compared to men. The age of the target sample was based on the definition of an adult. The time period selected for data collection was based on the most updated and available data for researchers. Two years of data were selected to increase the power of the sample. The years selected were consistent in terms of sampling, collection, and weighting methods.

Second, I used cross-sectional survey data taken at specific points in time, which generates threats to internal and external validity. The design of this study had the potential internal threats of selection bias, mortality bias, testing bias, instrumentation bias, and social desirability bias (see Chapter 3 for details). Because the survey design did not allow me to control all of the internal validity threats, I described the potential bias in the results. In terms of external validity, the use of randomly selected participants, the standards for the collection methods, and the stratification process assured the quality of the data and the representativeness of the target population under study.

Third, I relied on social risk factors as described by Aday (2001), who was selected because collaborations with Andersen, and whose determinants matched perfectly with this study. The social variables selected for this study were age, marital status, education, income, and employment due to the secondary data used. I did not select other Aday variables such as race/ethnicity because the population of Puerto Rico is 99% Hispanic and this variable is not measured in surveys done in the Island. Gender was controlled in selection criteria because only females were included in the sample.

In terms of behavioral and environmental risk factors, I included those related with asthma outcomes as described by Taore (2010) and March, Sleiman, and Hakonarson (2011). The behavioral variables were cigarette smoking, obesity, and physical activity. The environmental variables were indoor quality asthma triggers such secondhand smoke (which is also considered a behavioral determinant, but not for this investigation), pets and vectors inside, and modifications of the environment that can control those triggers such as air purifiers. Outdoor quality risk factors were excluded from this investigation.

Fourth, I employed the Andersen behavioral model (BM) as the theoretical foundation. BM was consistent with the operationalization of the variables and the logic of this study. BM has evolved according to new advances in knowledge, but has maintained its applicability in measuring health care utilization (Andersen, 2008). The model has the plasticity to include several individual or population determinants using secondary data according to what the researcher wants to answer across different populations (Hogan, Gaddy, & Yun, 2012; Lo & Fulda, 2008; Piper et al., 2010; Xu et

al., 2006). The determinants selected for this study under predisposing BM have been widely used by researchers (Babitsch, Gohl, & von Lengerke, 2012) to assess differences in health care utilization between women and men (Hogan et al., 2012; Redondo-Sendino et al., 2006; Xu et al., 2006) and to assess differences in asthma outcomes with consistent results (Jandasek et al., 2011; Piper et al., 2010).

Given the scope and delimitations, the findings of this study are applicable only to adult females diagnosed with asthma living in Puerto Rico. Therefore, the findings cannot be generalizable to other races/ethnicities or subpopulations with asthma living in Puerto Rico or elsewhere.

Limitations

First, the use of secondary data had limitations because I could not control the variables included, or the sampling and collection methods. The two years selected for this study (2011 and 2012) could be combined because the CDC employed the same data collection and weighting methods. However, the sample selection in ACBS 2011 differed from ACBS 2012 data because the 2011 sample included only landline phone participants, and the 2012 sample included both landline and cellular phones participants. Despite this difference, both databases were weighted according the type of sampling selection.

Second, a researcher using a cross-sectional design retrieves data at a single point in time and does not allow for establishing a relationship between disease and time of exposure.

Third, cross-sectional designs have low internal validity because of the nature of the survey data. Selection bias was a potential threat among participants who were willing to participate in the asthma Call-Back and who may have been different from those who did not participate. Mortality bias was present because not all of the potential participants who self-reported asthma in the parental survey completed the ACBS. However, Puerto Rico had a low refusal rate and high response rate among participants who were asked to complete the ACBS during 2011.

Significance

Results of this study could be used to create a women profile with supporting evidence regarding the determinants on asthma control among women living in Puerto Rico. Because women have nonmodifiable risks factors challenging them to keep asthma under control, knowledge of modifiable risk factors for asthma control could inform clinical practitioners about additional considerations relevant to the medical management of this target population (Van den Berge et al., 2009). This evidence could further inform public health practice in Puerto Rico and contribute to improved health education and health promotion interventions focused on adult female asthmatics. The results have the potential to contribute to positive social change by improving both the self-management and clinical management of asthma by the application of personalized medicine in the study population, and by reducing the incidence of uncontrolled asthma symptoms among the women of Puerto Rico. As well, the results have the potential to contribute to Healthy People's goals in reducing asthma-related health care costs and increasing productivity of those affected by asthma (Federal Interagency Workgroup, 2014).

Summary

This study was a quantitative secondary analysis of cross-sectional data from the most recently available Asthma Call-Back Survey (ACBS) data from the CDC. The dependent variables were current asthma status, asthma health service utilization, and achieved level of asthma control. The independent variables were sociodemographic variables (age, education, employment, marital status, and income); behavioral variables (smoking, body mass index, and physical activity); and environmental variables (secondhand smoke, pet inside home, vectors inside home, and home environment modifications). The independent variables for asthma-related health services were grouped in three sets: predisposing (age, marital status, education, employment); enabling (income and health insurance); and need (health status). The independent variables for achieved level of asthma control were the same set as above but included health care utilization.

The study included a cross-sectional design rather than experimental design, consistent with the examination of the relationship of asthma outcomes and the potential risks factors; the independent sociodemographic variables of the participants could not be manipulated. The sample included adult females 18 years and above living in Puerto Rico who self-reported asthma in the ACBS from 2011 and 2012. A power analysis at medium effect size was performed to determine whether the estimated sample size was sufficient to reach adequate power in the study. According to the results of the power sample analysis, I inferred that the number of participants with asthma selected for this study was

satisfactory to evaluate the hypotheses according the amount of variables included in multiple, logistic, and multinomial logistic regression analysis (see Chapter 3).

In the following chapter, I present the theoretical and conceptual foundations as well as the rationale for this study. I describe how these theoretical frameworks are linked with asthma outcomes, particularly those associated with adult females.

Chapter 2: Literature Review

Asthma is a chronic disease that affects the respiratory system and is characterized by wheezing, breathlessness, chest tightness, and coughing (National Center for Environmental Health, 2012). According to the Behavioral Risk Factor Surveillance System (BRFSS) from the Centers for Disease Control and Prevention (CDC, 2011a), the prevalence of adult lifetime asthma is higher (15.2%) in the unincorporated territory of Puerto Rico than in the continental United States and Hawaii combined (13.5%). From 1999 through 2007, the incidence of asthma-related mortality was consistently higher in Puerto Rico than in the rest of the United States (Bartolomei-Díaz et al., 2011). Consistently across the years, Bartolomei-Díaz & Acevedo (2013) report that lifetime and current asthma in Puerto Rico is more prevalent among adult females (9.4% during 2000; 9.2 during 2010) than for adult males (5.4 during 2000; 5.5 during 2010). Adult females report higher hospital admissions, higher emergency rooms visits, and higher drug claims for asthma-related symptoms and illnesses than any other segment of the population (Bartolomei-Díaz et al., 2009).

Asthma-related health care services have a significant impact on total direct medical expenditures (Rank et al., 2012). Puerto Rico invests millions of dollars every year on potentially preventable asthma care services (CDC's National Asthma Control Program, 2013a). Because uncontrolled asthma attacks account for the majority of asthma-related expenditures in the form of emergency room visits and hospitalizations, (CDC's National Asthma Control Program, 2013b), identifying the factors that distinguish controlled from uncontrolled asthma symptoms is essential to planning

effective and efficient health prevention activities (Peat & Li, 1999; Subbarao et al., 2009) and improving health care service distribution (Jandasek et al., 2011; Lara et al., 2009) for adult female asthma sufferers in Puerto Rico.

Asthma is a multifactorial disease in which sociodemographic, cultural, behavioral, environmental, and genetic factors influence the outcomes (Subbarao et al., 2009). Although the contribution of each of these factors has been examined relative to distinct populations within the United States, little literature exists in which researchers have characterized the relationship of risk factors to asthma control among adult asthmatics in Puerto Rico. Some researchers suggest reasons for increased asthma prevalence among Puerto Ricans and among women generally, but do not establish links to the sociodemographic, behavioral, and environmental factors potentially unique to asthma control.

With respect to this more general research, investigators have determined that Puerto Ricans of both genders have a genetic susceptibility to asthma (Chen et al., 2013; Loyo-Berrios et al., 2006; Naqvi et al., 2007; Reibman, & Liu, 2010) and are less responsive to bronchodilators than other Hispanic or ethnic groups (Gwynn, 2004; Naqvi et al., 2007). In addition, researchers have demonstrated that female hormone levels are associated with reduced lung function, increased asthma susceptibility, and an increased incidence of asthma-related symptoms (Real et al., 2008; Real, 2007; Macsali et al., 2009). Although genetic factors and hormonal risk factors explain some measure of the general propensity for asthma among Puerto Rican women, minimal research exists that targets the distribution of modifiable risk factors or examines the contribution of

modifiable risk factors to uncontrolled asthma symptoms among adult females in Puerto Rico.

Research outside of Puerto Rico has implicated income (Vogt, Bersamin, Ellemberg, & Winkleby, 2008), unemployment (Piirila et al., 2005; Strine et al., 2007), and education (Nguyen et al., 2011; Strine et al., 2007) as modifiable social risks for asthma. The relationship between income, unemployment, and asthma control has not been examined in Puerto Rico; however, as the percentage of the population with health insurance coverage is substantially higher in Puerto Rico than in the United States, and as coverage is not tied to employment status, an investigation into the relationship among income, service provision, and asthma control would better define asthma risks in the Commonwealth (Pérez-Perdomo, García-Rivera, & Serrano-Rodríguez, 2005; US Department of Health and Human Services, Office of Minority Health, 2012; Vogt et al., 2008).

Modifiable behavioral risk factors for asthma that have been broadly studied in the United States (Akerman et al., 2004; Gwynn, 2004), but not among Puerto Rican adult females living in Puerto Rico, include obesity, lack of physical activity and smoking (Bartolomei-Díaz et al., 2009; Cintrón, 2003; Pérez-Perdomo, Pérez-Cardona, Disdier-Flores, & Rose, Mannino, & Leaderer, 2006). Researchers investigating asthma in the United States found that obese asthmatics reported more chronic symptoms than nonobese asthmatics (Strine et al., 2007). Physically inactive asthmatic adults were more likely to visit the emergency room than physically active asthmatics (Ford et al., 2003; Strine, Balluz, & Ford, 2007), and asthmatics who smoke were more likely to have

poorly controlled asthma (Strine et al., 2007). Studies on asthmatics in Puerto Rico have indicated an association between obesity and asthma, but no studies have addressed the impact this and others behavioral risk factors may have on either asthma symptomology or service utilization, and no studies have targeted the adult female population.

Environmental risk factors for asthma include secondhand smoke (Loyo-Berrios et al., 2006; Pérez-Pedomo et al., 2003) and humid conditions that breed organic asthma triggers such as mold and cockroaches (Brooten et al., 2008). In Puerto Rico, secondhand smoke was associated with an increase in asthma among exposed children (Perez-Perdomo et al., 2003), but not among women. Neither of the other environmental risks has been examined relative to Puerto Rican women, despite the fact that Puerto Rico has a very humid climate (Quintero et al., 2010). Further, it is not known to what extent women with current asthma in Puerto Rico have environmental modifications in place in their homes to control these triggers (Lara et al., 2009).

This review of the literature indicates that there is a lack of knowledge regarding the determinants of asthma generally, and uncontrolled asthma symptoms specifically, among the adult female population in Puerto Rico. In addition, there have been no studies examining the impact of asthma among adult females on service utilization in Puerto Rico. Research specifically targeting females is supported by McHugh, Smymaski, Pompeii, and Delclos (2009), who stated that research should explore asthma risk factors by gender, and recommended disaggregating data by sex to better explain asthma prevalence, asthma-related health status, and health care use among women (Nowatski & Grant, 2011; Valerio et al., 2009).

Secondary data sources currently exist in Puerto Rico to develop a gender-specific asthma risk profile for the adult female population, but there has been no systematic exploration of this data in Puerto Rico. The existing national asthma profile includes generalized findings among the population of adults and children in Puerto Rico, but does not disaggregate data by sex, thereby masking patterns of sociodemographic, behavioral, and environmental determinants among women that could influence asthma outcomes. Given the marked difference in the incidence of asthma among women relative to men in Puerto Rico, I conducted a systematic examination of currently available databases to establish the relationships among the sociodemographic, behavioral, and environmental, risk factors for asthma, and to relate those factors to the level of service utilization and the control of asthma symptoms among adult females in Puerto Rico.

The purpose of my investigation was to assess the contribution among the social, behavioral, and environmental risk factors for asthma, and relate those factors to the level of service utilization and the control of asthma symptoms among adult females in Puerto Rico. I guided this investigation with the Andersen theoretical framework, which emphasizes the individual characteristics that influence the utilization of the health care system (Andersen & Newman, 1973). Andersen (1995) incorporated individual characteristics of predisposing, enabling, and need factors to predict health care utilization. Need factors are considered one of the most influential contributors in health care utilization (HCU), particularly need associated with chronic diseases and mental health (Parslow & Jorm, 2004; Redondo-Sendino et al., 2006). Researchers also found

that predisposing, enabling, and need factors, together with HCU, explain or predict health status outcomes.

In this chapter, I detail the literature research strategy, describe the historical evolution of the Andersen Model (BM), and summarize recent and representative studies using the BM to assess the relationship between predisposing, enabling, and need factors in health care utilization for chronic diseases generally or specifically related to asthma. I also describe the asthma epidemiology in Puerto Rico. Under the epidemiology section, I describe asthma prevalence, asthma health care utilization, and asthma mortality among adults in Puerto Rico. In addition, I address modifiable risk factors among adults with asthma in three major sections: (a) social risk factors, (b), behavioral risk factors, and (c) environmental risk factors. Each section is divided into appropriate subcategories. The social risk section includes risks associated with social capital and human capital. The section on behavioral risks includes subcategories for smoking habits, secondhand smoke, physical activity, and obesity. I subdivided the section of environmental risk factors into indoor asthma triggers, work-related asthma, and outdoor asthma triggers. The chapter ends with a presentation of the conceptual model that guided the investigation and a summary of the key points and findings from the literature.

Literature Search Strategy

I reviewed studies primarily related to asthma risk factors, health care utilization, and asthma control among adults generally and specifically among women. Because literature on asthma among women in Puerto Rico is limited, I included studies from other countries. The literature review targeted peer-reviewed journals and official

documents primarily from 2002 to 2014. The less recent literature, from 1968 to 1999, was used to develop the historical background of the Andersen framework and to ensure the inclusion of the seminal literature important to this study.

Using libraries from Walden University and Universidad Metropolitana, I compiled literature from the following databases: Academic Search Complete, Science Direct, ProQuest, CINAHL Plus, and Springer Science + Business Media. I also used open sources such as BioMed Central, PubMed from the National Center for Biotechnology Information (NCBI), and Google Scholar. I made special requests from the ProQuest system for information on the Andersen Model, and made requests through the Walden document delivery system ILLiad for articles not found in the databases. I also used Internet searches to secure the official documents from the World Health Organization, the National Center for Environmental Health, the National Asthma Control Program, and the Centers for Disease Control and Prevention.

I used the following search terms and combinations: *Puerto Rico + asthma*, *genetic asthma + Latinos, asthma control, women + asthma, asthma + health care utilization, health care utilization + women, Andersen behavioral model, Andersen + asthma, Andersen model + women, behavioral factors + asthma, psychological factors + asthma, sociodemographic factors + asthma, environmental factors + asthma, Asthma Call-Back Survey,* and *Behavioral Risk Factor Surveillance System.* I also searched for articles not easily found in regular databases such as those written in Spanish. I included studies conducted in Spain, Mexico, Cuba, and Puerto Rico from *Archivos de Bronchoneumonología, Boletín Médico del Hospital Infantil de México, Revista Cubana*

Obstreticia Ginecológica, and the *Puerto Rico Health Science Journal*. For searches in Spanish, I used the combination of the following words: *asma* + *mujeres*, *asma* + *proyecto asma*, *asma* + *ambiente*, *asma* + *Puerto Rico*.

Theoretical Foundation

I employed Andersen's behavioral model (BM) to evaluate how sociodemographic and behavioral determinants are related to health care utilization among women with controlled and uncontrolled asthma symptoms in Puerto Rico. The BM was initially developed in the 1960s to explain the use of health services (Andersen, 1968; Andersen, 1995). The model was originally used to explain utilization differences among families (Andersen, 1968), but Andersen redirected the model to evaluate health service utilization decisions at the individual level and is now solely credited with what has proven to be a more robust application of the earlier concepts (Andersen, 1995).

According to the BM, the determinants of health service utilization can be classified as predisposing, enabling, or need factors (Aday & Andersen, 1974; Andersen, 1968; Andersen, 1995; Andersen & Newman, 1973/2005). Predisposing characteristics are those variables that prime individuals to use health care services and include demographic characteristics, social structure, and health beliefs (Aday & Andersen, 1974). Enabling resources facilitate or impede health care use and include personal, family, and community resources. Need has two dimensions. Perceived need is the individual's own assessment of the need for medical services, while clinically evaluated need is the health care provider's professional recommendation for service use (Aday & Andersen, 1974). Figure 3 shows Andersen's original model and variables.

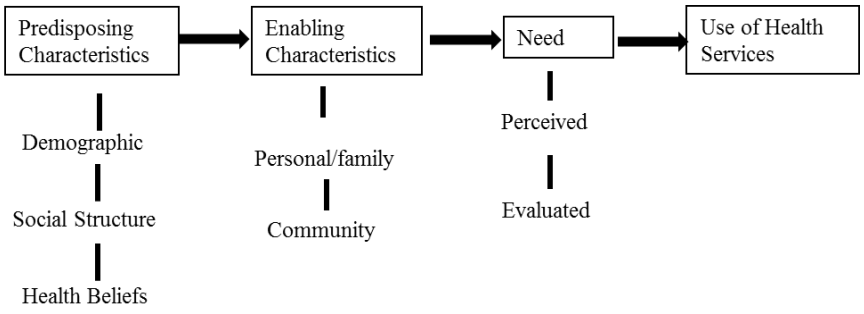

Figure 3. Original Andersen's model for use of health services. From "Revisiting the Behavioral Model and Access to Medical Care: Does It Matter?" by R. M. Andersen, 1995, *Journal of Health and Social Behavior, 36,* p. 2. Reprinted with permission.

Since the original inception, Andersen has collaborated with Aday and Newman to expand the BM to reflect paradigm shifts and a growing emphasis on the community, system, and environmental contexts in which the individual service utilization process takes place (Aday & Andersen, 1974; Andersen, 1968; Andersen, 1995, Andersen, 2000; Andersen, McCutcheon, Aday, Chiu, & Bell, 1983; Andersen & Newman, 1973). The first revision to the model came in 1973. Andersen and Newman (1973/2005) expanded the original theoretical framework to encompass the interaction of health care system level factors with individual level factors. This iteration of the model acknowledged the impact of the supply and distribution of health services on individual access to care (Andersen & Newman, 1973/2005). In 1974, Aday and Andersen added the concept of health policy to the revised model as a starting point of health care system, and further recognized consumer satisfaction as a terminal outcome of health services utilization. Figure 4 shows the 1970s version of the behavioral model.

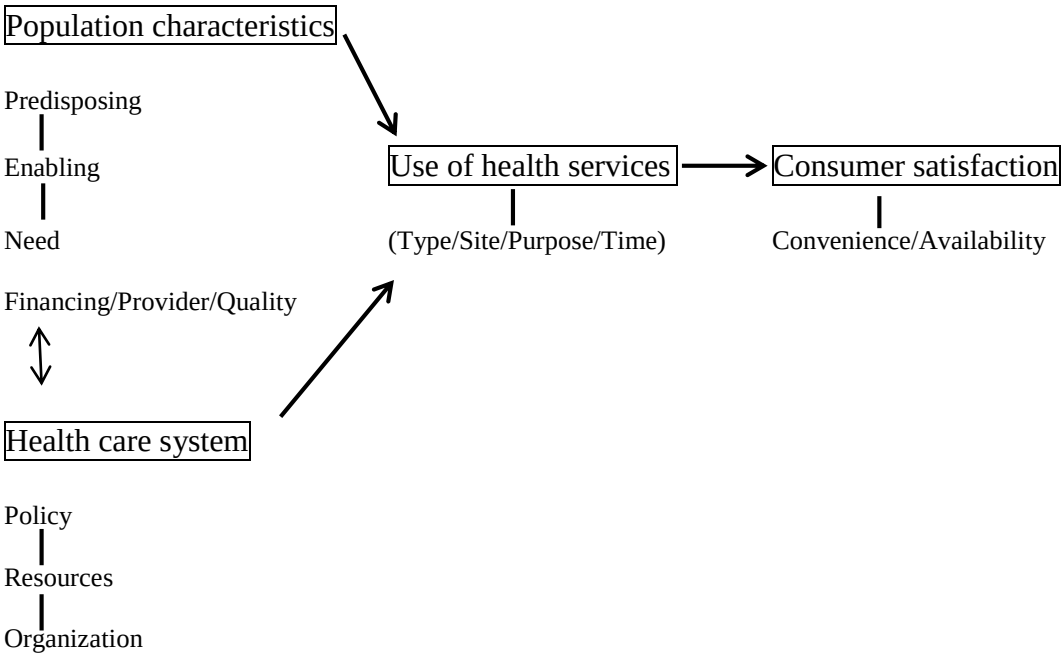

Figure 4. Behavioral model 1970's version. From "Revisiting The Behavioral Model and Access to Medical Care: Does It Matter?" by R. M. Andersen, 1995, *Journal of Health and Social Behavior, 36,* p.6. Reprinted with permission.

The 1980's – 1990's ushered in an emphasis on health status outcome measures, and Andersen revised the BM to include these factors (Andersen, 1995). In this iteration, Andersen cast both health care utilization and individual health behaviors as intermediate outcomes of the care seeking process and expanded the terminal outcome category to include the individual's *perceived* health status and a measure of clinically *evaluated health status*, in addition to consumer satisfaction (Andersen, 1995). System level and environmental level factors were now conceived of as primary determinants of service utilization, while the original individual level emphasis was subsumed by population level characteristics which rendered the core predisposing, enabling and need factors of

the earlier models latent (Andersen, 2008). In Figure 5, I present the 1980's -1990 version of the BM.

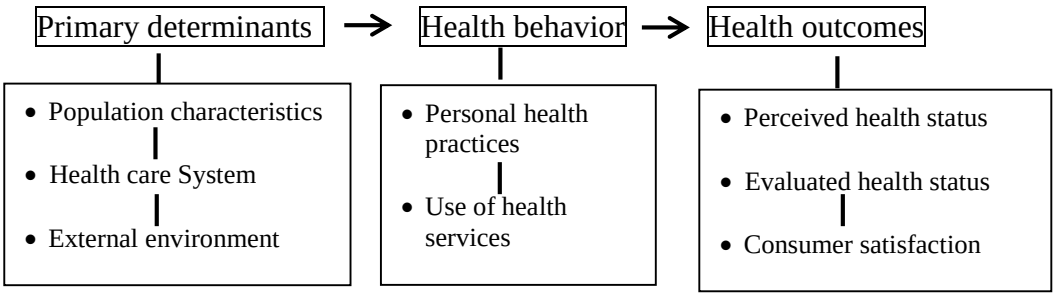

Figure 5. 1980's -1990's version for BM. From "Revisiting the Behavioral Model and Access to Medical Care: Does It Matter?" by R. M. Andersen, 1995, *Journal of Health and Social Behavior, 36,* p.7. Reprinted with permission.

Although this iteration of the model was designed to encompass developing concepts in health care outcomes, the 1980's -1990's version was a victim of its own expansion. Like all overarching models, BM proved to be too complex to operationalize in its entirety (Donabedian, 1973). Andersen model served primarily as a conceptually integrated depiction of both population and individual level factors that affect health service utilization, while its unique contribution to health services research continued to be in the operationalization of the underlying predisposing, enabling and need variables (Andersen, McCutcheon, Aday, Chiu, & Bell, 1983). In the 1990's, the fourth version of the BM restored an explicit emphasis on predisposing, enabling, and need factors, but retained the population health context (Andersen, 1995). This reconfiguration solidified the usefulness of the model as a tool for examining health service utilization and health status disparities across differing populations by framing subpopulation differences as reflecting differences in predisposing, enabling, and need factors within the same environmental, and system level context (Wolinsky & Johnson, 1991). Researchers using

the revised model continued to find support for Andersen's earlier results demonstrating that care-seeking and compliance behaviors are best explained by perceived need, while clinical need explains the type and quantity of service utilization (Andersen, 1995). Andersen and Newman (1973/2005) found the addition of social and system level variables did not change earlier findings regarding the type and volume of services used. Those outcomes were still best explained by individual level predisposing and need factors. Figure 6 shows the 1990's version of the BM.

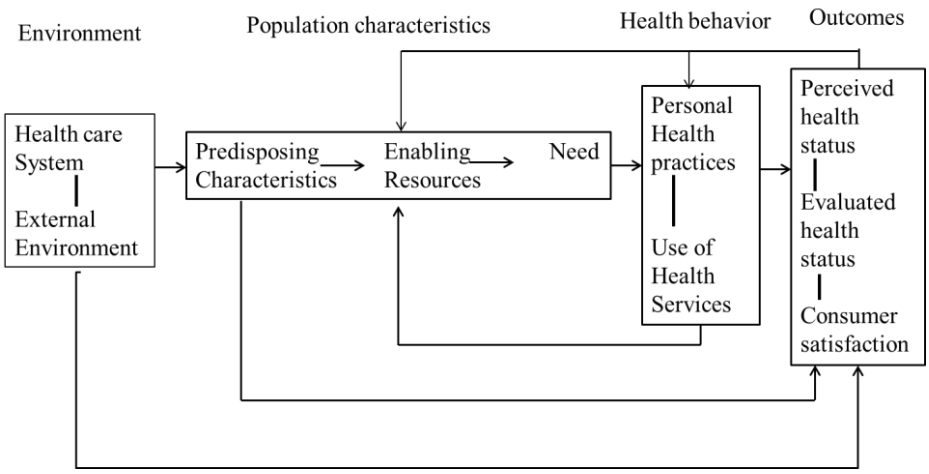

Figure 6. Andersen model 1990's version. Adapted from "Revisiting the Behavioral Model and Access to Medical Care: Does It Matter?" by R. M. Andersen, 1995, *Journal of Health and Social Behavior, 36*, p.8. Reprinted with permission.

The latest version of the BM was developed in 2000 (Andersen, 2008). In this version, Andersen acknowledged the model's continuing strength at the individual level by deconstructing and reconfiguring the environmental, system, and population levels into an aggregated version of the chief explanatory variables at the individual level: predisposing, enabling, and need (Andersen, 2008). Additionally, Andersen broke out the process of medical care from the larger category of health behaviors. This change

encouraged researchers to use the model to examine any one, or any combination of, intermediate outcomes to include: use of personal health care practices, both individually and culturally determined; use of medical care providers; and use of health care technology and other health care services. This version of the model is characterized by the degree of specificity it contributes to previously broadly conceived categories (Andersen, 2008). I demonstrate the 2000's version of the BM in Figure 7.

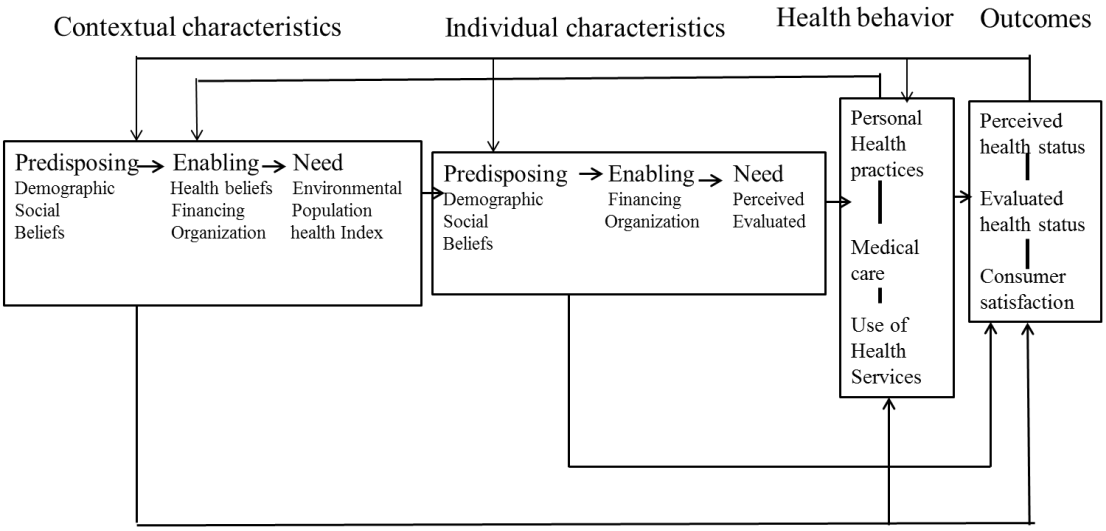

Figure 7. The behavioral model of health services use 2000's version, from "National Health Surveys and the Behavioral Model of Health Services Use" by R. M. Andersen, 2008, *Medical Care*, *46*, 651. Reprinted with permission.

In summary, Andersen's model has evolved according to a developing knowledge base and a greater appreciation for the distinctions among the complex array of factors that ultimately influence service utilization and health outcomes (Andersen, 2008). Each iterations of the model reflect Andersen's response to critics seeking a more all-inclusive conceptualization of the determinants of individual and population health outcomes, and has resulted in a model that has no identified limitations in literature. One consequence of

the model's inclusivity is that it demands an overwhelming variety and amount of data to operationalize in its entirety and is potentially cumbersome and overly expansive for any given piece of research. A review of the most recent literature using the BM illustrates how researchers have employed the model in a manageable form.

Recent Literature on Andersen Behavioral Model

Andersen's behavioral model has been widely used (Babitsch, Gohl, & von Lengerke, 2012) with eight studies published between 2004 and 2012. In 2004, Parslow & Jorm used the BM in a cross-sectional study of the predictors of health care utilization (HCU) among adults (40-45 years and 60-65 years) in Australia. The researchers operationalized predisposing factors for the BM as age, education, marital status, level of household responsibility, and social support; enabling factors as employment, financial problems, health insurance; and need as mental and physical health score, smoking, alcohol use, and chronic conditions (Parslow & Jorm, 2004). The researchers found that the significant predictors for HCU among adults are older age, have a poor mental/physical health score, chronic diseases, and cigarette smoking. The authors further determined that, after controlling need factors, marital status was a predictor for HCU for men only (Parslow & Jorm, 2004).

To evaluate how the BM explains HCU among women from 55 to 64 years, Xu, et al. (2006) used secondary data from the Health and Retirement Study in the United States. Researchers operationalized predisposing factors as age, marital status, race/ethnicity, and education; enabling factors as income and employment; and need factors were measured by the woman's self-perceived health status, level of obesity and

presence of chronic conditions (Xu et al., 2006). Xu found that women without health insurance coverage reported significantly poorer health status than women with health insurance. In addition, women without health insurance were significantly more likely to have one or more chronic disease, and were significantly less likely to use health care services. Conversely, the researchers found that the greater the extent of health insurance coverage the greater the use of health care.

Redondo-Sendino et al. (2006) examined HCU differences among adults age 60 years and over in Spain. The researchers analyzed primary cross-sectional data operationalizing predisposing factors as age and head-of-family status, enabling factors as educational level, marital status, head-of-family employment status and social network, and need factors as lifestyle, chronic diseases, functional status, cognitive deficit and health-related quality of life (HRQL). Redondo-Sendino et al. found gender differences relative to need and utilization with chronic conditions and quality of life contributing to more HCU among women than among men. The researchers also found that after adjusting need factors, women reported fewer hospital admissions compared to men.

The BM has also been employed to analyze secondary cross-sectional data from children in the Unites States. Lo and Fulda (2008) obtained data from the National Survey of Children's Health to evaluate which of the BM determinants affected HCU. Among predisposing factors, Lo and Fulda (2008) included demographic and sociostructural characteristics similar to the researchers already cited, but included access to services, community resources and language in addition to income, and health

insurance as enabling factors. The researchers operationalized need factors using parents' perceptions of the child's need of health care services (Lo & Fulda, 2008). Lo and Fulda demonstrated that lower SES and lack of health coverage were negatively associated with HCU, while having a personal health care provider was positively associated with HCU.

Johnson et al. (2010) examined the relationship between acculturation and self-reported health (SRH) are associated among Hispanics living in the United States by analyzing primary cross-sectional data from the North Texas Healthy Heart survey. The researchers adapted the BM to use SRH as the outcome variable instead HCU. Johnson et al. (2010) operationalized predisposing factors as sociodemographic characteristics; and enabling factors as income, health insurance and having a health care provider. Need was operationalized as clinical measurements on chronic diseases, and body mass index (BMI), but in addition, the researchers added sense of control, perceived stress, depression and social support: variables that are categorized as predisposing variables in the conventional Andersen model. The researchers found that the least acculturated participants were less likely to have health insurance and a health care provider and more likely to report a fair/poor SRH, after controlling for enabling, need, and predisposing factors.

Two researchers have used the BM to examine asthma (Jandasek et al., 2011; Piper et al., 2010). Piper et al. (2010) used secondary data from the National Health Interview Survey to determine the predictors of having an asthma management plan (AMP) among children in the United States. Piper et al. (2010) operationalized predisposing factors as race, age and gender, enabling factors as education and insurance

coverage; and need factors as asthma/asthma symptoms and AMP. The authors found that having an AMP was associated with type of insurance and race and that having an AMP was associated with less asthma care service utilization (Piper et al., 2010).

Jandasek et al. (2011) used primary cross-sectional data to assess the differences in asthma care service use among Latino children. The researchers distinguished between Puerto Rican children born in Puerto Rico, children of Puerto Rican parentage born in Rhode Island, and non-Latino white children. The researchers operationalized predisposing factors as gender, age, place of birth, and language; enabling factors as health insurance and type, and an indicator of poverty; and the parent's rating of the severity of their children's asthma as a need factor. In addition, Jandasek operationalized access to medical care as whether or not the participants had a regular source of asthma care. To operationalize HCU, researchers used physician and emergency room visits and hospital episodes for asthma care in the past 12 months. Jandasek et al. (2011) found Puerto Rico Island children with asthma were more likely to use the emergency room and the hospital care than to visit a physician regularly for asthma care as compared to Puerto Ricans living in the United States. The researchers attributed these differences to the effect of the organizational and distribution of health care services in both countries examined (Jandasek et al., 2011).

Hogan et al. (2012) used secondary data from a randomized clinical/behavioral trial to identify the variables influencing access to intercopceptual gynecological care or health care given between pregnancies, and 6 weeks after delivery. The researchers evaluated a sample of 442 vulnerable women, after health insurance, transportation, and

childcare barriers were eliminated thru an intervention. Hogan (2012) operationalized BM concepts similarly to other researchers, but included substance abuse among predisposing factors. Hogan et al. (2012) concluded that removing common barriers to care does not assure the participation of vulnerable women in preventive care.

In this literature review for Andersen framework, I illustrate that, despite the extensive set of concepts included in the latest versions of the BM, researchers continue employ a streamlined operationalization of the model's core predisposing, enabling and need factors as the primary determinants of health care service utilization and the resulting health status outcomes. The exact variables selected to operationalize these key factors varies from study to study with some investigators using primarily individual level variables and others using both individual level and system level factors in the same variable set. The researchers employed a limited number of variables to operationalize key input and outcome factors that are a function of the specific research questions. As well, researches use the model to guide both primary data collection and secondary data analysis, with the variable set reflecting the resource and measurement limitations specific to each of those study designs. No single study attempts to operationalize the BM in its entirety.

Summary of the literature. Despite variations in both the facets of the model represented, and the variables used to operationalize the data, researchers using Andersen's models have found that consistently explains disparities in utilization and health status outcomes among populations differing by ethnicity, age, gender, and socioeconomic status. Further, the model's characterization of both aggregate and

individual levels of predisposing, enabling, and need, factors has simplified the interpretation of study results without compromising the model's capacity to detect and differentiate among environmental, system level, population level and individual level influences on both intermediate utilization outcomes and terminal health status outcomes. The BM has proven useful for longitudinal, cross sectional, and clinical trial study designs, and lends itself to using either secondary or primary data. Although the array of the variables vary from study to study, researchers found that need factors strongly contribute to HCU, particularly need associated with chronic diseases and mental health (Parslow & Jorm, 2004; Redondo-Sendino et al., 2006). Predisposing determinants and enabling determinants have also been found to explain or predict HCU (Johnson et al., 2010; Lo & Fulda, 2008; Parslow & Jorm, 2004, Piper at al., 2010; Xu et al., 2006). In addition, researchers continue to find that predisposing, enabling, and need factors, together with HCU, explain or predict or health status outcomes. Furthermore, researchers have demonstrated that the findings from studies using the BM framework are instrumental in developing clinical guidelines (Piper et al., 2010), public health interventions (Jonhson et al., 2010), and health policy recommendations (Jandasek et al., 2011) to ensure access to care services among different population subgroups.

Rationale for the BM in this investigation. This investigation is a quantitative secondary data analysis consistent with the statistical logic used to operationalize the Andersen model, to date. The richness of data from the Asthma Call-Back Survey permits the inclusion of measures consistent with the later versions of Andersen framework, and with prior investigations using these versions of the model. The

independent variables coincide with the model's conceptualization of individual characteristics and health behaviors as the intermediate factors affecting outcomes. I evaluated the influence of the independent variables on two major model outcomes, the use of health care services and the resulting health status of my study population. Finally, the target population of this study suffers from a chronic illness state, a type of condition for which the BM has proven to be well suited. The positive social change I seek as a result of my investigation is to influence clinical practice, inform public health interventions, and inform health policies dealing with the distribution of resources appropriate to population need. For these stated reasons, I am adopting the BM to guide my investigation.

Asthma Epidemiology

The National Asthma Education and Prevention Program (NAEEP) defines *asthma* as a chronic respiratory syndrome characterized by narrowed and inflamed airways, which are hypersensitive to inhaled trigger substances (USDHHS, 2007). Asthma results in recurring episodes of constricted airflow due to muscle spasms. The constriction may be exacerbated by an increased production of mucus, which lines the airway walls and further narrows the passages. The condition may manifest as wheezing, tightness in the chest, shortness of breath, or coughing which is especially common at night and in the early morning hours (CDC, 2013a).

Asthma epidemiology focuses primarily on prevalence, and mortality. *Asthma prevalence* is measured by the number of persons and the percentage of the population with asthma at a given point in time (Moorman et al., 2012). Asthma prevalence is

classified as *current* or *lifetime asthma.* Current asthma is active at the point of assessment (Moorman et al., 2012). While lifetime asthma refers to cases where the individual has been diagnosed as having asthma, but is not necessarily symptomatic at the point of assessment (CDC, 2013a). *Asthma mortality* is defined by the World Health Organization as a death that occurs in conjunction with, and is attributable to a primary diagnosis of asthma as classified by the International Code of Diseases (ICD10th) codes J45 and J46 (WHO, 2004).

Asthma prevalence in Puerto Rico. The Centers for Disease Control and Prevention (2013b) collects data on asthma prevalence and its risk factors through the Behavioral Risk Factor Surveillance System (BRFSS) in 50 states and the US territories, including Puerto Rico Commonwealth. According to the CDC (2013b), the Puerto Rico-BRFSS shows that the lifetime and current asthma prevalence during 2000 were 15.9% and 7.5%, respectively, and nine years later the parameters remained similar (14.6% and 7.5%, respectively). Figure 8 shows the yearly variation in both lifetime and current asthma over this 10 year period (CDC, 2013b).

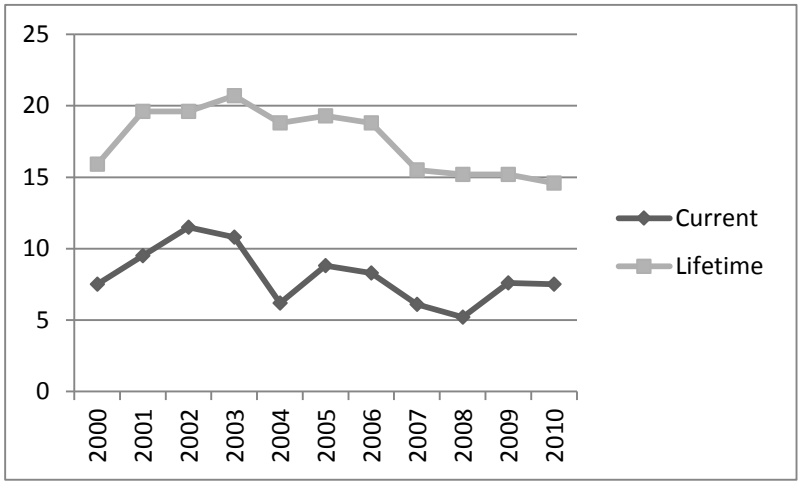

Figure 8. Percentage of respondents with current and lifetime asthma in Puerto Rico from 2000 -2010 (Data from BRFSS)

In Puerto Rico, both lifetime and current asthma prevalence is consistently higher for females across the years (Bartolomei-Díaz et al., 2009). Figure 9 shows current asthma by gender during 2000 to 2010 using data from the Puerto Rico BRFSS. As shown in this figure, during 2000 males reported 5.4% current asthma prevalence, while females reported 9.4%, and in 2010, the percentages remain similar (5.5% and 9.2%, respectively). In an earlier study, Pérez-Perdomo et al. (2003) made unconditional logistic regression model for 2000 Puerto Rico BRFSS data validating that asthma prevalence was significantly higher among females. In terms of age-group, Bartolomei-Díaz (2007) established that when lifetime asthma was stratified by age group, the 18 to 24 years age group had the highest asthma prevalence during 2000 to 2002 (Bartolomei-Díaz, 2007). However, current asthma prevalence did not present statistically significant differences between age groups during the same years (Bartolomei-Díaz, 2007). Pérez-

Perdomo et al. (2003) also found asthma prevalence in Puerto Rico did not differ among age groups, but neither among annual income level, and smoking.

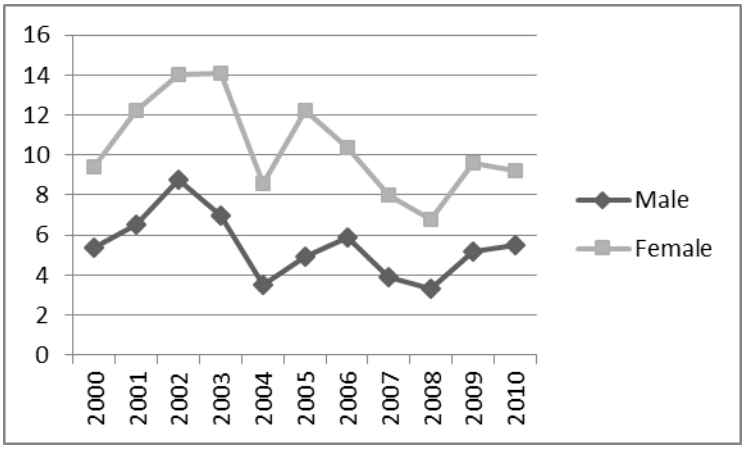

Figure 9. Percentage of current asthma by gender during 2000 to 2010 (Data from BRFSS)

Puerto Rico has 78 municipalities separated in eight health care regions. Bartolomei-Díaz and Amill-Rosario (2010) estimated that in 2007 both lifetime and current asthma prevalence were highest in the Caguas Region (20.1%; 10.2%, respectively), and lowest in the Ponce region (12.4%; 5.3%, respectively). Vélez, González and Rivera-Rentas (2009) suggested that gene-environment interactions may be responsible for the increased prevalence in Caguas region. Vélez et al. identified high presence of asthma-related fungi in four locations at the municipality of Caguas, but the relationship alone does not account for the high prevalence in this region. The researchers of the Puerto Rico Asthma Project (2013) validated this consideration when reported that health care regions have a highly variable pattern of asthma prevalence among adults across all the years assessed.

Asthma health care utilization in Puerto Rico. Ninety-three percent of the population in Puerto Rico is insured by public or private health care providers (Pérez-Perdomo et al., 2005). Using health insurance claims data for the years 2000 to 2003, Bartolomei-Díaz conducted the only available statistical analysis for asthma-related health care in Puerto Rico. During the time period analyzed, Bartolomei-Díaz quantified the rate of emergency room visits (ERV) ranging from 203 and 231 per 10,000 inhabitants. In all four years assessed, females had significantly higher ERV rates that males, and females with public health insurance had higher ERV claims rate than females with private insurance (Bartolomei-Díaz, 2007). Among asthmatics in Puerto Rico, The Asthma Project (2010) specified that 40% of respondents visited an emergency room during 2009.

Bartolomei-Díaz (2007) also assessed an average of 1,036 per month hospitalization admissions among adults and children during 2000 to 2003. There was no statistically significant difference in hospital admissions between private and public health insurance over the study time period (Bartolomei-Díaz, 2007). Females with private health insurance were 1.55 times more likely to be hospitalized for asthma than males, and females with public insurance were 1.28 times likely to be hospitalized than males with the same coverage (Bartolomei-Díaz, 2007). Among adults, asthma hospitalizations were highest in the 35-64 year age range (Bartolomei-Díaz, 2007). According to Bartolomei-Díaz (2007) inhaled corticosteroids, the most clinically effective medication for asthma control had the lowest utilization rate among available treatments during the study years. In addition, inhaled corticosteroid was less likely to be

prescribed for asthma sufferers than for individuals with private insurance (Bartolomei-Díaz, 2007). Females had significantly higher utilization rates of corticosteroids per 10,000 than did males during the same period (Bartolomei-Díaz, 2007). The researcher established that this health care utilization analysis (2000-2003) for Puerto Rico only considered a selected health care insurance claims from a largest insurance in Puerto Rico, and the results cannot be generalized to the whole population.

Asthma mortality in Puerto Rico. According to the National Vital Statistics System (NVSS) for 2007, the age-adjusted asthma mortality rate in Puerto Rico was 24.4 per million (CDC, 2008). Asthma mortality data in Puerto Rico is obtained through the Vital Statistics Office (VSO) of the Puerto Rico Department of Health. Bartolomei-Díaz and Amill-Rosario (2010) made the only historical assessment of asthma mortality data in Puerto Rico utilizing data from VSO. The researchers found a reduction in asthma mortality rates across the years (see Figure 10), establishing that a pronounced reduction coincided with the ICD-10 implementation during the 1999-2003 period (Bartolomei-Díaz & Amill-Rosario, 2010). The ICD-10 was endorsed in 1990, and adopted by the World Health Organization member states in 1994 (WHO, 2004), but the code was not implemented until 1999 in the United States and Puerto Rico (CDC, 2013c).

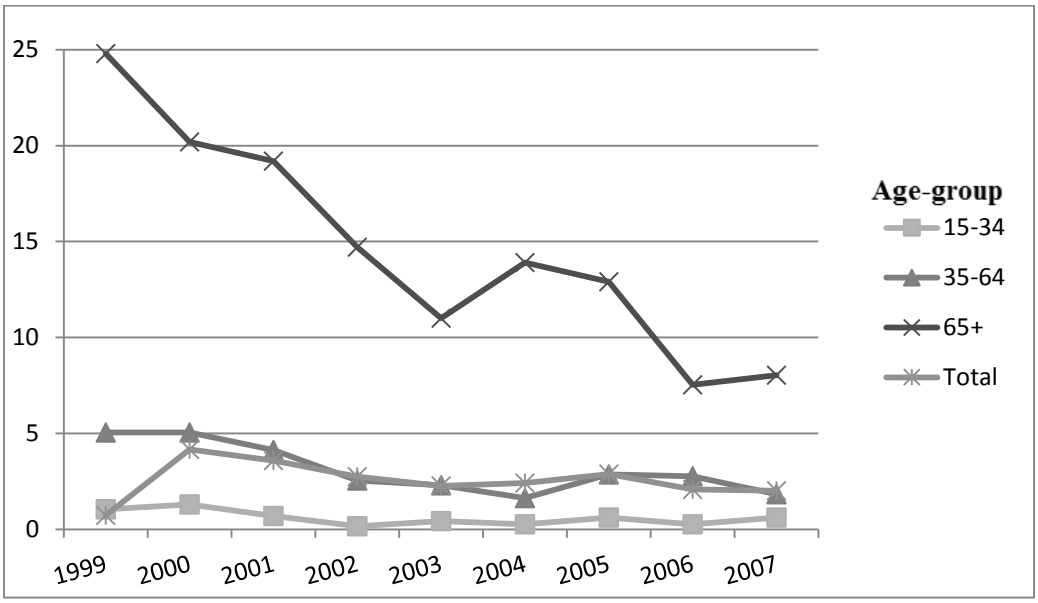

Figure 10. Asthma crude mortality rates (95% CI) per 100,000 inhabitants by age from 2000 to 2007 (data from Bartolomei-Díaz, Amill-Rosario, Claudio, & Hernández, 2011)

Anderson, Miniño, Hoyert and Rosenberg (2001) considered that the implementation of the ICD10 classification produced interruptions in time series of mortality statistics. Lotufo and Bensenor (2012) coincided that ICD10 also produced sharp fall of asthma death rates in Brazil during its implementation period. The fact is that the World Health Organization almost duplicated death categories for ICD10 compared to ICD-9, and made changes in the coding rules for mortality (CDC, 2013c). Bartolomei-Díaz, Amill-Rosario, Claudio, & Hernández (2011) attributed to an inaccurate reporting of asthma as the underlying cause of death during the ICD9 classification period. However, the researchers did not assess death certificates in Puerto Rico for potential misclassification of the underlying cause of death (Bartolomei- Díaz et al., 2011).

During the assessment of asthma mortality trends in Puerto Rico, Bartolomei-Díaz and colleagues (2011) also found that mortality rates were higher among older age groups, divorced or widowed, and persons with less educational level (Bartolomei-Díaz et al., 2011). Bellia et al. (2007) coincided that age is one of the predictors of death in asthmatics, but also found significant relation with other non-respiratory variables such as depression and smoking habits not assessed in the Puerto Rico study. Nevertheless, other researchers such as Furhman, Jougla, Uhry and Delmas (2009), and Moorman et al. (2007) have stated that asthma deaths rates among older age groups are less accurate due to other comorbid conditions present at the moment to classify the illness as the underlying cause of death.

Although females have higher asthma prevalence than males in Puerto Rico, Bartlomei-Díaz (2011) found that females did not differ in mortality risks from males. Furhman et al., (2009) and Sanchez, García, Perez, Martínez & Sanchez (2009) found higher asthma mortality among women in the general population of France, and Spain, respectively, and both studies attributed it to the increase in women's smoking. A limitation in the mortality study of Bartolomei-Díaz and colleagues is that they did not assess other covariates such as tobacco use, income, occupational exposure and other comorbidities.

Key Concepts and Variables of Asthma Risk Factors in Adults

Asthma is a multifactorial disease linked to both modifiable and nonmodifiable risk factors (Subbarao et al., 2009). Genetic vulnerability is well-established as a nonmodifiable risk factor linked not only to individual susceptibility, but to ethnic and

racial susceptibility as well (Reibman & Liu, 2010). Investigators have determined that Puerto Ricans have a greater susceptibility to asthma, and are less responsive to bronchodilators than other Hispanic or ethnic groups (Chen et al., 2013; Gwynn, 2004; Loyo-Berríos et al., 2006; Navqui et al., 2007). Researchers have also established that females are more susceptible to developing asthma than are males. Wood, Brown and Engel (2010) have documented that females are three times more likely to be admitted for asthma than men, reported longer stays at the hospital, higher health care costs during their hospital stay, and were more likely to need an upper and lower respiratory intervention than men. Harms (2006) linked asthma risk to lung size, and cited females' lesser pulmonary capacity as contributing to women's greater likelihood of developing the disease. Real et al. (2008), Real (2007) and Macsali et al. (2009) found that female hormone levels were associated with reduced lung function regardless of size-related capacity. These researchers concluded that female reproductive hormones further increase women's risk for developing asthma and may influence symptom severity in women once the disease presents.

These nonmodifiable risk factors place Puerto Rican women at greater risk for asthma than either Puerto Rican males or non-Puerto Rican women and, consequently, explain some measure of asthma-related health care utilization among this population. Researchers, however, have identified a set of modifiable risk factors that further contribute to the incidence and severity of asthma either in conjunction with, or independent of, nonmodifiable risks (Gorman & Asaithambi, 2008; Bel, 2004). As the goals of this investigation are to both determine the extent to which modifiable risk

factors contribute to the incidence of asthma among adult females in Puerto Rico, and to analyze the degree to which those factors drive asthma related service utilization by the target population, a review of the asthma-related modifiable risk literature follows.

Modifiable Risk Factors in Adults

A modifiable risk factor is a determinant that can be prevented, treated and controlled by direct intervention or by indirect mechanisms that reduce the risk, thus reducing the probability of the disease (McKenzie, Pinger & Kotecki, 2012; WHO, 2009).

Social risk factors in adults. The World Health Organization defines social risk factors as functions of the socioeconomic circumstances under which individuals live and work, and interaction of those circumstances with the prevailing cultural systems that determine access to personal and political status, social support, and the material resources known to impact the health status of populations (WHO, 2014b). According to Aday (2001), the health-related social risk factors are assessed considering both individual and community perspectives. At the individual level, Aday includes health determinants that define individual *social status.* These determinants include such as age, gender, race and ethnicity as nonmodifiable risk factors. Among modifiable social risk factors, Aday classifies family structure, marital status, organizations memberships and social networks as social capital determinants, and the *human capital* determinants that consist of goods and opportunities available to develop peoples' skills and capabilities, such as education, housing, jobs and income. At the community level, health outcomes are influenced by community resources and the ties between people in the neighborhood.

Aday (2001) asserts that the combination of individual and collective circumstances impact susceptibility to illness and limit the possibilities and resources for coping. A population's vulnerability will, consequently, be a function of the corresponding community and individual characteristics.

In the case of modifiable risks for asthma in adults, researchers consider a combination of social indicators to reflect the complexity of individual and community characteristics aggregated under the concept of socioeconomic status (Corvalan, Amigo, Bustos, & Rona, 2005). Researchers have operationalized *human capital* or socioeconomic status (SES) as education, occupation, income and housing. According to Hosseinpoor et al. (2012), human capital factors are key factors that determine social position as well as access to power and control. The Commission on Social Determinants of Health from the World Health Organization (2007) stated that when individuals have limited access to the elements of human capital they will experience less favorable living and working environments that increase their risk for poor health. This lower socioeconomic status further constrains access to health care services which, in turn, portends poor health outcomes when illness and disability manifest.

Additionally, Aday (2001) conceptualized *social capital* factors as the social support networks and family and community ties offer assistance in coping with health issues (Aday, 2001). Aday (2001) observed that the support inherent in social capital resources encourages the pursuit of shared interests and goals which may enhance human capital and reduce individual vulnerability. Health-related social risk is, consequently, lower among those who are married/cohabitating, or have an extended family structure.

Aday (2001) further observed that negative events such as job loss, divorce or death have different impacts among individuals in different socioeconomic groups, with members of the lower SES groups being most negatively affected relative to health and wellbeing. Among the differentially vulnerable, Aday stated that women are at higher risk than males due to disparities strengthened either by social norms or behaviors.

Human capital factors and asthma outcomes. Corvalán et al. (2005) examined the relationship between a complex set of human capital or SES variables and the rate of asthma in a semirural area of Chile. The researchers (2005) operationalized socioeconomic variables as level of education, occupation, receiving government welfare, and material belongings defined as quality and type of housing and tenancy as well as the number of domestic appliances. Additionally, Corvalan et al. operationalized overcrowding as the number of siblings, and the number of individuals per room. The researchers found that the relationship between severe asthma symptoms and lower human capital (less income, less education and overcrowding) was statistically significantly greater than the relationship between severe asthma symptoms and genetic predisposition. In individuals with higher levels of human capital, however, asthma symptoms were more highly correlated with genetic predisposition than with SES.

Bacon et al. (2009) conducted a cross-sectional study of 781 Canadian adults being treated at a tertiary care asthma clinic. The researchers examined the association between education level and measures of asthma control, asthma-related health service utilization, self-efficacy, and quality of life utilizing physician screening, pulmonary function and questionnaires. Bacon found that lower educational level was associated

with poorer asthma control, greater health care utilization and lower asthma-related self-efficacy. Bacon et al. also found that lower educational level was associated with lower incidence of allergic asthma. Education level was not associated with measures of quality of life.

Education level also contributes to asthma outcomes among older people. Shiue (2013) analyzed the relationship between social determinants and asthma among adults, including the elderly, using data from a longitudinal household survey conducted in United Kingdom. Shiue operationalized SES as age, sex, birth place, education, marital status, occupation, and income. Shiue found 47% of those individuals who had ever had asthma acquired asthma during adulthood. The author also found that among elderly aged 80 and above, those with less education were more likely to have asthma. Among young and middle-aged adults, being born in a place other than the UK was highly significant for the presence of asthma.

In the case of asthma, human capital and health literacy partially explains racial and ethnic disparities. Curtis et al. (2012) examined racial differences in the relationship of SES and health literacy with asthma outcomes among adults living in Chicago. The researchers conducted a longitudinal study of 353 adults aged 18–40 with persistent asthma. Baseline data was collected in 2004 and follow up data was collected every three months for two years. The researchers operationalized socioeconomic status as education, household income, quality of life, work status and insurance status. Asthma outcomes measures included ER visits, hospitalizations, and level of asthma control. Curtis et al. found that less educational, less income, and being a Medicaid recipient was associated

with poorer asthma outcomes. Lower SES and limited health literacy were significant variables among African Americans, and those had poorer asthma outcomes. Latinos with persistent asthma had lower quality of life.

Johannessen et al. (2010) assessed differences of SES and sex-related lung function decline over time among adults in Norway. Lung function is a measure for asthma outcomes and account for sex differences. Johannessen measured lung function of 1,644 participants from 26 to 82 years utilizing both questionnaires and spirometry at baseline and six years later. Human capital or SES indicators were income, education, and occupational status (from low level blue collar to high level white collar). Social capital was measured as marital status. In addition, Johannessen measured occupational dust exposure and smoking habits to adjust for confounding effects. The researchers found that males with lower education level and lower occupational status (blue collar) had decreased lung function. Differences in human capital did not affect lung function decline in females.

Ekerljung et al. (2010) conducted a prospective cohort study of 8000 Swedish adults to examine the relationship between occupation and asthma risk in urban environments. Researchers operationalized SES as occupation according to the following six categories: (a) manual workers in industry (b) manual workers in service (c) nonmanual employees, (d) civil servants and professionals (e) self-employed (f) unspecified. The first two categories were classified as low SES. The cohort was sampled at baseline and again 10 years later. Ekerljung et al. found that manual laborers had a greater risk of developing asthma than did civil servants or professionals. In addition, the

researchers found that among females engaged in manual labor, those working in manufacturing had a greater risk of developing asthma than did those working in the service industry.

Social capital factors and asthma outcomes. Researchers have demonstrated that marital status may contribute to poor health outcomes, particularly for women, and its influence varies across cultures (Hosseinpoor et al., 2012). In the case of asthma**,** the contribution of marital status to asthma outcomes does not account for significant differences among adults in general (Johannessen et al., 2010; Shiue, 2013). Shuie (2013 did not found significant differences in marital status among populations with asthma assessed in United Kingdom. Johannessen et al. (2010) found that marital status was a significant predictor of reduced pulmonary function among married and widowed females. Lung function is an important modifying factor that can be increased for asthma control (Droga et al., 2011).

Behavioral risk factors for asthma in adults. In addition to social risk factors, behavioral patterns may contribute to asthma in adults. Behavioral risk factors are those behaviors engaged in by the individual that can increase the chance of developing a disease. These behavior choices can be influenced by the social and economic environments (Institute of Medicine, 2001). Traore (2010) stated that the main behavioral risk factors that contribute to asthma in adults are smoking and exposure to secondhand smoke, lack of physical activity, and obesity. By its nature of involuntary exposure, secondhand smoke is also considered an environmental risk factor (Traore, 2010).

Researchers have widely recognized that smoking and secondhand smoke exposure is a risk factor for new-onset asthma among adults, and exacerbates preexisting adult asthma (Eisner, 2008; Jaakkola et al., 2003; Shavit et al., 2007; Weiss, Utell, & Samet, 1999). In addition, researchers investigating asthma in the United States have found that obese asthmatics reported more chronic symptoms than nonobese asthmatics and physically inactive asthmatic adults are more likely to visit the emergency room than physically active asthmatics (Strine et al., 2007). The World Health Organization (2014b) defines overweight and obesity in adults as the measure of the combination of weight-for-height known as body mass index (BMI). A person's weight in kilograms is divided by the square of his height in meters (kg/m2) to obtain the BMI (WHO, 2014a). The individual is classified as overweight when BMI is between 25 to 30 kg/m2, and obese when the BMI >30 kg/m2 (WHO, 2014a).

Cigarette smoking. Shavit et al. (2007) evaluated the relationship between cigarette smoking and asthma symptoms and health care utilization among adults from France, Germany and the United Kingdom. Shavit et al. operationalized cigarette smoking as being a current daily cigarette smoker. During four years, the authors surveyed a stratified random sample of 1,109 adults with persistent asthma. Shavit and colleagues found that smokers were more likely to experience asthma nighttime symptoms (OR 1.46) and more likely to use emergency rooms (OR=1.78) due to asthma exacerbations than nonsmokers. Smokers also have more hospitalizations (OR= 1.80) than nonsmokers.

Secondhand smoke (SHS). Although there are laws prohibiting tobacco smoke in public spaces, private settings continue to be a source of SHS. Nguyen et al. (2014) assessed the association between of SHS exposure in vehicles and asthma among 17, 863 nonsmokers adults. Researchers used secondary data from the 2011 BRFSS from the states of Indiana, Kentucky, Louisiana and Mississippi. Nguyen et al. utilized data from SHS exposure in vehicles, home, work or public spaces. Researchers concluded that among current asthmatics, 12.3% reported SHS exposure in vehicles. Adults exposed to SHS in a vehicle were more likely to have current asthma compared to adults without SHS exposure.

New cases of asthma in adults are also linked to secondhand smoke. Jaakkola et al. (2003) conducted a case-control study to assess the effect of smoke exposure and the development of asthma in adults from 21 to 63 years of age. During 2.5 years, the authors recruited the new cases of asthma diagnosed at hospitals in the country, and controls from the whole population in South Finland. After excluding all current and lifetime smokers, Jaakkola et al. had 239 new cases of asthma and 487 controls. Researchers operationalized exposure to cigarette smoking by asking the quantity of cigarettes per day and the duration of the exposure in their work and home during the last year. Jaakkola et al. accounted for the cofounding variables of gender, age, education level, and the presence of pets and molds in the home. Piipari et al. found that new cases of asthma were more likely to be female, and more likely to have lower educational levels than the controls. The researchers also found that exposure to cigarette smoke during the year assessed was significantly higher among new cases of asthma and was more likely to

occur in the working age population. Jaakkola et al. concluded that this study provided evidence of the association between exposures to cigarette smoking during adulthood.

Obesity. There is a positive relationship between obesity and asthma, especially among women. Akerman et al. (2004) conducted a medical record review of 143 adults diagnosed with asthma in New York. The authors selected records from patients that did not smoke cigarettes and did not have other lung diseases. Akerman et al. calculated obesity according BMI criteria, and asthma severity according clinical symptoms, medication, and pulmonary function. Asthma condition was classified as mild intermittent, mild persistent, moderate persistent or severe persistent. Akerman and colleagues found that 70% of the asthmatics patients were obese, and the mean of BMI was significantly higher among females than males. Akerman et al. found that increasing obesity was positively correlated with increasing degree of asthma severity.

Vortmann and Eisner (2008) assessed the impact of obesity on asthma health status in a cohort of 843 adults with current asthma in California. During four years, the researchers examined the outcomes on asthma severity, asthma quality of life, physical health status, and daily activity restriction. Vortmann and Eisner collected information on weight and height of each participant to obtain BMI according to the standard criteria and smoking status. Vortmann and Eisner operationalized health care utilization as emergency room visit and hospitalizations for asthma. The authors collected information on variables, such as depression and perceived control of asthma measured by specialized questionnaires. Vortmann and Eisner found that obese adults were more likely to be younger and females. Obesity was related with poorer health status, poorer asthma-

related quality of life, and increased asthma-related activity restriction (Vortmann & Eisner, 2008). Vortmann and Eisner also found that being underweight was related to poorer asthma quality of life and higher health care use than having a normal BMI. Obesity was associated with higher levels of depression and less perceived control over asthma.

Physical activity. Researchers have documented that people with asthma are less likely to be engaged in physical activity. Ford et al. (2003) assessed the leisure-time physical activity patterns among adults with current asthma participating in the 2000 BRFSS. The authors categorized leisure time physical activity as participation of any physical activity or exercise during the past month, such as running, calisthenics, golf, gardening, or walking for exercise. Ford et al. found that participants with asthma selected walking as their preferred exercise, but were more likely to be inactive compared to participants without asthma. Asthmatics also expended fewer kilocalories per week than people without asthma. The associations between asthma and physical activity did not differ by gender, but older adults were less likely to engaging physical activity than people who never had asthma (Ford et al., 2003).

To examine the relationship between physical activity and adult-onset asthma, Benet et al. (2011) followed a cohort of 51,080 women for 10 years (1993- 2003) in France. Benet et al. collected BMI and asthma incidence data at baseline and again in the tenth year. Benet et al. also collected self-report data on frequency of physical activity to include walking, cycling, gardening, home do-it-yourself activities, sports, and climbing stairs. At the 10 year of follow-up, Benet et al. did not find an association between

physical activity and new cases of asthma. Among those who had higher BMI, there was an association with an increased risk of new cases of asthma at the 10 years follow up.

Researchers have also examined the role of physical activity in preventing asthma exacerbation. During three years, García-Aymerich et al. (2009) studied a cohort of 2,218 women (mean age = 63 years) from the Nurses' Health Study. García-Aymerich operationalized asthma severity by symptoms, medications utilized, and days missed at work due to asthma symptoms. García-Aymerich accounted for the confounding effects of smoking, secondhand smoke, BMI, hormone replacement therapy, and menopause. For health care utilization, they collected information on hospitalizations, emergency room visits, and urgent visits to physician office. Physical activity was measured by type of exercise and hours per week of activity. García-Aymerich et al. found that the most frequent exercises reported were walking, biking and indoor exercise. The median physical activity was 10 hours per week. García-Aymerich found that the number of exacerbations and urgent visits to the physicians due to asthma decreased with increasing the level of physical activity.

Smoking, physical activity and obesity. Strine et al. (2007) examined the relationship of adverse health behaviors and obesity to asthma severity using data from 18, 856 respondents to the 2005 BRFSS in the United States. The researchers used participant responses on smoking, physical inactivity, and obesity. Strine et al. found that obese individuals were 70% more likely to have asthma than nonobese individuals; smokers were 60% more likely to visit an ER due to asthma than were nonsmokers, and those using inhalers were 90% more likely to be physically inactive than those who did

not require inhalers. Moreover, the presence of one or more of the behavioral risk factors analyzed was associated with increased health care utilization, active asthma symptoms, and work absences.

Environmental risk factors of asthma in adults. Researchers also have provided evidence that adult-onset asthma can be attributed to exposures to endogenous or exogenous triggers in the environment that interact with genes (Lee, Park, & Park, 2011). March et al. (2011) recognized that environmental stimuli, such as climate variables, infectious organisms, allergens and irritants interact with genetic factors to increase the risk of asthma attack exacerbations. According to Kabesch, Michel, and Tost (2010), the interaction between genetic and environmental factors is known to be mediated by epigenetic mechanisms that contributed to the development of asthma.

Researchers have evidenced that the exposure to outdoor or indoor triggers can induce contraction of the bronchioles or small airways, airway inflammation, and prolonged increases in contraction of the airways (Platts-Mills, 2009). Geller (2010) recognized that the effect of exposure to the environmental risks depends on the concentration of the agent in the environment, the time period the individual is exposed to the agent, and individual vulnerability. The Office on Women Health of the United States Department of Health and Human Services (2012) has established that individual vulnerability is greater for women who have asthma and are pregnant or nursing, or are older than 50 years. It is recommended that these individuals take special precautions to avoid environmental exposures. In addition, Le Moual et al. (2013) stated that new cases of adult-onset asthma can be generated by environmental exposures to asthma triggers.

Indoor asthma triggers. Nguyen et al. (2010) examined the contribution of home environment variables to the burden of asthma in New York State. The researchers operationalized indoor environmental exposures as the presence or absence of: mold, cockroaches, indoor pets, and tobacco smoke in the home. The researchers also examined the extent to which respondents used dehumidifiers, purifiers, exhaust fans, and mattress and pillow covers to reduce exposure to these allergens. Nguyen and colleagues found a positive association between current asthma and the presence of molds, but no association was found between asthma status and the presences of cockroaches, pets, or tobacco. Nguyen also found that adults with asthma were significantly more likely to use air cleaners, dehumidifiers and humidifiers at home to control asthma.

Nazario et al. (2012) evaluated the relationship between common allergens and asthma using data collected from a cohort of 395 subjects (mean age=29 years) recruited in ambulatory clinics in Puerto Rico. The researchers found that the most common sensitivities were related to mites and insects. In addition, Nazario et al. found that 65% of the subjects were sensitive to at least one allergen. In addition, Nazario et al. reported that subjects with mite sensitivity were 53% more likely to have an asthma history than those subjects who were not sensitive to mites.

Jie, Ismail, and Isa (2011) reviewed 72 studies on the relationship of asthma, allergic and respiratory symptoms to the home environment. The researchers included literature related to indoor air contaminants such as tobacco smoke; combustion from stoves, fireplaces; and furnaces; organic compound from cleaners, paints and deodorizers; and allergens from dust mites, fungi, bacteria, pets and pests. Jie et al. found that asthma

and asthma related-symptoms were associated most strongly with combustion, mold, and tobacco smoke. According to Jie et al., the studies linked a higher risk for asthma and asthma-related symptoms among adults who spend the majority of the time in their homes.

Work-related asthma triggers. Arif and Delclos (2012) conducted a population-based survey of 5, 600 health care professionals in Texas to evaluate the association between the cleaning products used in hospitals and the presence of asthma symptoms, asthma exacerbation, or occupational asthma. In addition to main exposures and outcomes measurements, the researchers collected data on potential confounders such as age, sex, race/ethnicity, and body mass index, number of years in work, atopy, and smoking status. Arif and Delclos found the most commonly reported outcome to be work-related asthma symptoms, especially among females. In addition, Arif and Delclos reported that the risk of experiencing asthma symptoms and symptom exacerbation increased as exposure to cleaning products increased. Bleach was associated with the highest risk increase.

Outdoor asthma triggers. Wen, Balluz, and Mokdad (2009) assessed the relationship between air quality media alerts and changes in outdoor activities among adults with asthma. The authors used data from the 2005 BRFSS from Colorado, Florida, Indiana, Kansas, Massachusetts, and Wisconsin, which included questions related to how participants reduced or changed their outdoor activity because of perceptions of bad air quality, media alerts of the air quality index, and the advice of physician to avoid outdoor activity. Their responses were classified under no activity changes and activity changes.

Wen and colleagues found that media alerts on air quality are related with changes in outdoor activities. Participants with asthma reported being more likely to make changes or reduce outdoor activities according to their perception of bad air quality than did individuals without asthma, and this perception was greater among women, participants with disabilities, and those over 35 years of age.

Quintero et al. (2010) analyzed air samples in the north of Puerto Rico to characterize airborne fungal spores throughout the year. The researchers found a predominance of mold spores, especially during the rainy months of May, September, and October. Furthermore, Quintero et al. found that spore concentrations were higher during early morning hours. Quintero and colleagues emphasized the importance of incorporating spore-related knowledge into the design of preventive measures for asthma and allergic patients. This study, however, did not provide conclusive information on mold spores sensitivity and its association with asthma in Puerto Rico.

Mixed Risk Factors and Asthma in Adults

Social and behavioral. Pérez-Perdomo et al. (2003) conducted the only existing study of association between behavioral risk factors and asthma prevalence and distribution in Puerto Rico. The researchers used the BRFSS to assess the behavioral risks of smoking and obesity among 4,206 adults living in Puerto Rico. The researchers found that 30% of participants with asthma were smokers, a higher percentage than found among nonasthmatics. Pérez-Perdomo found that income was not significant predictor for asthma prevalence, but higher educational attainment and having health insurance were predictive. The finding that asthma prevalence is related with higher educational level is

contradictory to other studies (Bacon et al., 2010; Corvalán et al., 2005; Nguyen et al., 2011). They also found an association between obesity and asthma. This association was greater for females than for males. Perez et al. did not stratify data by gender; consequently, the impact of modifiable risk factors relative to adult Puerto Rican women only was not analyzed.

Jackson, Roberts and Pearlman (2011) assessed differences on asthma-related quality of life and use of asthma medication among those adults with asthma who smoke and those who don't smoke. Researchers used data from 2008-2009 BRFSS and ACBS in Rhode Island. Jackson et al. included two statewide representative samples (1,234 and 579) from each survey in both years, respectively. The authors explored the relationship of asthma outcomes and use of medication with the following sociodemographic determinants: sex, age, race, marital status, educational level. Educational level was a surrogate for SES. Jackson et al. found that the prevalence of cigarette smoking did not differ among asthma patients and nonasthmatics. Among asthma patients, Jackson et al. concluded that smoking was associated with low educational level and recent depression, independent to other variables. However, researchers did not find significant differences on the use of asthma medication in any of the groups assessed.

Slejko et al. (2013) described asthma prevalence and the self-reported medication use, and indicators of control among 18,619 adults with lifetime or current asthma participating in the Medical Expenditure Panel Surveys during 2008-2010 in the United States. Slejko et al. assessed variables on race/ethnicity, education and income. Slejko et al. also assessed smoking behavior and physical activity, and the comorbidity burden.

Although, asthma control is the goal of the National Asthma Education and Prevention Program guidelines in the United States, Slejko et al. found that from the total sample, there is 4.8% of the population experiencing asthma exacerbations, 24% use inhalers and 14.6% of participants reported the use of more than three canisters of inhalers to control asthma symptoms in the past three months. Among this group, 60% use daily long term control medication. Slejko found that those who frequently used inhalers were more likely to be males, older, of lower SES, have more chronic conditions, and were physically inactive. Slejko concluded that asthma control among the population of the United States was suboptimal relative to goals and continued to be a public health concern.

Nguyen et al. (2011) examined the relationship between different risk factors and asthma control. The researchers used secondary data from 3,079 participants of the CDC's Adult Asthma Call-Back Survey residing in New England. The independent social risk factors were age, race, education, residence area, employment status. Behavioral risk factors included smoking status, and BMI. Additionally, the researchers examined the relationship of health care access and health care utilization with asthma outcomes. Nguyen et al. found that poorly controlled asthma was associated with unemployment, an inability to work, low educational level, smoking, and lack of access to health care. Poorly controlled asthma was also associated with higher levels of health care utilization.

Social and environmental. Trupin et al. (2010) evaluated the contribution of an integrated combination of environmental factors to adult asthma severity and asthma

quality of life in northern California. The researchers conducted an in-home survey to collect data on home environmental exposures among asthmatics. Trupin et al. collected data on the social risk factors of age, gender, race, family income, education, and employment status. Environmental exposure data was collected using dust samples to measure allergens from dogs, cats, and cockroaches as well as testing for dust mites. Dust samples were also analyzed for elemental metals (copper, zinc, magnesium, vanadium and iron) that can serve as biological markers of indoor exposures. During home visits, Trupin also quantified wall moisture percent. In addition, Trupin measured lung function, asthma severity and gathered blood samples for antibody testing to selected allergens. The external environment variables were measured using census block factors linked to subjects. Census factors represented geographic area income, poverty, employment status, home value, and population density. In addition, researchers included external air quality and climatic measures, road proximity, land use criteria (e.g. urban, agriculture), daily ozone levels, nitrogen oxide levels, and particulate matter and wind speed. Trupin found that mostly all the participants lived in urban or built environments and near roads. Among social risks factors, older age was associated with increased asthma severity scores and lesser lung capacity. Dog antigen was significant among antigens tested in dust samples. Among the environmental factors analyzed, none of the indoor elemental metals and external air quality factors were associated with asthma severity or decline in lung function. There was a significant positive association between having more severe asthma and using an at home air filter. Trupin et al. found the association between age and reactivity to dog antigens explained nearly a quarter of the variability in disease

severity in adult asthma. Age, less education, unemployment, and the total dust in bedroom were strongly associated with lung function decline.

Trupin et al. (2013) assessed the mediating role of housing and environmental factors in relation to asthma severity and quality of life among people with different gradients of socioeconomic status. Trupin et al. examined cross-sectional data from an asthma cohort of 515 adults (18 to 50 years) in California. Trupin operationalized human capital as income, education level, and housing type and ownership. Environmental factors were operationalized as exposures to irritants and allergens at home, perception of the neighborhood environment, and work-related exposures. Researchers found that lesser human capital was associated with greater severity of asthma and poorer quality of life. Additionally, Trupin found that asthma and rhinitis outcomes were mediated by home type and ownership, and a less favorably perceived neighborhood environment among those with lesser human capital group.

Knoeller et al. (2013) examined the relationship of exposures at work and work - related asthma (WRA) in the United States using data from the 2006-2007 Asthma Call-Back Survey. The researchers selected data from 17,637 adults with current asthma who were currently or previously employed in jobs which exposed them to chemicals, smoke, fumes, or dust. Knoeller et al. found that 9.7% of these adults had been diagnosed with work related asthma by a physician, and 47.5% had possible work-related asthma symptoms according to their responses to the study questionnaire. Knoeller et al. also found that lower SES was associated with a greater likelihood that adults with asthma would report that asthma to be occupationally induced. The researchers also found that

those without health insurance were more likely to have occupational asthma than those with health insurance.

Summary and Conclusions on Risk Factors of Asthma in Adults

Researchers have widely examined the association of asthma prevalence, asthma severity, asthma quality of life and health care utilization with social, behavioral, and environmental risk factors, alone or mixed, among different adult populations and countries. Researchers have evidenced that people with asthma in the lower social group level are more likely to be exposed to deteriorated housing, neighborhoods and environments where potential asthma triggers exacerbate their severity and increase health care utilization. Additionally, people with asthma with lesser human capital are more likely to present with in behavioral lifestyle risk factors, such as smoking, physical inactivity and obesity increasing their asthma risk and health care utilization. Researchers evidenced that atopic asthma was more frequent among higher human capital groups (Corvalan et al., 2005; and more sensitive to allergens (Nazario et al., 2012), thus validating the hygiene hypothesis, that states that less exposure to allergens early in life does not strengthen the immunological system to combat antigens (Gold & Wright, 2005).

From the total of 25 studies reviewed, only seven researchers examined mixed risk factors and asthma outcomes. Three researchers have examined the association of risk factors with asthma control (Bacon et al., 200; Curtis et al., 2012; Nguyen et al., 2011), but only one has examined mixed risk factors utilizing BRFSS in the United States (Nguyen et al., 2011). However, Nguyen et al. did not included important behavioral

factors, such as physical activity patterns, as well as indoor quality air, which can modify the results. Additionally, the authors did not sex-disaggregate data for the examination of factors associated with differences between males and females, nor did participants differentiate among those who have controlled asthma and those than have uncontrolled asthma symptoms.

Additionally, the relationship between social and behavioral risk factors and asthma prevalence was examined among general adult population in Puerto Rico (Pérez-Perdomo et al., 2003). Although, Perez-Perdomo et al. (2003) have found that obesity increased asthma among asthmatics women in Puerto Rico, the study did not assessed the impact of these risk factors on either asthma control or service utilization among this vulnerable population. There are no studies examining the contribution of these and other modifiable risk factors such as indoor environmental risks and asthma control and health care utilization among adult females in Puerto Rico, the target population of this investigation.

This review demonstrates that researchers have more commonly assessed social risk factors rather than behavioral and environmental factors. This literature review highlights the extent to which researchers have favored investigating asthma outcomes other than asthma control and health care utilization, which are the outcomes of interest in this investigation. Additionally, it demonstrates a lack of studies examining the relationship between, risk factors, and the extent to which asthma symptoms are controlled or uncontrolled in adult females.

Conceptual Model

Andersen's framework is consistently employed to explain disparities in health care access and utilization among populations examining three sets of factors: predisposing factors, enabling factors and need factors and their contribution to health status outcomes (Andersen, 1995). This investigation employed Andersen framework to explain health care utilization patterns among females in Puerto Rico, and differentiate patterns associated with varying levels of asthma control. As Puerto Rico has a high percentage of the population covered by health insurance, and that coverage is not tied to employment status, an investigation into the relationships among predisposing and enabling factors, health care utilization , and asthma control would define asthma risks among women in the Commonwealth of Puerto Rico than studies directed toward Puerto Ricans living in the United States (Pérez-Perdomo, García-Rivera, & Serrano-Rodríguez, 2005; US Department of Health and Human Services, Office of Minority Health, 2012; Vogt et al., 2008). I present the general conceptual model guiding this study in Figure 11. Specific statistical models derived from this conceptualization are presented in Chapter 3.

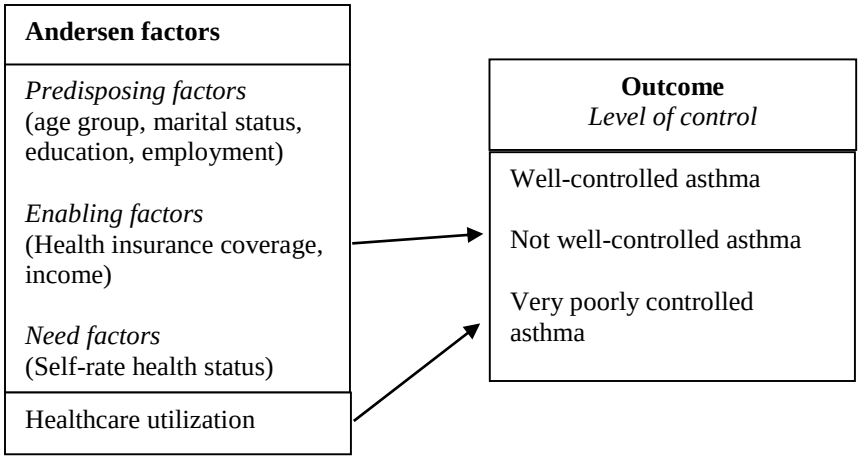

Figure 11. Andersen's conceptual model to asthma level of control

Chapter 3: Research Method

The purpose of my study was to develop a gender-specific asthma risk profile for the adult female population in Puerto Rico through a systematic examination of currently available data. In this chapter, I begin with a section on the research design, the selection rationale for that design, and a description of my dependent and independent variables. Next, I present my proposed methodology including my target population, the data sets used to answer my research questions, the sampling procedures used in the original data collection, the validity and reliability of the original data collection instrument, reliability or validity issues related to the sampling method used, the operationalization of the study variables, a restatement of the research questions and hypotheses, and the data analysis plan used for answering each of the research questions. I follow the methodology section with a discussion of the threats to validity associated with my research design. I conclude the chapter with a description of the ethical aspects of my study and provide a summary of key points addressed in Chapter 3.

Research Design and Rationale

Design and Rationale

A cross-sectional survey design was consistent with my intent to develop a gender-specific asthma risk profile. Cross-sectional investigations support screening hypotheses in prevalence studies for a diverse population in a range of settings (Carlson & Morrison, 2009). Levin (2006) noted that a cross-sectional design is used when a researcher is interested in examining the association of an outcome of interest with its potential and risk factors at a population or subpopulation level at a specific point in time.

Experimental and quasi-experimental designs were not appropriate for this investigation because the purpose was not to evaluate a specific treatment or intervention (Creswell, 2009). In addition, the study included independent variables such as sociodemographic characteristics that could not be manipulated in experiments. Frankfort and Nachmias (2008) established four considerations that justify not using an experimental design in social research: (a) differences in time interval to produce an outcome, (b) difficulties in isolating the exposure in natural observation, (c) difficulties comparing groups, and (d) difficulty establishing the time sequence of events.

Cross-sectional designs are strong on representation but weak on control (Frankfort & Nachmias, 2008). To address the limitations of the cross-sectional design, specific data analysis techniques, such as control of confounding variables, are needed to assess independent variables individually to uncover factors that would affect the original relation and create spurious relationships (Frankfort & Nachmias, 2008). In addition, elaboration is used to include other intervening variables that link the dependent and independent variables to explain the relationship between variables (Frankfort & Nachmias, 2008). Finally, the prediction process includes analysis of two or more independent variables to approximate results that could be obtained from an experimental design and permit comparisons between or among groups (Frankfort & Nachmias, 2008). I incorporated these techniques, as appropriate, in the data analysis plan.

Because this study was based on secondary data analysis, I transferred to this investigation all of the quality standards of the BRFSS ACBS, which is recognized as a well-designed survey (Mokdad, 2009; Piernnunzi, Hu, & Balluz, 2013). The CDC has

adopted a policy of ongoing development for the BRFSS ACBS to continually improve coverage and response rates and reduce potential threats to validity and reliability (Mokdad, 2009). The CDC adheres to the highest quality standards in the development of the BRFSS ACBS survey items, the sampling process, and the administration protocols (CDC, 2013b; Mokdad, 2009). The survey fielding consistently achieves high responses rates (CDC, 2014b). The continued utilization of BRFSS ACBS over time demonstrates its utility and power as a tool for assessing associations between outcomes and risk factors (Mokdad, 2009). Furthermore, evaluations of survey items have shown that the items are highly consistent over time and are defensible with respect to the content and constructs they are designed to measure, as described in detail in the section on validity (Fahimi et al., 2008; Li et al., 2012; Nguyen et al., 2011; Pierannunzi et al., 2013) and reliability (Nelson, Holtzman, Bolen, Stanwyck, & Mack, 2001; Pierannunzi et al., 2013). When using secondary data from available cross-sectional databases, I made sure that the databases had the specific measures for the assessment (Smith et al., 2011). My preliminary review of codebook reports confirmed that appropriate variables were available in the ACBS to build a women's asthma profile. However, cross-sectional data do not provide for the identification of those factors that have a causal impact on disease development because data is taken at a specific point in time. Consequently, the principle of temporality is not fulfilled (Ibrahim, Alexander, Shy, & Deming, 2001).

Study Variables

This study included data from the Centers for Disease Control's BRFSS and Asthma Call-back Surveys conducted in Puerto Rico in 2011 and 2012. The dependent

variables were current asthma status (active asthma, nonactive asthma), asthma-related health care utilization (asthma urgent visits, emergency room visits, hospitalizations), and achieved level of asthma control (well controlled, not well controlled, poorly controlled). Current asthma status was investigated using social risk factors (age group, education, marital status, employment, income, health insurance coverage), behavioral risk factors (smoking, physical activity, meets aerobics, body mass index), and environmental risk factors inside home (secondhand smoke, molds, pets, rats and cockroaches, air cleaner, dehumidifier) as the independent variables. Asthma-related health care utilization was evaluated using Andersen's predisposing factors (age group, education, marital status, employment), enabling factors (health insurance coverage, income), and need factors (self-rated health status) as the independent variables. Achieved level of asthma control was assessed to determine the extent to which it was associated with the independent variables of predisposing factors, enabling factors, need factors, and asthma-related health care utilization.

Methodology

Population

The target population for this study were women with asthma residing in Puerto Rico. My sample was a subsample of the BRFSS ACBS that consisted of adult females 18 years or older residing in Puerto Rico. Respondents in the subsample were categorized as asthmatic for having answered the ACBS module question "Have you ever been told by a doctor or other health professional that you have asthma?"(CDC, 2013d, p. 4). Respondents who answered the subsequent question, "Do you still have asthma?" in the

affirmative were classified as current or actively asthmatic, while those who answered that question negatively were classified as asthmatic, but not currently active (CDC, 2011a).

Sampling and Sampling Procedures

Sampling for the BRFSS. Since 2011, the BRFSS sampling protocol has combined a disproportionate stratified random sample for landline telephones, and a random sampling selection from a frame list of confirmed cellular telephones (CDC, 2013e). The eligible participants for BRFSS are individuals 18 years or older living in a typical household and adult students living in college housing. Eligible participants do not include residents in vacation homes, group homes, or institutions (CDC, 2013e). Each year, the total sample size includes at least 4,000 interviews per state or territory, including Puerto Rico; 20% of the interviews are from cellular telephones and 80% from landline telephones (CDC, 2013e).

Landline telephones sampling. For landline sampling, the sample frame is composed of a probability sample of all households with telephones in each state or territory (CDC, 2011b). Disproportionate stratified sampling is used in Puerto Rico. To achieve this, telephone numbers are divided by eight geographic regions or strata (Aguadilla, Arecibo, Bayamón, Metropolitan Area, Fajardo, Caguas, Ponce, and Mayaguez), from which a random sample is taken that is proportional to the stratum's density of the landline telephone numbers (Departamento de Salud, 2005).

***Cellular phone sampling*.** The cellular phone sample consists of individuals 18 years or older living in households who have a nonbusiness cellular phone and do not

have a landline telephone (CDC, 2011b). The cellular phone list is delivered by a private provider that utilizes a Windows-based application to produce the sampling frame. The frame is based on cellular banks sorted by area code and exchange (the three number prefix next to the area code that indicates the geographic location) within each state or territory (CDC, 2011b). Each state or territory is classified as a single stratum (CDC, 2011b). Then, the frame list is divided by *n* intervals based on population density, and one 10-digit cellular telephone number is then randomly selected from each interval. Although Puerto Rico initiated a pilot project with cell phones in 2010, a cell phone sample was not included in the 2011 BRFSS ACBS due to administrative and financial delays (R. Serrano, personal communication, September 8, 2014). Thus, the total sample interviews for 2011 were completed using only landline telephone numbers. For 2012, Puerto Rico included the appropriate 20% cell phone sample.

Weighting methodology. Since the addition of cell phones in the BRFSS sampling, the CDC changed the weighting methodology to an iterative proportional fitting (or raking) that includes the type of phone as a variable (CDC, 2013f). Sampling weighting for BRFSS includes two phases: design weighting and raking. The design weighting is equal to the stratum weight multiplied by one divided by the number of phones and multiplied by the number of adults in each household, as shown in the formula below (CDC, 2011b; CDC, 2013e).

Design weighting = (stratum weight) × (1÷ number of telephones) × (number of adults)

The stratum weight is calculated using the numbers of available records divided by the number of records selected within each geographic area and density stratum combination, as shown in the formula below (CDC, 2011b; CDC, 2013e).

Stratum weight = (number of available records) ÷ (number of selected records)

The new weighting process enhances the previous post stratification weighting procedures guaranteeing that BRFSS data is representative of the population for each state or territory, thus reducing bias in the sample (CDC, n.d.). The method, called iterative proportional fitting or raking, "adjusts the data within each state or territory so that groups which are underrepresented in the sample can be accurately represented in the final dataset" (CDC, n.d., p. 1). Raking allows adjustment for representation by telephone source, sex, age, race, education, marital status, age group by gender and by race, gender by race and ethnicity, home ownership, and substate region (CDC, 2013e). Raking adjusts by adding one variable at the time into the formula; for example, the formula will adjust first by gender, then by age group and so on until all variables mentioned above are adjusted.

The final weight of landline telephones and cellular telephones in the population (LLCPWT) is assigned to each respondent based on the design weight result and raking adjustment for each variable (CDC, 2013e). The final weight assigned to each respondent for combined landline and cellular telephones is available in the final data set, depending on the inclusion of cell phones or considering only landline phone numbers (CDC, 2013e). The latter does not affect combining data sets with or without both types of

telephone sources because data are weighted depending on the distinction of landline or cell phone sampling (R. Serrano, personal communication, September 8, 2014).

Sampling for the ACBS. The Asthma Call-Back Survey is an extension of the BRFSS (CDC, 2011c). The sample for the ACBS comes from those BRFSS participants who reported being diagnosed with asthma at any point in time. These respondents are recruited for call-back two weeks after the BRFSS interview completion date (CDC, 2013e). The ACBS follows the same data collection protocols as those operative for the BRFSS (CDC, 2011c). The ACBS meets CDC IRB guidelines (CDC, 2011c).

***Sampling from ACBS for this investigation*.** For this investigation, I used a purposive subsample culled from adult participants 18 years or older surveyed in the Puerto Rico BRFSS-ACBS during 2011 and 2012.

Inclusion criteria. Eligible participants for this investigation were those participants of the BRFSS-ACBS during 2011 and 2012 in Puerto Rico. By using data solely from the BRFSS ACBS, I included only those BRFSS respondents in Puerto Rico who answered the question "Has a doctor, nurse, or other health professional ever told you that you had asthma?" in the affirmative. The age of inclusion was restricted to adults, who were defined as being 18 years or older. The subsample was restricted to females.

I combined two years to increase power sample by using data that have the same weighing methodology and that the CDC makes available for the public. According to the CDC (2013f), a researcher can combine BRFSS ACBS data from years that have the same weighting methodology, but cannot use more than three years to avoid biases as a

result of potential changes occurring in the population characteristics (CDC, 2013f). The Puerto Rico BRFSS ACBS had 366 respondents during 2011 and 434 participants during 2012 for a total of 800 participants. From this total, I estimated that 81% would be females, or approximately 648 participants for my sample.

I cleaned and organized the databases to facilitate combining the two years. The two databases had the same format and included the same variables. Variables needed from each year were selected. The two databases were standardized in terms of variable order and answer codes for each year. Because the sampling frame of telephone numbers is different each year, overlapping of respondents does not occur between the two consecutive years selected (R. Serrano, personal communication, September 9, 2014). The combination of data from two years required the adjustment of the weights of each year. For that purpose, I used the final weight variable calculated by the CDC in the database. The final weight variable of each year was calculated, and the total was divided by two to obtain the final weight for this study population (R. Serrano, personal communication, August 16, 2014). With the result obtained, I created a new final weight variable for this study.

Power analysis. A priori power analysis was conducted using G*power 3.010 to identify the required sample size for the statistical test at the power and effect size required for this study (Faul, Erdfelder, Buchner, & Lang, 2009). I used multiple logistic regression models to address the relationship between a binary dependent variable and one or more independent variables with discrete or continuous probability distributions (Faul et al., 2009). Therefore, I selected *F* test and multiple regression R^2 deviation from

zero. I calculated the tests at a medium effect size ($f^2 = 0.15$), (α error = 0.05) and confidence level ($1-\beta = 0.95$). I calculated the power for three models containing 16, 7, and 10 variables respectively. The output sample size required was 204, 153, and 172 for each model respectively.

Archival Data

The Puerto Rico Behavioral Risk Factor Surveillance System (PR-BRFSS), located at the Puerto Rico Department of Health, conducts the BRFSS data collection in Puerto Rico (Departamento de Salud, 2005). The BRFSS database is composed of a core data set that includes socio demographic information, behaviors, chronic conditions, symptoms, episodes, and health care utilization (CDC, 2013f). The PR-BRFSS Asthma Call-Back Survey is composed of questions on asthma control, asthma health care utilization, modifications to the house environment, and the use of asthma medication. Both databases are matched to create a unique database of participants who self-report having, or having had, asthma. ACBS databases for the years 2011 and 2012 were conducted using the same data collection methods (CDC, 2013g; CDC, 2014a): sampling strategy and weighting methodology as discussed above, and recruitment protocol, participation criteria, and data collection methods.

Recruitment and participation for the PR-BRFSS. Recruitment for the PR-BRFSS is conducted utilizing the lists of both telephones numbers and cellular phone numbers provided by CDC and private providers, respectively. The Puerto Rico data set for 2011 is composed of landline respondents only, while 2012 data set included a combination of both landline and cell phone respondents (R. Serrano, Personal

Communication, September 9, 2014). The PR-BRFSS staff initiates up to 15 attempts to reach any potential participant (CDC, 2013g). Once an eligible participant is contacted and interviewed, the attempt is coded as either a completed or a partially complete interview depending on the circumstances, utilizing a disposition code (CDC, 2013g). If an eligible participant cannot be reached, refuses to participate in the survey, terminates the call, has language problems, or is physically or mentally unable to answer, the contact is classified as eligible but not interviewed (CDC, 2013g). These codes are used to calculate the response rates for all the participants of the BRFSS (CDC, 2013g; 2014a).

Recruitment and participation for ACBS. Participants for the ACBS are recruited during the PR-BRFSS interview, when the interviewer identifies a respondent as eligible for the ACBS (CDC, 2014c). An eligible respondent is an adult identified as asthmatic according to the BRFSS asthma screening questions, who consents to be called back for the ACBS (CDC, 2014c). The ACBS is conducted two weeks after the PR-BRFSS (CDC, 2014a). Eligible participant contacts are coded according to whether the contact results in a completed interview, a refusal to participate at the point of call-back or a terminated call, lost to follow-up due to inability to contact or communicate, or lost to follow-up for technical reasons. These codes are used to calculate the response rates for the ACBS.

ACBS responses rates. CDC measures the response rate for the ACBS by calculating the Interview Completion Rate, Cooperation Rate, Refusal Rate and the Council of American Survey Research Rate (CASRO) or the respondent cooperation rate (CDC, 2013g; 2014a). The following equations show the numerator and denominator of

each rate. The numbers (1100, 1200, etc.) represent the codes assigned to each respondent according the situation presented during the interview (CDC, 2013g; 2014a). Details on each of these equations are provided in Appendix A.

ACBS Interview Completion Rate

(1100 + 1200) - Completed interviews (COIN) plus the total telephone numbers contacted)
(1100 + 1200) + (2120 + 2211 + 2212 + 2112) - COIN plus those who refuse or terminate the interview (TERE)

ACBS Cooperation Rate: It requires >65%

(1100 + 1200) - COIN plus the total telephone numbers contacted)
(1100 + 1200) + (2120 + 2211 + 2212 + 2112 + 4413) + (2320 + 2330) - COIN plus the total telephone numbers contacted, plus TERE, plus those interviews with language barriers or physical/mental impairment

ACBS Refusal Rate: It requires <35%

(2120 + 2211 + 2212 + 2112 + 4413)
[1100 + 1200 + 2120 + 2211 + 2212 + 2112 + 4413] + P * [Eligible lost]
TERE divided by COIN plus the total telephone numbers contacted, plus TERE, plus a proportion of those eligible but lost to follow-up. Where: P (Proportion) = (COIN + ACBS TERE) /(COIN + ACBS TERE + Ineligible)

ACBS CASRO Rate: >40%

(1100 + 1200)
[(1100 + 1200) + (2120 + 2211 + 2212 + 2112 + 4413)] + P * [Eligible lost]
COIN plus the total telephone numbers contacted divided by COIN, plus TERE, plus a proportion of those eligible, but lost to follow-up who would be expected to remain eligible if they had been contacted. The proportion of cases lost to follow-up that are estimated to be eligible is the same as the proportion of cases not lost to follow-up that are eligible.

The response rates for Puerto Rico and the median for all the states for 2011 are provided in Table 1 (CDC, 2013g). Puerto Rico's responses rates in all measurements are higher than those reported for the 50 states. The comparable statistics are not available for 2012.

Table 1

ACBS Response Rate for Puerto Rico During 2011

Response Rate	Standard by CDC	Puerto Rico 2011	Median for all states 2011
Completion Rate	---	97.1%	93.1%
Cooperation Rate	>65%	76.7%	59.3%
Refusal Rate	<35%	18.6%	33.8%
CASRO Rate	>40%	61.4%	48.4%

BRFSS data collection. Puerto Rico collects BRFSS data throughout the entire to avoid seasonal bias. Interviews are conducted using the Computer-Assisted Telephone Interview (CATI) system. The core portion of the questionnaire lasts 18 minutes and the module and added questions add other 5 to 10 minutes, depending on the quantity of questions (CDC, 2011b, 2014c). The territory coordinator conducts training for interviewers according to the CDC protocols which establish standards for the interviewing process, the use of sampling codes, survey follow-up techniques, and practice sessions (CDC, 2011b, 2014c). Since 2011, CDC has the capability to monitor each interview call through the CATI System (CDC, 2011b, 2014c), technology. This technology (WIN CATI) that has been used in Puerto Rico since 2011 (R. Serrano, Personal Communication, October 8, 2014).

Interview process. Each state or territory has to complete a number of calls each month (CDC, 2014c). Interviewers attempt to contact each landline telephone number up to 15 times and each cellular phone number up to 8 times (CDC, 2014c). Interviewers call 7 days a week on a monthly basis all year. Calling is rotated over the days of the

week and over the daytime and nighttime hours (CDC, 2011b, 2014c). During weekdays before 5.00 pm, interviewers attempt 20% of the designated landline numbers. The interviewers contact the rest 80% of the numbers after 5:00pm, during weekdays and weekends (CDC, 2014c). For cellular numbers, interviewers attempt during three different occasions alternating weekday, weeknight and weekend, but data collectors adjust for holidays and user's preference (CDC, 2014c). State and territory coordinators supervise and monitor the quality of the interview process among the interviewers, assuring respondent's confidentiality (CDC, 2014c). State and territory coordinators submit collected data to CDC on monthly basis utilizing a standardized data layout file through a designated web site (CDC, 2014c).

ACBS data collection. The BRFSS office in Puerto Rico collects data for the ACBS two weeks after the PR-BRFSS, according to the standards and procedures of the CDC (Departamento de Salud, 2005). Thus, Puerto Rico applies the same data collection protocol for BRFSS as any State or Territory of United States (R. Serrano, Personal Communication, September 9, 2014). The interviewers call only those BRFSS participants already identified as having given permission to be called back. The interview takes from 5 to 15 minutes, according the current asthma status of the participant (CDC, 2013f). The information taken in ACBS is then matched with the core data set from the BRFSS survey. This means that databases are already merged (CDC, 2013f) when datasets are made available for research. The specific BRFSS questions, however, are not included in the ACBS codebook (CDC, 2013f), and the BRFSS

codebook required to fully understand the database. Links for both surveys BRFSS and ACBS for 2011 and 2012 included in this investigation are provided at the Appendix B.

BRFSS-ACBS data access. The Centers for Disease Control and Prevention is the principal agency responsible for data generation in the states and territories of the United States, but the final custodian of the BRFSS-ACBS databases of Puerto Rico is the Asthma Project. The CDC makes data available six months after the end of the yearly data collection cycle (CDC, 2013f). In order to access the databases for this research, I requested the 2011 and 2012 data files from the Asthma Project as CDC's representatives recommended (see Appendix C). The Asthma Project signed the approval of the Data Use Agreement with Laureate Universities (see Appendix D).

Instrumentation

This study used data from two instruments: the core BRFSS and the ACBS module. Both data sets are linked into the ACBS database. Both instruments are discussed in the following section:

BRFSS questionnaire. The BRFSS questionnaire was developed in a collaboration between CDC and the public health departments in each state, the District of Columbia and three US territories including Puerto Rico (CDC, 2014c). The current questionnaire has three parts: the core section, the optional modules and optional regionally developed questions (CDC, 2011b). Puerto Rico began using the questionnaire in 1996. The core section is composed of standard questions asked by all the states and territories. The core section includes demographic information, perceptual and behavioral information related to health insurance, cigarette smoking, and chronic health conditions

(CDC, 2011b). The second part includes the CDC optional modules, including the Asthma Call-Back Survey, that are selected by the state or territory in order to assess specific chronic conditions of interest (CDC 2011b). Finally, there is a set of added questions developed and utilized by individual states or territories to pursue issues of local interest (CDC, 2011b). Puerto Rico added questions related to autism, folic acid consumption and milk consumption during 2011 year, and vision problems, Alzheimer and childhood experience during 2012 (R. Serrano, Personal Communication, September 9, 2014). CDC provides a Spanish translation of the survey developed in collaboration with the Puerto Rico BRFSS director (R. Serrano, Personal communication, September 9, 2014). This investigation used 12 independent variables derived from the BFRSS: four sociodemographic and/or predisposing variables (age-group, marital status, education, and employment), five behavioral variables (smoking, smoking level, physical activity, meet aerobic recommendations, and BMI), two enabling variables (income, health insurance) and one need-related variable (health status).

ACBS module. The ACBS has been available in conjunction with the BRFSS every year since 2006 (CDC, 2013b2), but it was not implemented in Puerto Rico until 2009 (J. Bartolomei, personal communication, August 18, 2014). The ACBS module was developed in a collaboration between the CDC and public health departments in each state, the District of Columbia and three US territories including Puerto Rico, as part of the BRFSS (CDC, 2014c). CDC provides a Spanish translation of the survey, which is composed of questions about asthma control, asthma health care utilization, asthma management, asthma education, asthma-related indoor environment modifications, and the

use of asthma medication by type and dosage (CDC, 2014a; 2014b). Puerto Rico did not add questions for the selected years 2011 and 2012 for this investigation (R. Serrano, Personal Communication, September 9, 2014). From the 1,444 variables in the ACBS, I utilized 14 variables in this investigation. The variables are the 3 dependent variables of (a) current asthma status, (b) asthma-related health care utilization (composed by asthma urgent visits, asthma emergency room visit and asthma hospitalizations) and (c) asthma control (composed of number of asthma symptoms in past 30 days, frequency nighttime awakenings in past 30 days and frequency of rescue medicine). The independent variables included seven environmental variables (secondhand smoke, mold inside, pets inside, cockroach inside, rodents inside, dehumidifier use, and air cleaner inside).

Reliability and validity of the BRFSS-ACBS. Researchers have established that estimates from BRFSS-ACBS are valid (Nguyen et al., 2011; Pierannunzi et al., 2013). Validity refers to the capacity of an instrument to measure the phenomenon it is intended to measure (Vanderstoep & Johnston, 2009). Asthma-related measures have demonstrated face and construct validity in both BRFSS and ACBS surveys (Nguyen et al., 2011). Researchers rely on the consistency of BRFSS results when compared to other self-reports surveys such as the National Health Interview Study (NHIS) and the National Health and Nutrition Examination Survey (NHANES), which have analogous measures related to smoking prevalence, chronic conditions, health status, insurance coverage, and body measurements (Fahimi, Link, Mokdad, Schwartz, & Levy, 2008; Li et al., 2012; Pierannunzi et al., 2013). There is a difference between the BRFSS and the NHIS interview techniques as the BRFSS uses the telephone while the NHIS is conducted face

to face (Fahimi et al., 2008). Li et al. (2012) concluded that prevalence estimates of current smoking, obesity, and no health insurance were similar across the BRFSS, NHANES and NHIS, although health status from the BRFSS tends higher than similar data collected for the NHIS. Fahimi et al. (2008) found that self-reported height was identical for the BRFSS and the NHANES. BRFSS data on smoking status and obesity measures were similar to NHIS and NHANES. Using a systematic review of validity studies, Pierannunzi et al. (2013) was able to conclude that prevalence rates were comparable among the BRFSS, NHIS, and NHANES Questions related to health insurance coverage, general health, and chronic health from the BRFSS demonstrated high validity in the test-retest assessment (Pierannunzi et al., 2013). Validity for health insurance coverage also demonstrated that there were no statistical differences, when BRFSS was compared to NHIS (Pierannunzi et al., 2013).

Reliability refers to the consistency of an instrument to obtain the same scores over time (Vanderstoep, & Johnston, 2009). Nelson et al. (2001) found that the reliability of the BRFSS varies across the sections of the survey. The core BRFSS questions that showed high reliability were those dealing with current smoking behavior, blood pressure screening, height, weight, BMI, and several demographic characteristics. Pierannunzi et al. (2013) found that access to health care and general health, physical activity, chronic conditions, and mental health measures had high test-retest reliability. In addition, Pierannunzi et al. (2013) found that, among women, reliability of questions related to weight had moderate reliability. Additionally, Nelson et al. (2001) mentioned that other measures such as sedentary lifestyle, and intense leisure-time physical activity showed

moderate reliability. As an indicator of variability of the instrument, Pierannunzi et al. (2013) also reported differences among groups in questions for physical activity that showed higher reliability for those who engage in vigorous exercise, than for those who report moderate, light or no physical exercise.

Operationalization of the Study Variables

Dependent variables. The dependent variables in this study are current asthma status, asthma-related health care utilization, and achieved level of asthma control.

Current asthma status. Refers to asthma as an active condition at the point of assessment (Moorman et al., 2012). The indicator variable is current asthma status: active or inactive.

Asthma-related health care utilization. Refers to the times that a person see a doctor, have visit an emergency room or have stay overnight in a hospital because of asthma over a year's time (Andersen, 1995). To operationalize this definition in the ACBS, I select the following sets indicator variables:

During the past 12 months, how many times did you see a doctor or other health professional for a routine checkup for your asthma? (CDC, 2013d). This variable response is continuous indicating the number of times, the respondent required urgent visit to a physician.

During the past 12 months, have you had to visit an emergency room or urgent care center because of your asthma? yes/no (CDC, 2013d).

During the past 12 months, that is since, have you had to stay overnight in a hospital because of your asthma? Do not include an overnight stay in the emergency room? yes/no (CDC, 2013d).

Achieved level of asthma control. Refers to the control of asthma symptoms. This variable has two sets of indicators: *Clinical control* - refers to the frequency and intensity of asthma symptoms and patient's physical limitations during day and at night. The second indicator is *Exacerbations of asthma*, which refers to the number of times the participant required oral corticosteroids in the last 12 months (Bousquet et al., 2010). Asthma control is measured according to the definition of the National Asthma Education and Prevention Program (NAEPP, 2007) guidelines. There are some variations in Homan, Gaddy, and Yun (2008) approach, who used the Asthma Call-Back Survey (ACBS) data on symptoms, nighttime awakenings, and the use of asthma rescue medicine ranked by level of control, according to the criteria shown in the Table 2 that classify asthma as well controlled, not well controlled and very poorly controlled.

Table 2

Categories for Achieved Asthma Control Level

Asthma control	Number of days of symptoms in the past 30 days (SYMP-30D)	Times of nighttime awakenings in the past 30 days or times per day (ASLEEP30)	Times using a rescue medicine (LAST_MED)
Well controlled	≤ 8 days in past 30 days	≤ 2 times in the past 30 days	≤ 2 times per week or ≤ 0.29/day
Not well controlled	> 8 days in the past 30 days, but not through the day	≥ 3 but ≤ 12 times in the past 30 days	> 2 times per week to < 2 uses per day or > 0.29/day to 2 uses/day
Very poorly controlled	Every day in the past 30 days and during the day	≥ 13 times in the past days	Several times a day Or >2 uses per day

This study has independent variables associated with social variables, behavioral and environmental variables as available in the ACBS.

Independent social variables. The following are the independent variables.

***Age group*.** Refers to a calculated variable that correspond to the age of participant according to age by group as defined in the BRFSS (CDC, 2013d).

Education. Refers to the level of education completed (CDC, 2013d).

Income. Refers to the annual household income from all sources (CDC, 2013d).

***Marital status*.** Refers to whether or not a person is married, divorce, widowed, separated, or never married or member of an unmarried couple (CDC, 2013d).

Employment. Refers to the employment status selection among: employed by wages, self-employed, out of work more than 1 year, out of work more than 2 years, a homemaker, a student, retires, unable to work (CDC, 2013d).

Health care insurance. Refers to having any type of health insurance at the time of assessment (CDC, 2013d).

Independent behavioral variables. The following are the independent behavioral variables.

Body mass index (BMI). Refers to a simple index utilizing weight and to classify overweight and obesity in adults, where weight in kilograms is divided by the square of his height in meters (WHO, 2014b). This study use categories under BRFSS (CDC, 2013d) that classify as underweight those with BMI < 20 kg/m2, normal weight (20-25 kg/m2), overweight (BMI = 25-30 kg/m2), and obese (BMI=≥30 kg/m2).

Physical activity. Refers to the recommendation for US adults that should be 30 minutes or more of moderate-intensity physical activity on all or most days of the week (Pate et al., 1995). The question concerning adults reporting physical activity or exercise during the past 30 days other than their regular job was utilized: "During the past month, did you participate in any physical activities or exercise such as callisthenic, running, gardening, or walking for exercise (CDC, 2013d, p. 38). Then, if participants meet the physical activity index according this aerobic recommendation according to their response to "when you took part of physical activity, for how many minutes or hours did you usually keep at it" (CDC, 2013d p. 46).

Independent environmental variables. The following are the environmental variables.

***Smoking status*.** Refers to smoking cigarettes at the time of the assessment. nonsmokers are those who do not currently smoke (CDC, 2013d).

Current smoker – Refers to a person that smoke every day or some days at the time of the assessment (CDC, 2013d).

Exposure to secondhand smoke. Refers to the question, has anyone smoked in the home in the past week? (CDC, 2013d).

Molds inside home. Refers to the question, has anyone seen or smelled mold or a musty odor inside the home in the past 30 days (CDC, 2013d).

Pets inside home. Refers to the question, do pets, such as dogs, cats, hamsters, birds spending time indoors? (CDC, 2013d).

Cockroach inside home. Refers to the question, has anyone seen a cockroach inside home in the past 30 days? (CDC, 2013d).

Rodent inside home. Refers to the question, has anyone seen mice or rats inside home in the past 30 days? (CDC, 2013d).

Air cleaner use. Refers to the question, was an air cleaner or purifier filter used to trap indoor air pollutants like dust, pollen, mold and chemicals? (CDC, 2013d).

Dehumidifier use. Refers to the question, is a dehumidifier used to reduce moisture inside the home? (CDC, 2013d).

Predisposing variables. The following are the predisposing variables classified according the Andersen framework.

Age group. Refers to a calculated variable that correspond to the age of participant according to age by group as defined in the BRFSS (CDC, 2013d).

Education. Refers to the level of education completed (CDC, 2013d).

Marital status. Refers to whether or not a person is married, divorce, widowed, separated, or never married or member of an unmarried couple (CDC, 2013d).

Employment. Refers to the employment status selection among: employed by wages, self-employed, out of work more than 1 year, out of work more than 2 years, a homemaker, a student, retires, unable to work (CDC, 2013d).

Enabling variables. The following are the enabling variables classified according the Andersen framework.

Income. Refers to the annual household income from all sources (CDC, 2013d).

Health care insurance. Refers to having any type of health insurance at the time of assessment (CDC, 2013d).

Need variables. The following are the need variables classified according the Andersen framework.

Self-rated health. Refers to the general health status among Good, Better, Fair and Poor health status (CDC, 2013d).

Data Analysis Plan

I conducted a descriptive, bivariate and logistic regression analysis utilizing Statistical Package for the Social Sciences (SPSS) statistics version 21. All statistical tests were conducted at .05 as a level of confidence. Data from the ACBS of 2011 and 2012 were combined. A new weighting variable for both years was created. Data was cleaned of

errors, missing values, or other inconsistencies to develop a statistically improved data set (Gliklich & Dreyer, 2010). Even though the BRFSS staff performs the appropriate data cleaning and validation processes before publishing the data, I made sure that data from the subsample utilized were appropriately formatted for my operationalization requirements.

To recap, the research questions and hypotheses are as follows:

RQ1- To what extent do sociodemographic, behavioral, and environmental variables differentiate between current active and nonactive asthma at the point of assessment in the sample of adult females living in Puerto Rico?

$H_0$1: Sociodemographic (age-group, marital status, education, income, employment, health insurance coverage), behavioral (smoking, physical activity, meets aerobic, body mass index) and environmental variables (secondhand smoke, mold, pets, cockroach, dehumidifiers and air cleaner use) are not significantly associated with the presence of active asthma in the study sample

$H_1$1: Sociodemographic, (age-group, marital status, education, income, employment, health insurance coverage), behavioral (smoking, physical activity, meets aerobic, body mass index) and environmental variables (secondhand smoke, mold, pets, cockroach, dehumidifiers and air cleaner use) are significantly associated with the presence of active asthma in the study sample.

RQ2. To what extent do predisposing, enabling, and need factors explain health care utilization in the study sample of asthmatic adult females living in Puerto Rico?

$H_0$2 – Predisposing (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status) are not significantly associated with asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) in the study sample

$H_1$2 –Predisposing, (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status) are significantly associated with asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) in the study sample

RQ3- To what extent do predisposing, enabling, need, and health care utilization explain the level of asthma control in the study sample of asthmatic adult females in Puerto Rico?

$H_0$3- Predisposing, (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status) are not significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample

$H_1$3 – Predisposing, (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status)

are significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample

$H_0$4 - Asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) is not significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample

$H_1$4 – Asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) is significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample

In the following section, I detail the data analysis plan to assess each research questions. For the descriptive analysis, I assessed the baseline characteristics of the target population, using central tendency measures. A description of females with active and nonactive asthma by its sociodemographic characteristics are presented in chapter 4.

Research question 1. To answer the first research question, I conducted a logistic regression analysis. A logistic regression is used when the dependent variable is categorical and dichotomous (Burkholder, 2012). Independent variables can be a mixture of continuous and categorical, as in multiple ordinal least squares regression (Burkholder, 2012). The dependent variable was operationalized as whether or not a female participant has current active asthma or inactive asthma. The independent variables were sociodemographic variables: age-group (age-18-34, age- 35-44, age 45-54, age 55 or older), marital status (married, divorced, widowed, separated, never married), education

(high school graduate or not, college or technical college, graduate from college), income (< $15,000, 15,000 to less than $25,000, 25,000 to < $35,000, 35,000 to < $50,000, 50,000 or more), employment (yes/no) and health insurance coverage (yes/no); behavioral variables: smoking (yes/no), physical activity (yes/no, meets or does not meet aerobic recommendations), and body mass index (normal weight, overweight and obese); and environmental variables: secondhand smoke (yes/no), mold inside (yes/no), pets inside (yes/no), cockroach inside (yes/no), rodents inside (yes/no), dehumidifier use (yes/no), and air cleaner inside (yes/no), as I described in Table 3. A full model with all the independent variables was run looking for significant variables (p-values lower than .05). The nonmodifiable variable age group was kept in the model regardless the statistical significance because age is considered confounding. Older ages suggests the likelihood that people will need health services (Andersen, 1995). Odds ratio (OR) and confidence intervals (CI) were provided in Chapter 4.

Research question 2. To answer the second research question, I ran three regression models to determine the association between asthma-related health care utilization. A multiple linear regression was run for the dependent variable asthma urgent visit (continuous). For dependent variables ER visits (yes/no) and hospitalizations (yes/no), a logistic regression was run utilizing the potential predictors according to Andersen model (see Table 3). The independent predisposing variables are: age-group (age-18-34, age- 35-44, age 45-54, age 55 or older), marital status (married, divorced, widowed, separated, never married), education (did not graduate high school, high school graduate, college or technical college, graduate from college) and employment (employed

for wages, self-employed, out of work, homeworker, student, unable to work); enabling variables: income (less than $15,000, 15,000 to less than $25,000, 25,000 to less than $35,000, 35,000 to less than $50,000, 50,000 or more) and health insurance (yes/no); and need variable: self-rate health status (Good, Better, Fair and Poor) as shown in Table 3. The full model was run with all the independent variables, looking for significant variables (p-values lower than 0.05). OR and CI were provided.

Research question 3. To answer this question, I ran three models utilizing multinomial logistic regression to determine the relationship of achieved level of asthma control: number of symptoms in the past 30 days, frequency of nighttime awakenings in the past 30 days, and frequency of asthma medication, and the potential predictors, according to Andersen model. The continuous variable Number of asthma symptoms in the past 30 days (see Table 3), was statically manipulated to an ordinal variable (ASYMPYN), where 1-8 days was classified as well controlled; from 9 to 29 days was classified as not well controlled*;* and symptoms every day in the past 30 days and during the day was classified as very poorly controlled. Then, I transformed Times of nighttime awakenings in the past 30 days to an ordinal variable (ASLEEPYN), where less or equal 2 days/nights was classified as well controlled, from 3 to 12 days/nights, was classified as not well uncontrolled, and more or equal than 13 days/nights in the past 30 days was classified as very poorly control.

Table 3

Summary of Study Variables

Study variable	Variable Type	Indicator variable	Level of measurement	Variable code ACBS	Indicator responses	Statistical manipulation
Current asthma status	Dependent	Current asthma	Binomial	ACTASTH	1=Active 0=nonactive	n/a
Asthma health care utilization	Dependent	Physician urgent visit in previous 12 months	Continuous	URG_TIME	1-365 555-No AA 666-No MD	n/a
Asthma health care utilization	Dependent	ER- visits in previous 12 month	Binomial	ER_VISIT	1=Yes 0=No	n/a
Asthma health care utilization	Dependent	Hospitalizations in previous 12 month	Binomial	HOSP_VST	1=Yes 0=No	n/a
Asthma control	Dependent	Number of symptoms in the past 30 days	Continuous changed to ordinal	SYMP_30D	1-29 days 30=Every day 66=No symptoms past year 77=Don't know 88= No symptoms past 30 days	SYMPYN 1-8 days= well controlled 9-29 days=not well controlled Everyday= very poorly controlled
Asthma control	Dependent	Frequency of nighttime awakenings in the past 30 days	Continuous changed to ordinal	ASLEEP30	1-30 days/nights 66= no symptoms 77=Don't Know 88=none 100=symptoms 3 months to 1 year ago 111=no symptoms past three days	ASLEEPYN 1-2 days/nights = well controlled 3-12 days/nights =not well controlled ≥13- very poorly controlled

(table continues)

Table 3 continued

Study variable	Variable type	Indicator variable	Level of measurement	Variable code ACBS	Indicator responses	Statistical manipulation
Asthma control	Dependent	Frequency of short-acting beta-agonist use for symptom control in a day and a week	Continuous changed to ordinal	ilp08_3 - Albuterol ilp08_4 – Alupent ilp08_9 - Bitolterol ilp08_10 - Brethaire ilp08_20 - Maxair ilp08_21 - Metapropteronol ilp08_23 - Pirbuterol ilp0824 - Proventil ilp08_28 - Terbutaline ilp08_30 - Tornalate ilp08_33 – Ventolin	301-399-days 401-499- weeks 555-never 666-less than once a week 777-don't know 999-refused	LAST_MEDYN Total sum of use short-acting beta-agonist/ divided by 7 to obtain high recue medicine by days used Well controlled- ≤ 2 days a week Not well-controlled - > 2 days a week Very poorly controlled – several times a day
socio-demographic/ predisposing	Independent	Age-group	Categorical	AGEG_F4	1= Age 18-24 2= Age 25-34 3= Age 34 -44 4= Age 45-54 5= Age 55 or older	n/a

(table continues)

Table 3 continued

Study variable	Variable Type	Indicator variable	Level of measurement	Variable Code ACBS	Indicator responses	Statistical manipulation
sociodemographic/ predisposing	Independent	Marital status	Categorical	MARITAL	1=Married 2=Divorced 3=Widowed 4=Separated 5=Never Married 99= Refused	n/a
sociodemographic/ predisposing	Independent	Education	Categorical	_EDUCAG	1= Did Not graduated High school 2= High school graduate 3= Attended College or technical school 4= Graduate from college or technical school	n/a
sociodemographic/ predisposing	Independent	Employment	Categorical	EMPLOY	1=Employed for wages 2=Self-employed 3=Out of work for more than 1 year 4=A homemaker 5=A student 6=Retired 7=Unable to work 99=Refused	n/a
sociodemographic/ enabling	Independent	Income	Categorical	@_INCOMG	1=Less than $15,000 2=$15,000 to less than $25,000 3=$25,000 to less than $35,000 4=$35,000 to less than $50,000 5=$50,000 or more	n/a
sociodemographic/ enabling	Independent	Health insurance coverage	Binomial	INS1	1=Yes 2=No	n/a

(table continues)

Table 3 continued

Study variable	Variable Type	Indicator variable	Level of measurement	Variable Code ACBS	Indicator responses	Statistical manipulation
Need	Independent	Health status	Need	GENHLTH	1=Good; 2=Better 3=Fair; 4=Poor	n/a
Behavioral	Independent	Smoking	Binomial	@_RFSMOK3	1=Yes 2=No 9=Refuse, Missing	n/a
Behavioral	Independent	Current smoker	Binomial	_SMOKER3	1=Current smoker 2=Former smoker 9=Refuse, Missing	n/a
Behavioral	Independent	Body Mass Index	Categorical	@_BMI4CAT	1=Normal weight 2 =Overweight 3=Obese	n/a
Behavioral	Independent	Physical activity	Binomial	@_TOTINDA	1= Yes 2 =No	n/a
Behavioral	Independent	Physical activity	Categorical	_PAINDEX	1= Meet aerobic 2= Did not meet aerobic 9= Don't know	n/a
Environmental	Independent	Secondhand smoke	Binomial	S_INSIDE	1=Yes 2=No	n/a
Environmental	Independent	Mold inside	Binomial	ENV_MOLD	1=Yes 2=No	n/a
Environmental	Independent	Pets inside	Binomial	ENV_PET	1=Yes 2=No	n/a
Environmental	Independent	Cockroach inside	Binomial	C_ROACH	1=Yes 2=No	n/a
Environmental	Independent	Rodents inside	Binomial	C_RODENT	1=Yes 2=No	n/a
Environmental	Independent	Dehumidifier use	Binomial	DEHUMID	1=Yes 2=No	n/a
Environmental	Independent	Air cleaner inside	Binomial	AIRCLEANER	1=Yes 2=No	n/a

Finally, for Frequency of rescue medication (LAST-MEDYN), I statistically grouped responses for questions asking for utilization of rescue medicine (SABA's) in the ACBS (those variables coded as ILP number_number) and making a new variable called LAST-MEDYN. The question is "How many times a week you used this medicine Short-acting beta2 agonists (SABA)". There are 11 questions about different SABA medications including (ilp08_3 – Albuterol, ilp08_4 – Alupent, ilp08_9 – Bitolterol, ilp08_10 –Brethaire, ilp08_20 – Maxair, ilp08_21 – Metapropteronol, ilp08_23 – Pirbuterol, ilp0824 –Proventil ilp08_28 – Terbutaline ilp08_30 – Tornalate, ilp08_33 – Ventolin). The times that a participant used these medications were totalized and divided it by 7 (to estimate daily use in week). The collapsed variable has three categories according to the literature (< 0.29/day (well controlled), > 0.29 times/day, but < 2 times/day (not well controlled), and >2 times per day (very poorly control), as presented in Table 3. Then, I created the variable (CONTROL) control utilizing the worse criteria among the three variables: SYMP_30D, ASLEEP30 and LAST_MEDYN that clearly states very poorly control in asthma symptoms in each respondent. I ran an additional model, creating a dependent variable named Control, where all the responses of these three criteria were integrated. For that purpose, a dichotomous variable was created: (ControlB) derived from the above set of responses. Those who were well controlled were classified as *Controlled,* and those having at least one of the criteria shown in Table 3 for uncontrolled asthma were classified as *Uncontrolled*.

The independent predisposing variables are: age-group (age-18-34, age- 35-44, age 45-54, age 55 or older), marital status (married, divorced, widowed, separated, never

married), education (did not graduate high school, high school graduate, college or technical college, graduate from college) and employment (employed for wages, self-employed, out of work, homeworker, student, unable to work); enabling variables: income (less than $15,000, 15,000 to less than $25,000, 25,000 to less than $35,000, 35,000 to less than $50,000, 50,000 or more) and health insurance (yes/no); need variable: self-rate health status (good, better, fair, poor); asthma-related health care utilization: Asthma urgent visit (continuous), emergency room visits (yes/no), hospitalizations (yes/no), as presented in Table 3. The full model was run with all independent variables according the Andersen model factors, looking for significant variables (p-values lower than .05). OR and CI were provided in Chapter 4.

Threats to Validity

Because cross-sectional survey designs like this one utilized sampling randomness and stratification, the design has high external validity and low internal validity (Carlson & Morrison, 2009). Threats to external validity occur when researchers draw incorrect conclusions from the nonrandom sample data and generalize to individuals from other populations groups in other settings or future events (Creswell, 2009). The BRFSS-Asthma Call-back Survey employs random sampling thus ensuring an equal chance for participation across a regional sample. This design controls on systematic differences across participant responses (Nelson et al., 1998), and increases the generalizability of the results. Nevertheless, when interpreting the results, conclusions were restricted to asthmatic women living in Puerto Rico.

Internal validity threats refer to the variability of the experiences of the participants that affect the ability of the researcher to draw correct conclusions (Creswell, 2009) or accurately interpret between the influence of independent variables on the outcome under investigation (Carlson & Morrison, 2009). This investigation reflects the internal validity threats inherent in the survey design that generated the data. Selection bias is a potential threat because eligible respondents for ACBS are have the right and the opportunity to refuse to participate. There is a possibility that those who refuse may be systematically different from those who choose to participate. Although this threat cannot be controlled beyond the participant approach protocol used by those who fielded the survey, this potential bias was acknowledge in conclusions and study limitations (Creswell, 2009). History, and maturation threats are controlled by the cross-sectional nature of the survey and the brief period of time that elapses between the fielding of the BRFSS and the ACBS. The time between both is too short to produce maturation or change of the participants.

Mortality is present as lost to follow up in the ACBS data relative to the BRFSS parent survey as explained under instrumentation. The original data collection protocol was designed to limit lost to follow- up by restricting the time to two weeks between measures of both surveys and by making sufficient calling attempts to reach each eligible respondent and adhering to their availability requests. Puerto Rico has one of the lowest refusal rates (18.6%) according to the CDC standards and median of the United States (see Table 1). As defined by Campbell and Stanley (1963), testing and instrumentation threats are two potential threats in this investigation. Regarding this study, testing could

effects the results if the answers of respondents during the second survey change based on their familiarity with asthma-related questions in the parental survey. As well, instrumentation threat could affects results based on the changes on the way or construction of asthma-related questions in the parental survey compared to the ACBS. However, this study utilized only responses from asthma related questions in the second survey, thus eliminating the effect of testing and instrumentation over the results.

Validity of self-response data is best when questions ask about behaviors that are not sensitive (Pierannunzi et al., 2013). The comparisons of self-reported data of the ACBS-BRFSS showed that validity of some measures were compromised, especially when reporting on measures of height, and weight due to social desirability (Pierannunzi et al., 2013). However, BRFS-ACBS has demonstrated high validity in test-retest assessment. Additionally, Vandestoep and Jonhston (2009) found high reliability in the BRFSS for self-responses of height, weight, BMI and sociodemographic characteristics.

This study was correlational in nature, focusing on three types of relationships: between social, behavioral, environmental, and current asthma status; between predisposing, enabling and need and asthma health care utilization; and between predisposing, enabling, need, asthma health care utilization, and achieved asthma control level as the corresponding outcome variables. However, the cross-sectional nature of the data, do not allow the assessment of causation.

Ethical Procedures

This study considered several ethical procedures for this investigation. First, I have assured that the secondary data (BRFSS-ACBS) used for this investigation was

collected under the approval of the Institutional Review Board of the Centers for Disease Control and Prevention. The ACBS-BRFSS has a surveillance exemption (Protocol #2988) from IRB at CDC and required participants' informed consent (Mazurek, Knoeller & Moorman, 2012). While participating states are subject to state-specific IRB requirements (Knoeller et al., 2013), Puerto Rico follows the procedures of CDC protocol only (R. Serrano, Personal Communication, September 9, 2014). Interviewers are trained and retrained on data collection protocol and procedures on confidentiality and privacy rights of the participants (CDC, 2014c). Once the interviewers reach an eligible participant, they ask for permission to initiate the survey and make participants aware that study participation is voluntary and data are confidential in order to protect their privacy (CDC, 2013d; 2014b). Additionally, the interviewers make clear that the respondent may choose not to answer any question or stop the interview at any time (CDC, 2013d; 2014b).

The 2011 BRFSS-ACBS database is available for public use at CDC website without any identifiers of the participants, which makes database anonymous. For the 2012 database, which is not available for public), I requested and signed the Walden Data Agreement with the Puerto Rico Asthma Project (Appendix D) that provide me access to limited data set for the use in this research and assure confidentiality procedures according to "HIPAA regulations". Additionally, the data agreement has provisions to avoid sharing the database with third beneficiaries. Database from 2011 and 2012 is storage in a laptop computer protected by password for five years and then, data will be deleted from my archives. Data were analyzed at the country level. Finally, I submitted

the research protocol for the approval of the Institutional Review Board (IRB) of Walden University. The IRB approved the research protocol with the number 05-14-15-0153777.

Summary

This investigation used quantitative secondary analysis of cross sectional survey data. My goal was to develop a gender-specific asthma risk profile for the asthmatic adult female population in Puerto Rico through a systematic examination of data from the ACBS for Puerto Rico for the years 2011 and 2012. I analyzed three dependent variables among asthmatic adult females in Puerto Rico relative to multiple potential predictor variables. Current asthma status was examined with regards to sociodemographic variables, behavioral variables and environmental variables using logistic regression. Additionally, I assessed the relationship between asthma health care utilization variables and Andersen's predisposing, enabling and need factors, for the study sample using multiple linear regression and logistic regression. Finally, I examined the relationship between achieved level of asthma control and predisposing, enabling and need factors, and asthma health care utilization for the study sample using multinomial logistic regression. This study incorporated data gathered from a well-designed and evaluated survey instrument that considers all scientific quality standards and ethical procedures. In the fourth chapter, I present the analysis and results of the research questions and hypotheses tested.

Chapter 4: Results

The purpose of this quantitative cross-sectional study was to assess the contribution among the social, behavioral, and environmental risk factors for asthma, and relate Andersen's model predictors to the level of service utilization and the control of asthma symptoms among adult females in Puerto Rico.

The research questions and hypotheses of this study were as follows:

RQ1: To what extent do sociodemographic, behavioral, and environmental variables differentiate between active and nonactive asthma status at the point of assessment in the sample of adult females living in Puerto Rico?

$H_0$1: Sociodemographic (age-group, marital status, education, income, employment, health insurance coverage), behavioral (smoking, physical activity, meets aerobic, body mass index) and environmental variables (secondhand smoke, mold, pets, cockroach, dehumidifiers and air cleaner use) are not significantly associated with the presence of active asthma in the study sample. $H_0$1

$H_1$1: Sociodemographic (age-group, marital status, education, income, employment, health insurance coverage), behavioral (smoking, physical activity, meets aerobic, body mass index) and environmental variables (secondhand smoke, mold, pets, cockroach, dehumidifiers and air cleaner use) are significantly associated with the presence of active asthma in the study sample.

RQ2. To what extent do predisposing, enabling, and need factors explain health care utilization in the study sample of asthmatic adult females living in Puerto Rico?

$H_0$2 – Predisposing (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status) are not significantly associated with asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) in the study sample.

$H_1$2 –Predisposing, (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status) are significantly associated with asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) in the study sample.

RQ3- To what extent do predisposing, enabling, need, and health care utilization explain the level of asthma control in the study sample of asthmatic adult females in Puerto Rico?

$H_0$3- Predisposing, (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status) are not significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample.

$H_1$3 – Predisposing, (age-group, marital status, education, employment), enabling (income, health insurance coverage) and need factors (self-rate health status)

are significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample

$H_0$4 - Asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalizations) is not significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample.

$H_1$4 – Asthma-related health care utilization (physician urgent visits, emergency room visits and hospitalization) is significantly associated with achieved level of asthma control (well controlled, not well controlled and very poorly control) in the study sample.

In this chapter, I present information related to the data collection process and the results of the study. Specifically, I report the descriptive analyses performed for the dependent and independent variables. For each research question, I present the findings of the analyses. Finally, there is a summary of the primary findings of the study, and a transition into the interpretation of findings in Chapter 5.

Data Collection

The secondary data for this study was collected during 2011 and 2011 in Puerto Rico by the BRFSS from CDC. Recruitment and response rates are fully described in Chapter 3, according to standard methods implemented by the BRFSS in the states and territories of the United States. After obtaining Walden's IRB approval (05-14-15-0153777), I requested ACBS data from both years to the Chronic Division of the Puerto Rico Department of Health, according to the signed data user agreement (Appendix D).

The PRDH provided the ACBS data in flat file format by Dropbox™. PRDH sent me an Excel file with the variables requested in a new database already weighted. I converted the Excel file into Statistical Package of Social Science format. I took a subsample of women from the ACBS, which assured a representative sample of participants in Puerto Rico.

Pre-Analyses Data Screening

In SPSS, I created the variable view according to string or numeric variables. I also assigned label and values to each variable. Data was cleaned of accuracy errors, missing values, or outliers (Gliklich & Dreyer, 2010). Even though the BRFSS staff performs the appropriate data cleaning and validation processes before publishing the data, steps were taken to ensure that data from the subsample were appropriately formatted for analyses. Standardized values were computed to determine whether the participants' responses were considered outliers. Tabachnick and Fidell (2012) described outliers as values that fall above 3.29 and below -3.29 from the standardized values.

Results

This section presents the findings of this study beginning with the descriptive figures followed by the results that answer each of the research questions.

Descriptive Analysis

Table 4 presents the frequencies of missing values for sociodemographic, behavioral, and environmental variables among women with asthma in Puerto Rico. The variables current smoker, and meets aerobics recommendations showed significant

missing values in the frequency analysis; therefore, they were not considered in the remaining analysis.

Table 4

Frequencies of Missing Values for Sociodemographic, Behavioral, and Environmental Variables

Variables	*n*	Missing
Age Group	625	0
Marital Status	625	0
Education	625	0
Employment	625	0
Income	533	92
Health Status	624	1
Smoking	624	1
Current Smoker	44	581
Body Mass Index	607	18
Physical Activity	625	0
Meets Aerobics Recommendation	299	326
Smoke Inside Home	624	1
Mold Inside Home	621	4
Rodent Inside Home	625	0
Pets Inside Home	625	0
Roach Inside Home	625	0
Dehumidifier	623	2
Air Cleaner	624	1

During 2011 and 2012, there were 625 women who affirmatively responded to the question “Have you ever been diagnosed by a doctor that you had asthma?” in the Asthma Call Back Survey in Puerto Rico. From the total sample, 300 participants (48%) were from 2011, and 325 (52%) were from 2012. Both selected years had equal percentages of participants with active asthma. Table 5 presents the frequency of asthma status among women during 2011 and 2012 in Puerto Rico.

Table 5

Frequency of Asthma Status Among Women in Puerto Rico in 2011 and 2012

	Asthma Status		
Year	Inactive (%)	Active (%)	Total (%)
2011	109 (36)	191 (64)	300 (48)
2012	121 (37)	204 (63)	325 (52)
Total	230 (37)	395 (63)	625 (100)

Note. $N = 625$

Sample population characteristics. The sample was composed entirely of females. Sixty five percent of the participants were 55 years or older (Table 6). Nearly 40% of adult females were married; 34% did not graduate from high school, and 41% were out of work for more than 1 year. Sixty one percent of the participants had an income of less than $15,000. Overall, 97% of the respondents had insurance to cover health-related services. Only a small portion of the subsample smoked (7%). Thirty-seven percent of the females were categorized as obese according to the calculated body mass index. Fifty six percent of women did not make physical activity, according the recommendations for U.S. adults that should be 30 minutes or more of moderate-intensity physical activity on all or most days of the week (Pate et al., 1995). The frequency distribution of environmental risks shows that only 8% of the participants were exposed to secondhand smoke in their homes (Table 6). A small portion of the females in the sample self-reported to have roaches (9%), pets (23%), and molds (32%) inside their homes. However, half of the participants (50%) self-reported to have rodents inside homes. Environmental controllers for humidity and dust in homes were used infrequently among participants. Ten percent of the females reported having a dehumidifier, and 15%

had an air cleaner in their homes. The frequencies and percentages of the sociodemographic, behavioral, and environmental risks are shown in Table 6.

Table 6

Frequency Distribution of the Sociodemographic, Behavioral, and Environmental Characteristics Among Women with Asthma in Puerto Rico in 2011 and 2012

Variables	*n*	%
Age Group		
18-24	27	4.3
25-34	52	8.3
35-44	51	8.2
45-54	87	13.9
55+	408	65.3
Marital Status		
Married	246	39.4
Divorced	96	15.4
Widowed	135	21.6
Separated	35	5.6
Never Married	112	17.9
Education		
Not Graduated HS	215	34.4
Graduated HS	142	22.7
Attended College	127	20.3
Graduated College	141	22.6
Income		
> $15k	323	60.6
15k to <$25k	135	25.3
$25k to <$35k	35	6.6
$35k to <$50k	20	3.8
>$50	20	3.8
Employment		
Employed	97	15.5
Self-Employed	25	4.0
Out of Work > 1 year	256	41.0
Homemaker	26	4.2
Student	3	0.5
Retired	139	22.3
Unable to Work	78	12.5
Health Insurance		
Yes	607	97.1
No	18	2.9

Note. *n*=number of cases

(table continues)

Table 6 (continued)

Frequency Distribution of the Sociodemographic, Behavioral, and Environmental Characteristics Among Women with Asthma in Puerto Rico in 2011 and 2012

Variables	*n*	%
Smoking		
Yes	44	92.8
No	580	7.0
Body Mass Index		
Normal Weight	175	28.0
Overweight	201	32.2
Obese	231	37.0
Physical Activity		
Yes	277	44.3
No	348	55.7
Smoke Inside Home		
Yes	48	7.7
No	576	92.2
Pets Inside Home		
Yes	144	23.0
No	482	77.0
Mold Inside		
Yes	200	32.0.
No	421	67.4
Rodent Inside Home		
Yes	312	49.9
No	312	49.9
Roaches Inside Home		
Yes	58	9.3
No	567	90.7
Dehumidifier		
Yes	65	10.4
No	558	89.3
Air Cleaner in Home		
Yes	95	15.2
No	529	84.6

Note. *n*=number of cases

Table 7 presents the percentage distribution of risks by age group among women with asthma. Among the four age groups, adult females 55 years or older reported a higher percentage (88%) of less education; a higher percentage were out of work for more than 1 year (71%), were retired (97%), or were unable to work (80%). This age group also had less annual income (75%) compared to other age groups. Additionally, 76% of adult females 55 years or older reported to have fair or poor self-rated health. This age group also reported a lower percentage of physical activity and a higher percentage of being obese.

Table 7

Frequency of Sociodemographic and Behavioral Risks by Age Group Among Women With Asthma in Puerto Rico During 2011 and 2012

Risks		Age Group				
	n	18-24 (%)	25-34 (%)	35-44 (%)	45-54 (%)	55+ (%)
Marital Status						
Married	246	0.4	6.5	10.6	16.3	66.3
Divorced/Separated	131	0.0	5.3	11.5	16.0	67.2
Widowed	135	0.0	0.0	0.7	6.7	92.6
Never Married	112	23.2	25.9	7.1	15.2	28.6
Education						
Not Graduated HS	215	.9	2.3	1.4	7.4	97.9
Graduated HS	142	2.1	6.3	5.6	17.6	68.3
Attended College	127	12.6	9.4	14.2	18.1	45.7
Graduated College	141	4.3	18.4	15.6	16.3	45.4
Employment						
Employed	97	5.2	21.6	20.6	34.0	18.6
Self-Employed	25	4.0	28.0	20.0	20.0	28.0
Out of Work > 1 year	256	1.2	7.0	7.0	13.7	71.1
Homemaker	26	69.2	19.2	3.8	3.8	3.8
Student	3	0.0	0.0	66.7	0.0	33.3
Retired	139	0.0	0.0	1.4	1.4	97.1
Unable to Work	78	0.0	1.3	3.8	14.1	80.8
Income						
< $15k	323	1.5	5.0	7.4	11.1	74.9
15k to <$25k	135	1.5	14.1	9.6	17.0	57.8
$25k to <$35k	35	5.7	8.6	5.7	37.1	42.9
$35k to <$50k	20	10.0	10.0	15.0	35.0	30.0
>$50	20	5.0	30.0	25.0	5.0	35.0

(Table continues)

Table 7 continued

Risks		Age Group				
	n	18-24 (%)	25-34 (%)	35-44 (%)	45-54 (%)	55+ (%)
Health Coverage						
Yes	607	4.3	8.1	8.2	13.3	66.1
No	18	5.6	16.7	5.6	33.3	38.9
Self-Rated Health Status						
Good/Better	205	11.7	15.1	14.6	15.1	43.4
Fair/Poor	419	0.7	5.0	5.0	13.4	75.9
Smoking						
Yes	44	0.0	11.4	9.1	22.7	56.8
No	580	4.7	8.1	8.1	13.3	65.9
Body Mass Index						
Normal Weight	175	9.1	12.0	6.3	6.9	65.7
Overweight	201	2.0	7.5	7.5	16.9	66.2
Obese	231	3.0	6.5	10.4	16.9	63.2
Physical Activity						
Yes	277	6.1	11.9	9.7	13.0	59.2
No	348	2.9	5.5	6.9	14.7	70.1
Smoking inside house						
Yes	48	6.3	10.4	12.5	25.0	45.8
No	576	4.2	8.2	7.8	13.0	66.8

Note. *n*=number of cases

The descriptive results for health care utilization demonstrated that 30.4% of women visited a physician urgently during the previous year to the assessment, where 37% of this total visited just one time. The average amount of urgent visits due to asthma among women was 3.66 (*SD* = 4.83). Twenty percentage of the sample had visited an emergency room in the last year. Additionally, 12% women had hospitalization in the previous year of the assessment. In terms of asthma control criteria, the average number of days with asthma symptoms in the last 30 days was 7.38 (*SD* = 10.99). For nighttime awakenings in the last 30 days, the mean was 3.90 (*SD* = 8.62). The standard deviation of physician urgent visits, asthma symptoms and nighttime awakenings was larger than its mean (Table 8). The *SD* can be larger than the mean if the range of numbers are large, which means that the data points have a great variability spread out over a wider range of values (Gerstman, 2008). These three measures showed wide range of numbers grouped

mainly at both ends. Finally, the average frequency of rescue medication use in the last 7 days was 3.91 (*SD* = 1.91). The measures of central tendency are presented in Table 8.

Table 8

Measures of Central Tendency and Dispersion for Physician Urgent Visits, Symptoms and Nighttime Awakenings in the Last 30 Days, and Frequency of Rescue Medication for Women in Puerto Rico in 2011 and 2012

Continuous variables	*n*	*Min.*	*Max.*	*M*	*SD*
Physician urgent visits	190	1	26	3.66	4.83
Asthma symptoms	619	0	30	7.38	10.99
Nighttime awakenings	599	0	30	3.90	8.62
Frequency of rescue medication	623	1	7	3.31	1.91

Note. *n*=number of cases, M= mean, *SD*= standard deviation

In terms of achieved level of asthma control, 61.1% of women with asthma had it under controlled, and 37.9 had not well controlled or very poorly controlled asthma, where 30% of the last total are under 55 years of age or more. Most of the respondents had well controlled asthma in all the age groups (61.1%), marital status (61.1%), all education groups (61.1%), all income brackets (61.1%), employment levels (61.1%), health insurance coverage (61.1%), smoking habits, (61.2%), BMI categories (61.4%), and level of physical activity (61.1%). Table 9 shows the frequency of the sociodemographic and behavioral characteristics among women with different levels of asthma control.

Table 9

Frequency Distribution of the Sociodemographic Characteristics Among Women with Different Levels of Asthma Control in Puerto Rico in 2011 and 2012

Variables	Asthma Control		
	Well Controlled	Not Well Controlled	Very Poorly Controlled
Total (%)	61.1	12.5	25.4
Age group			
18-24	21	2	4
25-34	39	4	9
35-44	34	7	10
45-54	50	15	22
55+	238	50	120
Total (%)	61.1	12.6	26.4
Marital status			
Married	154	29	63
Divorced	61	15	20
Widowed	74	18	43
Separated	18	4	13
Never Married	74	12	26
Total (%)	61.1	12.5	26.4
Education			
Not graduated HS	113	31	71
Graduated HS	89	20	33
Attended college	84	8	35
Graduated college	96	19	26
Total (%)	61.1	12.5	18.4
Income			
> $15k	187	40	96
15k to <$25k	86	22	27
$25k to <$35k	22	6	7
$35k to <$50k	14	1	5
>$50	16	1	3
Total (%)	61.1	13.1	25.9
Employment			
Employed	69	9	19
Self-employed	19	3	3
Out of work > 1 year	141	32	83
Homemaker	20	1	5
Student	2	1	0
Retired	93	18	28
Unable to Work	37	14	27
Total (%)	61.1	12.5	26.4
Health Insurance			
Yes	369	76	162
No	13	2	3
Total (%)	61.1	12.5	26.4

Chi-square analysis for active asthma was verified for the independence of each of the study's variables. I made sure that there were no cells with expected values below five; in that case, I reported the Fisher's exact test. For those chi-square tests that are statistically significant, I assessed post hoc test for the standardized residuals using the *z* score to determine which cell or cells produced the significance difference. I compared the size of the standardized residuals to an alpha of 0.025 (+/-1.96) or an alpha of 0.01 (+/- 2.58). Positive values mean that cell are overrepresented and negative values mean that the cell was under-represented in the sample.

Table 10, 11 and 12 shows the results of the chi-square test for sociodemographic, behavioral and environmental characteristics of women with asthma in Puerto Rico, respectively. The sample size requirement was satisfied in all the chi-square test of independence, except for variables of marital status, employment and rodents inside home. Neither the sociodemographic nor the environmental variables were statistically significant for asthma status. However, behavioral variables shows differences among two of the variables. There was a statistically significant association between physical activity and asthma status, Pearson χ^2 (2), where $n = 625 = 6.326$, $p \leq 0.05$. The strength of this association was weak according Cramer's V=0.101.

Additionally, there was a statistically significant association between body mass index and asthma status, where Pearson χ^2 (1), $n = 607 = 17.853$, $p \leq 0.001$. The strength of this association was weak according Cramer's V=0.171. Finally, there was a statistically significant association between self-rate of health and asthma status, Pearson χ 2 (4), n =624 = 11.172, $p \leq 0.05$), with a weak association, Cramer's V = .134.

Table 10

Chi-Square test results for sociodemographic characteristics among women with asthma in Puerto Rico in 2011 and 2012

Sociodemographic Characteristics	Inactive Asthma		Active Asthma				
	n	*%*	*n*	*%*	X^2	*p*	*Cramer's V*
Age Group					4.358	.360	.084
18-24	12	5.2	15	3.8			
25-34	23	10.0	29	7.3			
35-44	19	8.3	32	8.1			
45-54	25	10.9	62	15.7			
55+	151	65.7	257	65.1			
Marital Status					1.447	.919	.048
Married	92	40.0	154	39.0			
Divorced	35	15.2	61	15.4			
Widowed	48	20.9	87	22.0			
Separated	11	4.8	24	6.1			
Never Married	44	19.1	68	17.2			
Education					2.291	.514	.061
Not Graduated HS	74	32.2	141	35.7			
Graduated HS	58	25.2	84	21.3			
Attended College	43	18.7	84	21.3			
Graduated College	55	23.9	86	21.8			
Employment					10.816	.094	.132
Employed	42	18.3	55	13.9			
Self-Employed	12	5.2	13	3.3			
Out of Work > 1 year	84	36.5	172	43.5			
Homemaker	13	5.7	13	3.3			
Student	0	0.0	3	0.8			
Retired	55	23.9	84	21.3			
Unable to Work	23	10.0	55	13.9			
Income					6.270	.180	.108
> $15k	118	62.4	205	59.6			
15k to $25k	48	25.4	87	25.3			
$25k to $35k	6	3.2	29	8.4			
$35k to $50k	8	4.2	12	3.5			
>$50	9	4.8	11	3.2			
Health Insurance					1.389	.321	.047
Yes	221	96.1	386	97.7			
No	9	3.9	9	2.3			

Note. * $p \leq .050$, Otherwise $p > .050$

Table 11

Chi-Square test results for behavioral characteristics among women with asthma in Puerto Rico in 2011 and 2012

Behavioral Characteristics	Inactive Asthma		Active Asthma				
	n	*%*	*n*	*%*	X^2	*p*	*Cramer's V*
Smoking					.005	.944	0.003
Yes	16	7.0	28	7.1			
No	214	93.0	366	92.9			
Physical Activity					6.326	.012	0.101
Yes	117	50.9	160	40.5			
No	113	49.1	235	59.5			
Body Mass Index					17.853	<.001	0.171
Normal Weight	78	34.8	97	25.3			
Overweight	85	37.9	116	30.3			
Obese	61	27.2	170	44.4			

Note. * $p \leq .050$, Otherwise $p > .050$

Table 12

Chi-Square test results for environmental characteristics among women with asthma in Puerto Rico in 2011 and 2012

Environmental Characteristics	Inactive Asthma		Active Asthma				
	n	*%*	*n*	*%*	X^2	*p*	*Cramer's V*
Smoke Inside Home					.278	0.598	0.021
Yes	16	7	32	8.1			
No	214	93	362	91.9			
Pets Inside Home					.618	0.432	0.031
Yes	49	21.3	95	24.1			
No	181	78.7	300	75.9			
Mold Inside					.446	0.504	0.027
Yes	70	30.6	130	33.2			
No	159	69.4	262	66.8			
Rodent Inside Home					1.575	0.455	0.050
Yes	121	52.6	191	48.4			
No	109	47.4	203	51.4			
Roaches Inside Home					.010	.922	0.004
Yes	21	9.1	37	9.4			
No	209	90.9	358	90.6			
Dehumidifier					.328	0.567	0.023
Yes	26	11.4	39	9.9			
No	203	88.6	355	90.1			
Air Cleaner in Home					1.910	0.167	0.055
Yes	41	17.8	54	13.7			
No	189	82.2	340	86.3			

Research Question 1

To what extent do sociodemographic, behavioral, and environmental variables differentiate between active and non-active asthma status at the point of assessment in the sample of adult females living in Puerto Rico?

To answer this question, I conducted a binary logistic regression utilizing the Enter method for the dichotomous dependent variable asthma status (active/inactive asthma) and the independent sociodemographic variables (age-group, marital status, education, employment, income, health insurance) behavioral variables (smoking, physical activity, body mass index), and environmental variables (SHS, mold inside, roaches inside, rodent inside, dehumidifier use and air cleaner use). Using dummy coding for logistic regression, each group for the categorical variable was compared to a reference group. Significant odds ratios were interpreted according the reference category. The Wald test was used to demonstrate statistical significance. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The logistic regression model was statistically significant, χ^2 (33) = 50.813, p = 0.025. The model had a weak relationship (Nagelkerke R^2=.131) that explained only 13% of the variance for active asthma. The *H-L* statistic had a significance of .148, which means that is not statistically significant; therefore the model is quite a good fit. The model correctly classified 69% of cases, but it was not a considerable improvement from the constant model. The sensitivity of the model predicts 28% of inactive asthma, and their specificity to predict active asthma is 92%. The classification table showed a little improvement of the percentage correct from the block 0 to block 1 (from 64.6% to 68.1%). Individual

coefficients were examined further by using the Wald criterion. Predicted probabilities of active asthma were determined for all variables by Exp (*B*). For negative coefficients in the regression, the inverse Exp (*B*) was taken to assess the predicted probabilities (Leech, Barrett, & Morgan, 2008). The 95% confidence interval (CI) was calculated for all variables. A 95% CI suggests that the researcher is 95% confident that the true population odds ratio lies between the lower and upper limit of the interval for the outcomes relative to the reference group. Logarithmic CIs are sensitive to changes and inadequate sample sizes, but the estimates will be accurate as long as the bounds do not change directions (Tabachnick & Fidell, 2012). The model showed that being out of work for more than a year was a significant predictor, $B = .851$, $p = .014$, $OR = 2.342$, indicating that these respondents were 2.34 times more likely to have active asthma than respondents who were employed. Income of $25k to <$35k was also a significant predictor, $B = 1.143$, $p = .031$, $OR = 3.135$, indicating that respondents within that income bracket were 3.14 times more likely to have active asthma than respondents who made less than $15k. The BMI indicator of obese was also a significant predictor, $B = .85$, $p = .001$, $OR = 2.349$, suggesting that obese respondents were 2.35 times more likely to have active asthma than respondents who were of normal weight. The rest of sociodemographic and environmental variables were not significant. The fact that 95% confidence intervals for the slope of the variables out of work > than 1 year, income bracket $25K to 35K, and BMI Obese does not contain the value 1, indicates that the null hypothesis should be rejected at the .05 level. Results of the logistic regression are shown in Table 13.

Table 13

Summary of Logistic Regression for Sociodemographic, Behavioral and Environmental Characteristics Among Women with Asthma in Puerto Rico during 2011 and 2012

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Age Group {*reference* 18-24}							
25-34	-1.071	.816	1.722	.189	.343	.069	1.697
35-44	-.984	.864	1.296	.255	.374	.069	2.034
45-54	-.393	.842	.218	.641	.675	.130	3.514
55+	-.872	.844	1.068	.301	.418	.080	2.186
Marital Status { *reference*: Married}							
Divorced	.080	.297	.073	.788	1.083	.605	1.939
Widowed	.246	.289	.720	.396	1.278	.725	2.255
Separated	.138	.482	.082	.775	1.148	.446	2.954
Never Married	.244	.331	.543	.461	1.276	.667	2.439
Education { *reference*: Not Graduated HS}							
Graduated HS	-.249	.279	.795	.373	.780	.451	1.347
Attended College	.286	.326	.768	.381	1.331	.702	2.521
Graduated College	.129	.354	.134	.715	1.138	.569	2.276
Employment { *reference*: Employed}							
Self-Employed	.039	.508	.006	.938	1.040	.384	2.813
Out of Work > 1 year	.851	.346	6.037	.014*	2.342	1.188	4.617
Homemaker	.375	.758	.245	.620	1.455	.330	6.426
Student	21.465	>1000	.000	.999	>1000	.000	.
Retired	.516	.382	1.823	.177	1.676	.792	3.545
Unable to Work	.774	.432	3.200	.074	2.168	.929	5.059
Income { *reference*: > $15k}							
15k to $25k	.091	.268	.115	.734	1.095	.648	1.851
$25k to $35k	1.143	.531	4.632	.031*	3.135	1.107	8.874
$35k to $50k	-.283	.574	.243	.622	.753	.244	2.322
>$50	.023	.570	.002	.968	1.023	.335	3.129
Health Insurance { *reference*: No}							
Yes	-.698	.612	1.299	.254	.498	.150	1.653
Smoking { *reference*: No}							
Yes	.374	.461	.658	.417	1.454	.589	3.591
BMI { *reference*: Normal Weight}							
Overweight	.013	.248	.003	.958	1.013	.623	1.648
Obese	.854	.259	10.858	.001*	2.349	1.413	3.903
Physical Activity { *reference*: No}							
Yes	-.350	.205	2.917	.088	.705	.472	1.053
Smoke Inside Home { *reference*: No}							
Yes	.404	.471	.735	.391	1.497	.595	3.769
Pets Inside Home { *reference*: No}							
Yes	-.158	.246	.411	.521	.854	.528	1.382
Mold Inside { *reference*: No}							
Yes	.060	.217	.076	.783	1.061	.694	1.624

(continued)

Table 13 continued

Predictors		*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Rodent Inside Home {reference: No}							
Yes	-.222	.340	.426	.514	.801	.411	1.560
Roaches Inside Home {reference: No}							
Yes	-.298	.204	2.127	.145	.743	.498	1.108
Dehumidifier {reference: No}							
Yes	.094	.396	.056	.813	1.098	.505	2.387
Air Cleaner in Home {reference: No}							
Yes	-.174	.339	.263	.608	.840	.432	1.634

Note. * $p \leq .050$. ** $p \leq .010$. Otherwise $p > .050$.

Research Question 2

To what extent do predisposing, enabling, and need factors explain health care utilization in the study sample of asthmatic adult females living in Puerto Rico? To answer this question, I conducted a multiple logistic regression (MLR) for the continuous variable physician urgent time visits, and two logistic regressions for emergency room visit (y/n) and hospitalization (y/n) in the last 12 months for the predictors variables according the Andersen model: Predisposing (age-group, marital status, education and employment) enabling (insurance and income) and need (self- rate health status). Dummy coding was used for categorical variables in the model. Significant OR were interpreted according the reference category in all cases with the first category, except for health status that was compared to the last category.

Physician urgent time visits in the last 12 months related to Andersen's factors. The results of the MLR were not significant, $F(26, 133) = 1.218$, $p = .223$ as shown in Table 14. That means that the regression model was not a good fit for the data. There was insufficient evidence to reject the null hypothesis. This suggests that age-group, marital status, education, employment, insurance, income, and self-rated health

status are not significant predictors of urgent time visits in the previous year. The R^2=.034 of this model indicates that just 3.4% of the variance of urgent time visits for asthma related services is accounted for by the variables within. The fact that the 95% CI for the slope of all variables contain the value 1, indicates that the null hypothesis should not be rejected at the .05 level. Table 14 shows the results of the multiple linear regression.

Table 14

Results of the Linear Regression of Predisposing, Enabling, and Need Factors Predicting Urgent Visits for Asthma Related Services in the last 12 months

Predictors	*B*	*SE*	*B*	*t*	*p*	95% CI	
						Lower	Upper
Age Group {reference: 18-24}							
25-34	-.700	3.356	-.040	-.209	.835	-7.337	5.937
35-44	-1.854	3.378	-.106	-.549	.584	-8.536	4.828
45-54	3.047	3.042	.256	1.002	.318	-2.970	9.064
55+	-.833	3.188	-.085	-.261	.794	-7.139	5.472
Marital Status {reference: Married}							
Divorced	-2.122	1.166	-.171	-1.820	.071	-4.429	.184
Widowed	-.432	1.165	-.036	-.371	.711	-2.736	1.872
Separated	.748	1.963	.034	.381	.704	-3.135	4.631
Never Married	.191	1.270	.015	.150	.881	-2.321	2.703
Education {reference: Not Graduated HS}							
Graduated HS	-.109	1.166	-.010	-.093	.926	-2.415	2.197
Attended College	.653	1.286	.057	.507	.613	-1.891	3.197
Graduated College	.367	1.405	.034	.261	.794	-2.413	3.147
Employment {reference: Employed}							
Self-Employed	-.538	2.124	-.025	-.253	.801	-4.738	3.663
Out of Work > 1 year	.808	1.477	.078	.547	.586	-2.115	3.730
Homemaker	3.024	2.823	.099	1.071	.286	-2.560	8.609
Student	.174	4.012	.004	.043	.965	-7.761	8.109
Retired	3.504	1.629	.294	2.151	.033*	.282	6.726
Unable to Work	2.889	1.597	.223	1.809	.073	-.270	6.048
Income {reference: < $15k}							
15k to $25k	-2.291	1.035	-.225	-2.213	.029*	-4.338	-.243
$25k to $35k	-2.382	1.916	-.121	-1.243	.216	-6.173	1.409
$35k to $50k	-2.344	2.042	-.113	-1.147	.253	-6.384	1.696
>$50	.838	2.260	.038	.371	.711	-3.632	5.308
Health Insurance {reference: No}							
Yes	-2.837	3.027	-.081	-.937	.350	-8.825	3.150
Self-Rated Health Status {reference: Poor}							
Excellent	-2.123	2.630	-.077	-.807	.421	-7.326	3.079
Very Good	-2.567	1.847	-.142	-1.390	.167	-6.219	1.086
Good	-.565	1.470	-.044	-.385	.701	-3.473	2.342
Fair	-1.627	1.074	-.170	-1.515	.132	-3.752	.497

Note. * $p \leq .050$. Otherwise $p > .050$.

Emergency room visits in the last 12 months related to Andersen's factors. A logistic regression utilizing the Enter method for the dichotomous dependent variable emergency room visits in the last 12 months (yes/no) and the following independent variables: Predisposing (age-group, marital status, education and employment) enabling (insurance and income) and need (self- rate health status). Wald test was used to demonstrate statistical significance between a binary dependent variable of emergency room visit in the last 12 months (yes/no) and the Andersen model predictors. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The logistic regression model was statistically significant, χ^2 (26) = 44.925, p = .012. However, it has a weak relationship (Nagelkerke R^2=.167) that explained only around 17% of the variance in emergency room visits in the last 12 months. The *H-L* statistic has a significance of .187 which means that is not statistically significant; therefore the model is quite a good fit. The model correctly classified 72% of cases, but it was not a considerable improvement from the constant model. A little improvement was seen from the block 0 to block 1 (70.6% to 72.3%).

Individual coefficients were examined further by using the Wald criterion. Predicted probabilities of ER visits in the last 12 months will be determined for all variables by Exp (*B*). For negative coefficients in the regression, the inverse Exp (*B*) was taken to assess the predicted probabilities (Leech et al., 2008).

The model showed that being self-employed was a significant predictor, B = 1.581, p = .030, OR = 4.860, indicating that self-employed respondents were 4.86 times more likely to have a visit to the ER in the last 12 months than respondents who were

employed. A self-rated health status of Very Good was a significant predictor, B = -2.710, p = .003, OR = .067, indicating that these respondents were 14.93 times more likely to not have a visit to the ER in the last 12 months than respondents who rated their health status as Poor. A self-rated health status of Good was also a significant predictor, B = -.999, p = .024, OR = .368, indicating that these respondents were 2.72 times more likely to not have a visit to the ER in the last 12 months than respondents who rated their health status as Poor. Finally, a self-rated health status of Fair was also a significant predictor, B = -.797, p = .016, OR = .450, indicating that these respondents were 2.22 times more likely to not have a visit to the ER than respondents who rated their health status as Poor. The rest of the predisposing, enabling, and need factors were not significant. The fact that the 95% confidence intervals for the slope of variables Self-employed, and Self-rate health status does not contain the value 1 indicates that the null hypothesis should be rejected at the .05 level. Results of the logistic regression are presented in Table 15.

Table 15

Results of the Logistic Regression of Predisposing, Enabling, and Need Factors Predicting a Visit to the ER for Asthma Related Services in the last 12 months

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Age Group {reference: 18-24}							
25-34	-1.519	1.152	1.739	.187	.219	.023	2.093
35-44	-1.426	1.172	1.482	.223	.240	.024	2.387
45-54	-.468	1.093	.184	.668	.626	.074	5.329
55+	-1.121	1.098	1.044	.307	.326	.038	2.802
Marital Status {reference: Married}							
Divorced	-.351	.392	.800	.371	.704	.327	1.519
Widowed	-.232	.341	.463	.496	.793	.407	1.547
Separated	.972	.613	2.514	.113	2.644	.795	8.797
Never Married	.308	.417	.546	.460	1.361	.601	3.080
Education {ref: Not Graduated}							
Graduated HS	-.110	.352	.097	.755	.896	.449	1.786
Attended College	-.115	.401	.082	.775	.892	.407	1.956
Graduated College	-.231	.445	.269	.604	.794	.332	1.898
Employment {reference: Employed}							
Self-Employed	1.581	.728	4.714	.030*	4.860	1.166	20.255
Out of Work > 1 year	.694	.460	2.277	.131	2.002	.813	4.931
Homemaker	1.243	1.097	1.285	.257	3.467	.404	29.748
Student	-19.219	>1000	.000	.999	.000	.000	.
Retired	.145	.511	.081	.777	1.156	.425	3.146
Unable to Work	.432	.528	.669	.413	1.540	.547	4.335
Income {reference: < $15k}							
15k to $25k	.581	.338	2.946	.086	1.787	.921	3.469
$25k to $35k	.558	.596	.875	.349	1.747	.543	5.623
$35k to $50k	-1.177	1.117	1.110	.292	.308	.034	2.753
>$50	.790	.824	.918	.338	2.203	.438	11.082
Health Insurance {reference: No}							
Yes	-.263	.887	.088	.767	.769	.135	4.376
Self-Rated Health Status {ref: Poor}							
Excellent	-1.452	.883	2.704	.100	.234	.041	1.321
Very Good	-2.710	.909	8.899	.003**	.067	.011	.395
Good	-.999	.442	5.108	.024*	.368	.155	.876
Fair	-.797	.329	5.859	.016*	.450	.236	.859

Note. * $p \leq .050$. ** $p \leq .010$. Otherwise $p > .050$.

Hospitalizations related to Andersen's factors. The Wald test was used to demonstrate statistical significance between the binary dependent variable hospitalizations in the last 12 months (yes or no) and the Andersen model predictors. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The logistic regression model was statistically significant, χ^2 (26) = 42.244, p = .023. However, it has a weak relationship (Nagelkerke R^2=.200) that explained only around 20% of the variance in hospitalizations. The *H-L* statistic has a significance of .212, which means that is not statistically significant; therefore the model is quite a good fit. The model correctly classified 85% of cases, but it was not a considerable improvement from the constant model. A little deterioration was seen from the block 0 to block 1 (85.6% to 85.0%).

Individual coefficients were examined further by using the Wald criterion. Predicted probabilities of hospitalizations in the last 12 months will be determined for all variables by Exp (*B*). For negative coefficients in the regression, the inverse Exp (*B*) was taken to assess the predicted probabilities (Leech et al., 2008). An income of $15k to <$25k was a significant predictor, B = -1.015, p = .017, OR = .362, which suggests that respondents within that income bracket were 2.76 times more likely to not have hospitalizations than respondents who made less than $15k. Also, a self-rated health status of Good was a significant predictor, B = 1.835, p = .006, OR = 6.268, indicating that these respondents were 6.27 times more likely to have hospitalizations than respondents who rated their health status as Poor. The rest of the predisposing, enabling, and need factors were not significant. Results of the logistic regression are in Table 16.

Table 16

Results of the Logistic Regression of Predisposing, Enabling, and Need Factors Predicting Hospitalizations for Asthma-Related Services in the last 12 months

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Age Group {*reference*: 18-24}							
25-34	2.806	1.767	2.522	.112	16.548	.518	528.370
35-44	3.547	1.899	3.489	.062	34.726	.840	1436.057
45-54	1.833	1.607	1.302	.254	6.255	.268	145.864
55+	2.251	1.600	1.981	.159	9.500	.413	218.450
Marital Status {*reference*: Married}							
Divorced	.004	.528	.000	.994	1.004	.357	2.824
Widowed	-.286	.435	.432	.511	.751	.321	1.762
Separated	-.663	.710	.871	.351	.515	.128	2.073
Never Married	-.203	.582	.122	.727	.816	.261	2.553
Education {*ref*: Not graduated HS}							
Graduated HS	.101	.451	.050	.823	1.106	.457	2.675
Attended College	.221	.536	.170	.680	1.247	.437	3.562
Graduated College	-.003	.581	.000	.995	.997	.319	3.111
Employment {*reference*: Employed}							
Self-Employed	-.703	1.042	.455	.500	.495	.064	3.818
Out of Work > 1 year	-.088	.631	.019	.889	.916	.266	3.153
Homemaker	-1.139	1.574	.523	.469	.320	.015	7.002
Student	17.901	28408.457	.000	.999	>1000	.000	.
Retired	.479	.717	.445	.504	1.614	.396	6.584
Unable to Work	.193	.696	.077	.781	1.213	.310	4.743
Income {*reference*: < $15k}							
15k to $25k	-1.015	.424	5.740	.017*	.362	.158	.831
$25k to $35k	19.290	7850.753	.000	.998	>1000	.000	.
$35k to $50k	.203	1.188	.029	.864	1.226	.119	12.574
>$50	18.322	10064.377	.000	.999	>1000	.000	.
Health Insurance {*reference*: No}							
Yes	18.847	14506.974	.000	.999	>1000	.000	.
Health Status {*reference*: Poor}							
Excellent	20.233	10047.900	.000	.998	>1000	.000	.
Very Good	1.858	1.162	2.557	.110	6.411	.658	62.500
Good	1.835	.673	7.446	.006**	6.268	1.677	23.423
Fair	.749	.396	3.571	.059	2.115	.973	4.600

Note. * $p \leq .050$. ** $p \leq .010$. Otherwise $p > .050$.

Research Question 3

To what extent do predisposing, enabling, need, and health care utilization explain the level of asthma control in the study sample of asthmatic adult females in Puerto Rico?

To answer this question, I ran three models utilizing multinomial logistic regression to determine the relationship of achieved level of asthma control (the number of symptoms in the past 30 days, frequency of nighttime awakenings in the past 30 days, and frequency of asthma medication in the last 7 days) and the potential predictors, according to Andersen model. The model was made up of *Predisposing* (age-group, marital status, education and employment), *enabling* (insurance and income), *need* (self-rate health status) and asthma-related health care utilization (urgent visits, ER visits and hospitalizations) variables. Dummy coding was used for categorical variables in the model. Significant odds ratios were interpreted according the reference category in all cases with the first category, except for health status that was compared to the last category. The variable urgent physician visits is continuous.

Symptoms in the past 30 days related to Andersen's factors and asthma – related health services. The Wald test was used to demonstrate statistical significance between the multinomial dependent variable and the Andersen model predictors and health care utilization. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The first logistic regression model was statistically significant, χ^2 (58) = 91.746, p = .003. The Nagelkerke R^2= .538, suggesting that the model explained around 54% of the variance in number of symptoms in the past 30 days. The chi-square statistic has a significance of .952, which means that is not statistically significant;

therefore the model is quite a good fit. This suggests that age-group, marital status, education, employment, insurance, income, self-rated health status, and asthma-related health care utilization might be significant predictors for achieved level of asthma control according by the number of days with symptoms in the last 30 days.

Individual coefficients were examined further by using the Wald criterion. Predicted probabilities of symptoms will be determined for all variables by Exp (*B*). For negative coefficients in the regression, the inverse Exp (*B*) was taken to assess the predicted probabilities (Leech et al., 2008). Although for the category of *Not Well Controlled*, the variables age group of 25-34, 55 years plus, being self-employed, being out of work > than a year, being retired, and health insurance coverage showed p-values lower than .05 as significant predictors, the wide confidence intervals demonstrated errors that should not be interpreted. Results of the logistic regression are presented in Table 17.

For the category of *Very Poorly Controlled*, Urgent visits was a significant predictor, $B = .261$, $p = .001$, $OR = 1.299$, indicating that a one unit increase in urgent visit would result in a 1.299 increase in the relative risk for very poorly controlled symptoms relative to well controlled symptoms. The rest of the predisposing, enabling, need and asthma-related health care utilization factors for not well controlled symptoms were not significant. Results of the logistic regression are presented in Table 17.

Table 17

Results of the Multinomial Logistic Regression of Predisposing, Enabling, Need and Asthma-Related Health Care Utilization Factors in the last 12 months Predicting Asthma Control by frequency of Asthma Symptoms in the last 30 days

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Not Well Controlled							
Age Group {*reference*: 18-24}							
25-34	-6.475	3.155	4.212	.040	.002	3.179E-6	.747
35-44	-1.952	2.986	.427	.513	.142	.000	49.449
45-54	-4.495	2.861	2.467	.116	.011	4.095E-5	3.045
55+	-6.321	2.895	4.768	.029	.002	6.174E-6	.524
Marital Status {*reference*: Married}							
Divorced	.141	1.005	.020	.889	1.151	.161	8.248
Widowed	1.296	.925	1.964	.161	3.656	.596	22.409
Separated	2.908	1.508	3.720	.054	18.321	.954	351.85
Never Married	.860	1.182	.529	.467	2.364	.233	23.984
Education {*ref*: Not Graduated HS}							
Graduated HS	-.860	.932	.851	.356	.423	.068	2.631
Attended College	-.182	.969	.035	.851	.834	.125	5.570
Graduated College	-.735	1.162	.400	.527	.480	.049	4.678
Employment {*reference*: Employed}							
Self-Employed	5.104	2.431	4.407	.036	164.650	1.403	19320
Out of Work > 1 year	4.236	1.803	5.517	.019	69.111	2.016	2368.8
Homemaker	4.652	2.622	3.147	.076	104.788	.614	17881.
Student	-15.39	6297.16	.000	.998	2.095E-7	.000	.
Retired	4.654	1.928	5.827	.016	104.965	2.399	4591.8
Unable to Work	4.030	1.749	5.310	.021	56.237	1.826	1731.7
Income {*reference*: > $15k}							
15k to $25k	.712	.800	.792	.374	2.038	.425	9.783
$25k to $35k	-16.54	1903.04	.000	.993	6.534E-8	.000	.
$35k to $50k	2.128	1.628	1.709	.191	8.401	.345	204.31
>$50	-.109	2.388	.002	.964	.897	.008	96.614
Health Insurance {*reference*: No}							
Yes	6.954	2.683	6.717	.010	1047.246	5.447	>1000
Health Status {*reference*: Poor}							
Excellent	2.955	2.646	1.247	.264	19.211	.107	3437.4
Very Good	-.536	1.521	.124	.725	.585	.030	11.527
Good	-1.102	1.384	.633	.426	.332	.022	5.012
Fair	.258	.768	.113	.737	1.294	.287	5.825
Urgent Visits (*continuous*)	.105	.095	1.222	.269	1.111	.922	1.339
ER Visit {*reference*: No}							
Yes	-1.670	.981	2.901	.089	.188	.028	1.286
Hospitalizations {*reference*: No}							
Yes	-.700	1.096	.408	.523	.496	.058	4.255

.

(*continued*)

Table 17 continued

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Very Poorly Controlled							
Age Group {*reference*: 18-24}							
25-34	-2.116	2.335	.821	.365	.121	.001	11.71
35-44	-18.10	1960.10	.000	.993	1.298E-8	.000	.
45-54	-2.562	1.998	1.644	.200	.077	.002	3.87
55+	-2.071	2.103	.969	.325	.126	.002	7.78
Marital Status {*reference*: Married}							
Divorced	-.768	.795	.934	.334	.464	.098	2.20
Widowed	-.301	.708	.180	.671	.740	.185	2.97
Separated	-.605	1.684	.129	.720	.546	.020	14.83
Never Married	-.127	.898	.020	.888	.881	.151	5.12
Education {*ref*: Not Graduated HS}							
Graduated HS	-.763	.784	.946	.331	.466	.100	2.17
Attended College	.512	.868	.347	.556	1.668	.304	9.15
Graduated College	-.631	.967	.425	.514	.532	.080	3.54
Employment {*reference*: Employed}							
Self-Employed	-16.18	2153.15	.000	.994	9.510E-8	.000	.
Out of Work > 1 year	-.451	1.158	.151	.697	.637	.066	6.17
Homemaker	.569	2.243	.064	.800	1.766	.022	143.44
Student	-.494	5567.70	.000	1.000	.610	.000	.
Retired	-1.173	1.364	.739	.390	.310	.021	4.49
Unable to Work	.625	1.194	.274	.601	1.867	.180	19.38
Income {*reference*: > $15k}							
15k to $25k	-.511	.732	.488	.485	.600	.143	2.52
$25k to $35k	-1.668	1.547	1.163	.281	.189	.009	3.91
$35k to $50k	-.329	1.290	.065	.799	.720	.057	9.02
>$50	-4.049	2.847	2.023	.155	.017	6.578E-5	4.62
Health Insurance {*reference*: No}							
Yes	-15.93	.000	.	.	1.156E-7	1.156E-7	1.156E-7
Self-Rated Health Status {*ref*: Poor}							
Excellent	3.476	1.705	4.157	.041	32.315	1.144	912.77
Very Good	.126	1.478	.007	.932	1.135	.063	20.56
Good	-.726	1.211	.359	.549	.484	.045	5.197
Fair	.342	.705	.236	.627	1.408	.353	5.610
Urgent Visits (*continuous*)	.261	.082	10.171	.001*	1.299	1.106	1.525
ER Visit {*reference*: No}							
Yes	.652	.704	.857	.355	1.919	.483	7.623
Hospitalizations {*reference*: No}							
Yes	.160	.723	.049	.825	1.174	.284	4.845

Note. Multinomial logit model for nominal responses used well controlled as reference category. Categorical variables used reference category as pointed out in the table. * $p \leq .050$. Otherwise $p > .050$.

Nighttime awakenings in the past 30 days related to Andersen's factors and asthma –related health services in the past 12 months. The Wald test was used to demonstrate statistical significance between the multinomial dependent variable and the Andersen model predictors and health care utilization in the past 12 months. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The second logistic regression model was statistically significant, χ^2 (58) = 120.073, p <.001. The Nagelkerke R^2= .662, suggesting that the model explained around 62% of the variance in number of nighttime awakenings in the past 30 days. The chi-square statistic has a significance of .091, which means that is not statistically significant; therefore the model is quite a good fit. This suggests that age-group, marital status, education, employment, insurance, income, self-rated health status, and asthma-related health care utilization might be significant predictors for achieved-level of asthma control by nighttime awakenings in the last 30 days.

Individual coefficients were examined further by using the Wald criterion. Predicted probabilities of achieved level of asthma control by nighttime awakenings in the last 30 days will be determined for all variables by Exp (*B*). For negative coefficients in the regression, the inverse Exp (*B*) was taken to assess the predicted probabilities (Leech et al., 2008). For the category of *not well controlled*, urgent visits in the past 12 months was a significant predictor, B = .373, p = .001, OR = 1.452, indicating that a one unit increase in urgent visit would result in a 1.452 increase in the relative risk for very poorly controlled according nighttime awakenings in the last 30 days relative to well controlled symptoms. The rest of the predisposing, enabling, need and asthma-related

health care utilization factors for not well controlled according nighttime awakenings in the last 30 days were not significant. Results of the logistic regression are presented in Table 18.

For the category of Very Poorly Controlled, all age groups were significant, however the OR for all of them were over 10,000 indicating multicollinearity in between the age groups so the coefficients were not interpreted. Also, the self-rated status of Fair was a significant predictor, B = -1.714, p = .046, OR = .180, indicating that respondents who self-rated their health as fair, relative to respondents who self-rated as poor health status, were 5.55 times more likely to have well controlled to very poorly controlled asthma according nighttime awakenings in the last 30 days. Urgent visits in the past 12 months was a significant predictor, B = .297, p = .001, OR = 1.345, indicating that a one unit increase in urgent visit would result in a 1.345 increase in the relative risk for very poorly controlled asthma relative to well controlled according nighttime awakenings. ER visits in the past 12 months was a significant predictor, B = 1.851, p = .032, OR = 6.363, which suggests that having ER visits would result in a 6.363 increase in the relative risk for very poorly controlled relative to well controlled asthma according nighttime awakenings. The rest of the predisposing, enabling, need and asthma-related health services factors for not well controlled asthma were not significant. Results of the logistic regression are presented in Table 18.

Table 18

Results of the Multinomial Logistic Regression of Predisposing, Enabling, Need and Asthma-Related Health Care Utilization in the last 12 months Predicting Asthma Control by Nighttime awakenings in the last 30 days

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Not Well Controlled							
Age Group {*reference*: 18-24}							
25-34	-50.536	3608.78	.000	.989	1.128E-22	.000	.
35-44	-12.772	1664.04	.000	.994	2.840E-6	.000	.
45-54	1.918	2.023	.899	.343	6.807	.129	359.036
55+	1.726	2.080	.689	.407	5.618	.095	330.902
Marital Status {*reference*: Married}							
Divorced	-.533	.869	.376	.540	.587	.107	3.225
Widowed	-.841	.868	.938	.333	.431	.079	2.366
Separated	-32.064	6601.85	.000	.996	1.188E-14	.000	.
Never Married	1.648	1.061	2.412	.120	5.196	.649	41.583
Education {*reference*: Not Graduated HS}							
Graduated HS	1.287	.900	2.047	.153	3.622	.621	21.122
Attended College	.147	1.124	.017	.896	1.159	.128	10.490
Graduated College	1.256	1.113	1.272	.259	3.510	.396	31.110
Employment {*reference*: Employed}							
Self-Employed	2.558	2.263	1.277	.258	12.904	.153	1089.430
Out of Work > 1 year	.443	1.305	.115	.734	1.557	.121	20.076
Homemaker	33.219	2865.88	.000	.991	>10,000	.000	.
Student	-3.836	8878.74	.000	1.000	.022	.000	.
Retired	-.918	1.605	.327	.567	.399	.017	9.270
Unable to Work	-.757	1.438	.277	.598	.469	.028	7.856
Income {*reference*: > $15k}							
15k to <$25k	1.028	.817	1.585	.208	2.796	.564	13.855
$25k to <$35k	1.515	2.010	.568	.451	4.551	.089	233.999
$35k to <$50k	-.135	1.416	.009	.924	.874	.054	14.013
>$50	-20.065	2540.69	.000	.994	1.931E-9	.000	.
Health Insurance {*reference*: No}							
Yes	22.440	4334.15	.000	.996	>10,000	.000	.
Health Status{*reference*: Poor}							
Excellent	.647	1.881	.118	.731	1.910	.048	76.220
Very Good	-17.144	2220.81	.000	.994	3.585E-8	.000	.
Good	-5.314	1.942	7.488	.006	.005	.000	.221
Fair	-.321	.808	.158	.691	.725	.149	3.533
Urgent Visits (*continuous*)	.373	.109	11.813	.001**	1.452	1.174	1.797
ER Visit {*reference*: No}							
Yes	-1.711	1.166	2.155	.142	.181	.018	1.775
Hospitalizations {*reference*: No}							
Yes	-.991	1.106	.803	.370	.371	.042	3.244

(continued)

Table 18 continued

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Very Poorly Controlled							
Age Group {*reference*: 18-24}							
25-34	20.663	1.680	151.213	.000	>10,000	>10,000	>10,000
35-44	19.483	1.692	132.584	.000	>10,000	>10,000	>10,000
45-54	19.829	1.391	203.274	.000	>10,000	>10,000	>10,000
55+	20.744	.000	.	.	>10,000	>10,000	>10,000
Marital Status {*ref*: Married}							
Divorced	1.129	1.011	1.247	.264	3.093	.426	22.436
Widowed	.842	.870	.937	.333	2.322	.422	12.789
Separated	1.008	1.368	.543	.461	2.741	.187	40.059
Never Married	.218	1.504	.021	.885	1.243	.065	23.690
Education {*reference*: Not Graduated HS}							
Graduated HS	1.289	.946	1.858	.173	3.630	.569	23.163
Attended College	1.098	.983	1.248	.264	2.998	.437	20.582
Graduated College	-1.882	1.387	1.840	.175	.152	.010	2.310
Employment {*ref*: Employed}							
Self-Employed	-13.238	4131.33	.000	.997	1.782E-6	.000	.
Out of Work > 1 year	2.056	1.798	1.309	.253	7.817	.231	264.961
Homemaker	3.063	2.670	1.317	.251	21.402	.114	4007.725
Student	-11.925	8875.17	.000	.999	6.625E-6	.000	.
Retired	1.914	1.838	1.085	.298	6.782	.185	248.667
Unable to Work	1.837	1.901	.934	.334	6.278	.151	260.686
Income {*reference*: < $15k}							
15k to $25k	.457	.796	.329	.566	1.579	.331	7.520
$25k to $35k	-18.401	2785.10	.000	.995	1.020E-8	.000	.
$35k to $50k	.060	1.906	.001	.975	1.062	.025	44.557
>$50	-2.798	2.663	1.105	.293	.061	.000	11.249
Health Insurance {*reference*: No}							
Yes	-15.476	6218.71	.000	.998	1.900E-7	.000	.
Health Status {*reference*: Poor}							
Excellent	7.614	2.910	6.847	.009	2025.444	6.758	>10,000
Very Good	2.446	1.524	2.575	.109	11.540	.582	228.834
Good	-1.244	1.234	1.016	.313	.288	.026	3.238
Fair	-1.714	.857	3.998	.046*	.180	.034	.967
Urgent Visits	.297	.086	11.856	.001**	1.345	1.136	1.592
ER Visit {*reference*: No}							
Yes	1.851	.863	4.593	.032*	6.363	1.171	34.564
Hospitalizations {*reference*: No}							
Yes	-.353	.816	.187	.665	.702	.142	3.478

Note: Multinomial logit model for nominal responses used well controlled as reference category. Categorical variables used reference category as pointed out in the table. * $p \leq .050$. ** $p \leq .010$. Otherwise $p > .050$.

Frequency of asthma medication in the past seven days related to Andersen's factors and asthma–related health services in the last 12 months. The Wald test was used to demonstrate statistical significance between the multinomial dependent variable (frequency of asthma medication in the past week) and the Andersen model predictors and health care utilization. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The third logistic regression model was statistically not significant, χ^2 (58) = 0.00, p = 1.000. The Nagelkerke R^2= .000, suggesting that the proposed model explained 0% of the variance in achieved level of asthma control according by asthma medication use in the past 7 days. The *Chi-square* statistic has a significance of .00, which means that is not statistically significant; therefore the model is not a good fit. This suggests that age-group, marital status, education, employment, insurance, income, self-rated health status, and asthma-related health care utilization are not significant predictors. Results of the multinomial logistic regression are presented in Table 19.

Table 19

Results of the Multinomial Logistic Regression of Predisposing, Enabling, Need and Asthma-Related Health Care Utilization Factors in the last 12 months Predicting Asthma Medication Use in the last seven days

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Not Well Controlled							
Age Group {reference: 18-24}							
25-34	-1.432	4.865	.087	.768	.239	1.727E-5	3301.555
35-44	-.302	5.026	.004	.952	.739	3.894E-5	14031.172
45-54	-.007	4.460	.000	.999	.993	.000	6209.266
55+	1.144	4.323	.070	.791	3.138	.001	15022.491
Marital Status {reference: Married}							
Divorced	-2.826	1.626	3.020	.082	.059	.002	1.435
Widowed	-2.379	1.701	1.956	.162	.093	.003	2.599
Separated	-1.720	2.826	.370	.543	.179	.001	45.566
Never Married	-1.001	2.012	.247	.619	.368	.007	18.981
Education {ref: Not Graduated HS}							
Graduated HS	-1.917	1.998	.921	.337	.147	.003	7.372
Attended College	.526	1.696	.096	.756	1.692	.061	46.997
Graduated College	1.036	1.846	.315	.575	2.818	.076	105.083
Employment {reference: Employed}							
Self-Employed	-.639	3.892	.027	.869	.528	.000	1083.687
Out of Work > 1 year	.761	2.193	.120	.729	2.140	.029	157.475
Homemaker	.888	5.333	.028	.868	2.430	7.015E-5	84153.850
Student	-52756.78	.000	.	.	.000	.000	.000
Retired	.816	2.034	.161	.688	2.262	.042	121.810
Unable to Work	-.615	2.330	.070	.792	.541	.006	52.045
Income {reference: < $15k}							
15k to $25k	.494	1.420	.121	.728	1.639	.101	26.497
$25k to $35k	-.866	2.724	.101	.750	.420	.002	87.647
$35k to $50k	-2.293	3.113	.542	.462	.101	.000	45.128
>$50	-3.338	2.634	1.606	.205	.036	.000	6.199
Health Insurance {reference: No}							
Yes	1.236	5.943	.043	.835	3.443	3.010E-5	393778.59
Self-Rated Health {reference: Poor}							
Excellent	1.274	3.341	.145	.703	3.574	.005	2492.449
Very Good	2.777	2.202	1.591	.207	16.077	.215	1203.916
Good	-.661	2.498	.070	.791	.517	.004	69.097
Fair	.234	1.732	.018	.892	1.264	.042	37.671
Urgent Visits	-.038	.112	.115	.735	.963	.774	1.198
ER Visit {reference: No}							
Yes	-1.005	1.344	.559	.455	.366	.026	5.103
Hospitalizations {reference: No}							
Yes	.318	1.729	.034	.854	1.375	.046	40.744

(continued)

Table 19 continued

Predictors	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Very Poorly Controlled							
Age Group {reference: 18-24}							
25-34	.307	3.021	.010	.919	1.359	.004	507.038
35-44	.336	3.004	.012	.911	1.399	.004	504.039
45-54	.780	2.828	.076	.783	2.180	.009	556.745
55+	1.328	2.915	.207	.649	3.772	.012	1142.497
Marital Status {reference: Married}							
Divorced	-.190	.798	.057	.812	.827	.173	3.949
Widowed	-.050	.745	.005	.946	.951	.221	4.093
Separated	.063	1.355	.002	.963	1.065	.075	15.173
Never Married	.251	.850	.087	.768	1.285	.243	6.798
Education {ref: Not Graduated}							
Graduated HS	-1.571	.832	3.562	.059	.208	.041	1.062
Attended College	-.302	.856	.125	.724	.739	.138	3.956
Graduated College	-.908	.973	.871	.351	.403	.060	2.715
Employment {ref: Employed}							
Self-Employed	-.958	1.813	.279	.597	.384	.011	13.388
Out of Work > 1 year	.415	.938	.196	.658	1.515	.241	9.516
Homemaker	3.491	1.680	4.317	.038	32.809	1.219	883.212
Student	-52773.91	.000	.	.	.000	.000	.000
Retired	-1.095	1.245	.774	.379	.334	.029	3.839
Unable to Work	.511	1.000	.260	.610	1.666	.235	11.835
Income {reference: < $15k}							
15k to $25k	.834	.726	1.318	.251	2.302	.555	9.552
$25k to $35k	1.462	1.416	1.065	.302	4.314	.269	69.262
$35k to $50k	1.697	1.252	1.838	.175	5.457	.469	63.456
>$50	-.389	1.950	.040	.842	.678	.015	31.001
Health Insurance {reference: No}							
Yes	-.200	2.896	.005	.945	.819	.003	239.003
Self-Rated Health {ref: Poor}							
Excellent	-.076	2.341	.001	.974	.927	.009	91.050
Very Good	.520	1.403	.138	.711	1.682	.108	26.294
Good	.817	1.049	.606	.436	2.263	.290	17.682
Fair	.440	.715	.378	.539	1.552	.382	6.305
Urgent Visits (*continuous*)	.049	.056	.761	.383	1.050	.941	1.173
ER Visit {reference: No}							
Yes	-.167	.690	.059	.809	.846	.219	3.270
Hospitalizations {reference: No}							
Yes	-2.113	.702	9.064	.003**	.121	.031	.478

Note: Multinomial logit model for nominal responses used well controlled as reference category. Categorical variables used reference category as pointed out in the table. * $p \leq .050$, ** $p \leq .010$, Otherwise $p > .050$.

Overall asthma control related to Andersen's factors and health care utilization. As not intended analysis, the Wald test was used to demonstrate statistical significance between the binary dependent variable overall asthma control (**controlled or uncontrolled**), and the Andersen model predictors and health care utilization. The explained variation in the dependent variable was based on Nagelkerke R^2 method. The logistic regression model was statistically significant, χ^2 (29) = 44.750, p = .031. However, it has a weak relationship (Nagelkerke R^2=.337) that explained only around 38% of the variance in hospitalizations. The *H-L* statistic has a significance of .180, which means that is not statistically significant; therefore the model is quite a good fit. The model correctly classified 75% of cases, but it was not a considerable improvement from the constant model. A sizeable improvement was seen from the block 0 to block 1 (54.5% to 74.7%).

Individual coefficients were examined further by using the Wald criterion. Predicted probabilities of hospitalizations will be determined for all variables by Exp (*B*). For negative coefficients in the regression, the inverse Exp (*B*) was taken to assess the predicted probabilities (Leech et al., 2008). Only urgent visits were a significant predictor of overall asthma control, B = -.156, p = .021, OR = .855. This suggests that a one unit increase in urgent visit would result in a 1.170 increase in the odds to have uncontrolled asthma. The rest of the predisposing, enabling, need and asthma-related health services factors for uncontrolled asthma were not significant. Results of the multinomial logistic regression are presented in Table 20.

Table 20

Results of the Logistic Regression of Predisposing, Enabling, Need and Asthma-Related Health Care services in the last 30 days Predicting Overall Asthma Control

Predictor	*B*	*SE*	Wald	*p*	*OR*	95% CI	
						Lower	Upper
Uncontrolled							
Age Group {reference: 18-24}							
25-34	3.518	1.972	3.182	.074	33.717	.706	1609.180
35-44	1.746	1.879	.864	.353	5.732	.144	227.811
45-54	1.393	1.717	.659	.417	4.028	.139	116.580
55+	1.682	1.806	.868	.352	5.377	.156	185.100
Marital Status {reference: Married}							
Divorced	-.081	.593	.019	.891	.922	.289	2.947
Widowed	.039	.579	.004	.947	1.040	.334	3.235
Separated	-.014	1.118	.000	.990	.986	.110	8.827
Never Married	-.397	.694	.327	.567	.672	.173	2.618
Education {ref: Not Graduated HS}							
Graduated HS	.512	.602	.723	.395	1.669	.513	5.432
Attended College	-.014	.646	.000	.982	.986	.278	3.498
Graduated College	-.022	.711	.001	.976	.978	.243	3.940
Employment {reference: Employed}							
Self-Employed	-.586	1.161	.255	.613	.556	.057	5.412
Out of Work > 1 year	-1.169	.784	2.223	.136	.311	.067	1.445
Homemaker	-1.800	1.500	1.441	.230	.165	.009	3.124
Student	-.696	1.844	.143	.706	.498	.013	18.498
Retired	-.032	.867	.001	.971	.969	.177	5.300
Unable to Work	-.907	.837	1.175	.278	.404	.078	2.082
Income {reference: < $15k}							
15k to $25k	-.189	.530	.128	.721	.828	.293	2.339
$25k to $35k	.876	1.122	.608	.435	2.400	.266	21.661
$35k to $50k	.235	.987	.057	.812	1.265	.183	8.757
>$50	.965	1.319	.536	.464	2.625	.198	34.805
Health Insurance {reference: No}							
Yes	-1.988	1.683	1.396	.237	.137	.005	3.705
Self-Rated Health Status {ref: Poor}							
Excellent	-.721	1.411	.261	.610	.486	.031	7.733
Very Good	1.138	.983	1.339	.247	3.119	.454	21.418
Good	1.593	.818	3.793	.051	4.917	.990	24.423
Fair	.399	.573	.485	.486	1.490	.485	4.577
Urgent Visits (*continuous*)	-.156	.068	5.341	.021*	.855	.749	.977
ER Visit {reference: No}							
Yes	.401	.511	.614	.433	1.493	.548	4.068
Hospitalizations {reference: No}							
Yes	.694	.606	1.312	.252	2.002	.610	6.563

Note: * $p \leq .050$. ** $p \leq .010$. Otherwise $p > .050$.

Summary of the Findings

In the examination of the RQ1 that assessed the ability of sociodemographic, behavioral, and environmental variables to differentiate between active and non-active asthma status among the sample of adult females in Puerto Rico, the logistic model was significant for the predictors being out of work for more than a year, income of $25k to <$35k, and the BMI indicator obese. To examine the RQ2 for the extent to which predisposing, enabling, and need factors, I conducted a multiple linear regression to explain urgent visits to the physician, and two logistic regression to explain emergency room visits and hospitalization in the study sample. Results of the multiple regression for physician's urgent time visits were not significant. For its part, the results of the logistic regression models for emergency room visits and hospitalizations were significant. Predisposing variables (self-employed) and need factors (very good, good and fair health status) were significant predictors for asthma's emergency rooms visits. Asthma hospitalizations were explained better by income (15k to 25k) and need factor of health status (good).

To answer RQ3, I conducted three multinomial logistic regressions that looked at the extent that predisposing, enabling, need, and asthma-related health services explain the achieved-level of asthma control in the study sample of asthmatic adult females in Puerto Rico. For the category of very poorly controlled asthma, the best predictor for the number of days with asthma symptoms was physician urgent time visit. The second model for asthma control according nighttime awakenings in the last 30 days was statistically significant. For the category of poorly controlled asthma according nighttime

awakenings, the best predictors were fair health status, physician urgent visits and emergency room visits. The third multinomial model for asthma control by asthma medication use in the last seven days was statistically not significant. An additional binary logistic regression was conducted to assess the relationship between overall asthma control and the variables of interest. The logistic regression model for overall asthma control (controlled or uncontrolled) was statistically significant. However, only physician urgent visits were a significant predictor of overall asthma control.

Chapter 4 presented the results of the contributions among the social, behavioral, and environmental risk factors for asthma, and relating Andersen predictors to the level of service utilization, and the achieved-level of asthma control among adult females in Puerto Rico. A summary of the data collection was given. Descriptive statistics were presented for all the risk factors and control of asthma symptoms. The proposed analyses were conducted to answer each of the research questions and the significant predictors were discussed. I will discuss the findings of the results in Chapter 5. Chapter 5 will also contain suggestions for future research and implications of the findings.

Chapter 5: Discussion, Conclusions, and Recommendations

In this quantitative study I assessed cross-sectional data from 625 participants who completed the Asthma Call Back Survey during 2011 and 2012 in Puerto Rico. I sought to determine the relationships among the sociodemographic, behavioral, and environmental risk factors for current asthma status, and relate predisposing, enabling, and need factors to asthma-related service utilization and the achieved level of asthma control. The importance of this study is based on female disparity in asthma morbidity compared to adult males in Puerto Rico, and the differences in asthma management and impact of utilization of asthma-related health services. I assessed the relationship between current asthma status and the independent variables (age group, education, marital status, employment, income, smoking, physical activity, obesity, secondhand smoke, pets, vectors, and environmental modifications). Additionally, I assessed the independent variables of predisposing factors (age group, education, marital status, employment); enabling factors (health insurance, income); and need factors (self-rated health status) with asthma-related health care utilization (physician urgent visits, emergency room visits, hospitalizations). Finally, I assessed the independent variables of predisposing, enabling, need, and asthma-related health services to explain achieved level of asthma control.

Main Findings

The main findings of this study are the following: There was high percentage (65%) of women with asthma older than 55 years, with lower income (75%%), poorer (75.9%) health status, lower physical activity (70.1%), and higher BMI (63.2%) than

other age groups. Neither sociodemographic nor environmental factors were significant to differentiate between active or inactive asthma among women in Puerto Rico. Among behavioral factors, the chi-square analysis showed that only obesity and physical activity showed a significant difference among participants by asthma status.

The logistic model to differentiate between active and inactive asthma explained only 13% of the variance. The significant predictors for active asthma were two sociodemographic characteristics (being out of work for more than one year as compared to being employed, and income from $35,000 to $25,000 as compared to less than $15,000) and the behavioral BMI indicator (obese as compared to normal weight).

From the three models to explain asthma-related health services utilizing Andersen's factors, only emergency rooms visits and hospitalizations were significant; however, they had a weak relationship. The multiple linear regression for urgent time visits was not significant. The predictors of being self-employed (predisposing) and the health status (need) explained 17% of the variance of the emergency room visits due to asthma among women in Puerto Rico. Finally, income level of $15,000-25,000 (enabling) and the self-rated health status of good (need) explained 20% of the hospitalizations for asthma-related health services.

Among the three multinomial models to elucidate the achieved level of asthma control (number of symptoms in 30 days, frequency of nighttime awakenings in 30 days, and frequency of asthma medication in a week), according the Andersen's factors and asthma-related health services, only the first two were significant. The model for the number of asthma symptoms in the last 30 days explained 54% of the variance. For very

poorly controlled asthma, the predictors were health status (need) and physician urgent time visits (asthma-related health services). The model for nighttime awakenings in the last 30 days explained 62% of the variance by Andersen factors and asthma-related health services. Very poorly controlled asthma was explained by physician urgent time visits, and emergency room visits in the last year. The last model for frequency of medication use was not significant. The additional model for overall asthma control (controlled/uncontrolled) showed significance for physician urgent time visits in the last year.

Interpretation of the Findings

The findings indicated that Puerto Rico had 63% prevalence of active asthma among adult females age 18 years or older who self-reported as asthmatics during 2011 and 2012. This prevalence was consistent in each of the two years assessed. Sixty one percent of women diagnosed with asthma had an annual income less than $15,000 as compared to the 40.2% of population with the same household income in Puerto Rico (U.S. Census, 2013). From this poor sector, 60% had active asthma and 16% had asthma not well controlled or very poorly controlled.

Almost the entire subsample (97.1%) had health insurance coverage, which is considered a strong predictor of health care access (Andersen et al., 2012). In Puerto Rico, nearly 40% of the population is eligible for public health insurance covered through programs offered by the local government (Departamento de Salud & Organización Panamericana de la Salud, 2004). Additionally, the Department of Health reported that 37% of the population is covered by private health insurance offered through employers,

and 18% is covered by federal programs such as Medicare and Veterans (Departamento de Salud & Organización Panamericana de la Salud, 2004). Overall, Puerto Rico has 6.4% fewer people without health insurance coverage as compared to 13.4% in the United States (Smith & Medalia, 2014). Even though Puerto Rico has high health insurance coverage, Pao (2012) reported higher percentages of health care cost barriers as compared with other unincorporated U.S. territories, such as Guam and Virgin Islands.

Sociodemographic Factors and Asthma Status

Although the bivariate analysis did not indicate association between the sociodemographic factors and active asthma, the logistic model confirmed an association between out of work for more than one year and income from $25,000 to $35,000 as important predictors for active asthma among participant women. In this study, 41% of women self-reported to be out of work for more than one year. Women out of work for more than one year were 2.34 times more likely to have active asthma than those who were employed. Pirila et al. (2005) found that unemployment is a significant predictor for poorer asthma outcomes, and is one of the reasons for a patient's dissatisfaction with life. Findings from this study also indicated that women with a lower middle income ($25,000 -$35,000) were 3.14 time more likely to have active asthma than women who earned less than $15,000. Vogt et al. (2008) and Trupin et al. (2013) found that lower income was a predictor of asthma severity in the United States. However, in Puerto Rico, the group of women classified in the lower middle income experience greater economic pressure because they have no social welfare like those who are under lower income bracket. Additionally, the U.S. Census (2012) classified 25% of women in Puerto Rico as the head

of the family with no husband present, and who in the majority of cases do not receive alimony from the former husband. Aday (2001) stated that women are at higher risk of being more vulnerable to bad health outcomes due to disparities strengthened by social factors, such as being the only family head.

Behavioral Factors and Asthma Status

The bivariate analysis confirmed that physical activity and body mass index were important predictors for active asthma. Smoking was low among women with asthma in Puerto Rico, and it was not significant in bivariate analysis or the logistic model for asthma status. Among women with active asthma, 60% did not engage in physical activity. Additionally, almost three quarters of women with active asthma were classified as overweight (25-30 kg/m2) and obese (>30kg/m2), and a third were under the age of 55. Obesity is a known risk factor for activity restriction among women (Vortmann & Eisner, 2008). The logistic model did not confirm physical activity as an important predictor for active asthma; however, obese women were 2.35 times more likely to have active asthma, which was significant. Obesity has been associated with increased degree of asthma prevalence (Perez-Perdomo et al., 2003; Strine et al., 2007), asthma severity among women (Akerman et al., 2004), and worse physical health status, activity restriction and worse quality of life (Vortmann & Eisner, 2008). Conversely, regular physical activity is associated with reduced risk of exacerbation of asthma among women (García-Aymerich et al., 2009).

Environmental Factors and Asthma Status

The results of this study indicated that environmental factors such as secondhand smoke, molds, pets, rodents, roaches, or modifications inside the home, such as the use of dehumidifiers and air cleaners were not significantly associated with active or inactive asthma among participant women. Nguyen et al. (2010) found associations of asthma with molds but not with cockroaches, pets, or smoking inside the house. Although Quintero et al. (2010) reported molds as the main component of particulate matter during rainy days and mornings in Puerto Rico, this study did not find any association of molds with active asthma among the population assessed.

Asthma-Related Health Services and Andersen Factors

Jandasek et al. (2011) and Piper et al. (2010) used the Andersen framework to analyze asthma care services and asthma management plans. However, this study was the first to assess the relationship between Andersen's factors and asthma health care utilization among adult females in Puerto Rico. The multiple regression model for urgent visits to the physician due to asthma did not indicate significant results for age group, marital status, education, employment, income, health insurance, or self-rated status. Conversely, the logistic regression for emergency room (ER) visits due to asthma did indicate significant results for the predisposing variable of employment. Women who were self-employed were 4.86 times more likely to visit an emergency room than women who worked for an employer. Social characteristics such as employment make people more or less prone to use health services (Andersen & Newman, 1973). According to the study of the Henry J. Kaiser Family Foundation (2014), most uninsured workers are self-

employed, and the emergency room is the first option for health care because it is a required service by federal provision to all patients without insurance. In this study, there were only 3% of women without health insurance in Puerto Rico.

Additionally, women who self-reported very good health status were 14.9 times less likely to visit an emergency room; those with good health status were 2.72 times less likely, and those with fair health status were 2.22 times less likely to visit an emergency room. Emergency room visits are more likely associated with acute illness (de Boer et al., 1997); this study confirmed that women with active asthma with better health status were less likely to use the emergency room. This result also confirmed that perceived need factors in chronic conditions such as asthma have a significant impact on health care utilization (Andersen, 1995; Andersen et al., 1983; Boer et al., 1997; Parslow & Jorm, 2004).

For hospitalizations due to asthma, the enabling factor of income of $15,000-$25,000 predisposed women 2.76 times more likely to not have hospitalizations than respondents who made less than $15,000. In this subsample, females in the higher brackets of income did not report any hospitalization visits in the previous year. This result is different from studies on Andersen framework that showed that low income brackets are not related with hospitalizations among those who were chronically ill (Boer et al.,1997)

The model showed that women who rated their health status as good were 6.27 times more likely to have an asthma hospitalization than those who reported poor health status. However, this result should not be perceived as conflicting because of the wide

confidence intervals. It has been well established that worse-perceived health predicts more hospitalizations (Andersen, 1995; Andersen et al., 1983; Boer et al., 1997; Parslow & Jorm, 2004).

Achieved-Level of Asthma Control, Andersen Factors and Asthma-Related Health Services

The results showed that 61% of women had well-controlled asthma, 12.5% had not well-controlled asthma, and 26.4% has very poorly controlled asthma. The small sample size for the category of not well-controlled asthma was insufficient to demonstrate accurate results in the multinomial logistic regression model. The models were significant for very poorly controlled asthma, according to asthma symptoms and nighttime awakenings in the previous 30 days, but not for asthma medication use. Asthma symptoms was predicted by physician urgent visits in the previous 12 months. The mean for number of urgent visits to the physician was nearly four times in the previous year, and the maximum number of visits was 26 times in the previous year. Odd ratio showed that one unit of increase in physician urgent time visits among women would result in 1.30 increase in relative risk of asthma symptoms poorly controlled.

For nighttime awakenings in the previous 30 days, the category of not well controlled was predicted by physician urgent visits, and very poorly controlled was predicted by physician urgent visits and emergency room visits. Results showed that one unit of increase in physician urgent time visits would result in women having 1.35 increase in the relative risk to have more than 13 days/nights with nighttime awakenings in one month. Additionally, emergency room visits would result in 6.36 increase in

relative risk to have more than 13 days/nights by month with nighttime awakenings. Nighttime awakenings was also predicted by self-rated health (need factor), indicating that women who rated their health as fair were 5.55 times more likely to well control nighttime awakenings than women who self-rated their health as poor. Health care services received in response to more serious conditions would be primarily explained by need factors (Andersen, 1995; Andersen et al., 1983; Boer et al., 1997; Parslow & Jorm, 2004).

Limitations of the Study

First, as a cross-sectional study, the observed relationships between asthma outcomes and predictors assessed do not imply causality because the temporal sequence of events is not known. Second**,** the findings cannot be generalized to populations that did not participated in the asthma call back survey for the years assessed or to other populations surveyed during other time periods. Therefore, the results are only applicable to adult females diagnosed with asthma living in Puerto Rico.

Third, because this study had a cross-sectional design, it had low internal validity (Carlson & Morrison, 2009). ACBS data came from participants randomly selected, thus ensuring an equal chance for participation across a regional sample, and controlling for systematic differences across participant responses (Nelson et al., 1998). Selection bias was a potential threat because eligible respondents for ACBS had the right and the opportunity to refuse to participate. There is a possibility that those who refused may have been systematically different from those who chose to participate. History and maturation threats were controlled by the cross-sectional nature of the survey because the

time between the BRFSS and the ACBS was too short to produce maturation of participants. Mortality could be present due to lost to follow up in the ACBS relative to the BRFSS parental survey. To avoid lost to follow up, data collection protocol restrict the time to only two weeks between measures of both surveys, and the staff make sufficient calling attempts to reach each eligible respondent. However, Puerto Rico has one of the lowest refusal rates (18.6%) as compared to the median of the United States.

Fourth, answers for behavioral variables, such as physical activity, smoking, and weight to calculate body mass index are subject to validity of self-response, because are sensitive to social desirability (Pierannunzi et al., 2013). Even though, Vandestoep and Jonhston (2009) found high reliability in the BRFSS for self-responses of height, weight, BMI and sociodemographic characteristics.

Finally, although the total subsample size was adequate according the power sample analysis, the broad confidence intervals in some of the predictors of the multinomial models reflected small samples by each cell. Small samples will results in very wide confidence intervals around the estimated OR, independently if the predictor had a significant p-value (Pallant, 2005). Additionally, missing responses of some of the behavioral predictors such as current smoker and meet aerobic recommendations did not allow including them in the logistic regression model.

Recommendations

The findings in this study give clues to the following recommendations. Public health insurance should cover women classified as working poor class that currently is not eligible for any health benefit in Puerto Rico. Additionally, women classified as self-

employed and working poor class should be considered as subgroups with greater risks than their counterparts having higher utilization asthma-related health services.

Asthma management plans need to include targeted actions for women with active asthma. Activities that reinforce regular physical activity among women may reduce poor asthma outcomes. Perceived' health status could be used as an indicator during asthma health care interventions to address the causes in a timely manner to avoid excess of health care utilization and costs. Reducing emergency room visits due to asthma is one of the national target of 2020 Healthy People.

Implications

Results of this study produced a profile of women with asthma in Puerto Rico with supporting evidence on modifiable risk factors for asthma health care utilization and asthma control. First, women that are out of work, women classified as the poor working class, and women classified as obese are more susceptible to have active asthma. Women classified under category self-employed utilized more the emergency room than their counterparts. In addition, need factor of self-rate health status is a good predictor to know the odds ratio of a women to use emergency room. The better is the self-rate of health, the better the chance not to visit an emergency room. Additionally, increase in physician urgent time visits predicts that women will be more likely to have everyday asthma symptoms and nighttime awakenings in one month. Likewise, the results bring information on subgroups that utilize more asthma-related health services. This information should be used among clinical practitioners in Puerto Rico in terms of what considerations need to have to the medical management with this target population.

Moreover, this information should be used in promotional and educational programs to increase asthma knowledge among women on how improve asthma self-management, as well as personalized medicine in asthma management plan.

Implications for Analysis and Theoretical Framework

The Andersen behavioral model demonstrated a good fit to assess asthma-related health services, except for continuous variable physician urgent time visits. In addition to health care utilization, this study employed Andersen model to assess the level of a chronic illness, such as asthma. The BM was good to assess achieved level of asthma control, especially for very poorly controlled condition, by symptoms and by nighttime awakenings, but not for asthma medication use.

The fact that body mass index was significant in logistic regression models supports further analysis including this predictor in the Anderson framework as a need factor for asthma-related health services and asthma achieved level of control. BMI was included as need factors in the Anderson model to predict hypertension, diabetes and other chronic diseases, but not asthma (Johnson et al., 2010; Redondo et al., 2006). Finally, a further study requires including three years of data, which is the maximum time frame allowable for the Asthma Call Back Survey, in order to increase the sample for multinomial logistic regression analysis.

Conclusion

This study contributed to the limited literature on asthma-related health services and asthma control among women in Puerto Rico. Even though the existence of national asthma guidelines, nearly 40% of women with active asthma in Puerto Rico had

uncontrolled asthma. The findings confirmed significant determinants for active asthma, and adds information on odds ratio for sensitive subgroups that utilize asthma-related health services in higher proportion than their counterparts. As well, the study adds information on odds ratio for subgroups of women that are more vulnerable to have poorly controlled asthma. These findings could guide health care professionals to develop a more individual asthma management plan for adult females. The fact that certain subgroups among women with asthma are at higher risks than others is important information to be considered by health care professionals dealing with patient's asthma management and control. Understanding socio-demographic and behavioral characteristics of women with asthma could improve the asthma management plan to reduce poorly asthma outcomes and higher costs in asthma-related health care utilization.

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Appendix A: ACBS Response Rates (CDC, 2014a, p.8)

"The ACBS Interview Completion Rate is the proportion of completed interviews among eligible respondents who are actually contacted for and started the ACBS interview. Those who refuse at the initial BRFSS interview (4413), those ineligible, and those never contacted are excluded from the denominator. This rate is based on actual contacts with the eligible respondent at the time of the call-back interview. The numerator of the rate includes completed interviews (COIN). The denominator of the rate includes completed interviews (COIN) plus the number contacted later for the ACBS interview who refuse or terminate the interview (disposition codes 2112, 2120, 2211, and 2212).

ACBS Interview Completion Rate:

$$\frac{1100 + 1200}{1100 + 1200 + 2120 + 2211 + 2212 + 2112}$$

The ACBS Cooperation Rate is the proportion of completed interviews among all eligible respondents who are recruited and actually contacted for the ACBS interview. Eligible respondents who refuse the call-back at the time of the BRFSS interview are included. Non-contacts are excluded from the denominator, but contacts with communication problems specific to the respondent with asthma are included. The numerator of the rate includes completed interviews (COIN). The denominator of the rate includes completed interviews (COIN) plus refusals and terminations (TERE) plus the number of non-interviews that involved language problems with the respondent with asthma (2330) or physical/mental impairment of the respondent with asthma (2320). A Cooperation Rate below 65 percent may indicate some problem with interviewing techniques.

ACBS Cooperation Rate:

$$\frac{1100 + 1200}{1100 + 1200 + 2120 + 2211 + 2212 + 2112 + 4413 + 2320 + 2330}$$

The Refusal Rate is the percentage of all eligible respondents who refuse to be interviewed or terminate an interview early in the questionnaire. The numerator includes terminations and refusals (TERE). The denominator is the same as for the CASRO rate (below). The denominator includes completed interviews (COIN), terminations and refusals (TERE), and a proportion of those eligible but lost to follow-up. The proportion represents an estimate of the number of those lost to follow-up who would be expected to remain eligible if they had been contacted. The proportion of cases lost to follow-up that are estimated to be eligible is the same as the proportion of cases not lost to follow-up that are eligible. A Refusal Rate above 35 percent indicates some problem with interviewing techniques.

ACBS Refusal Rate:

$$\frac{2120 + 2211 + 2212 + 2112 + 4413}{[1100 + 1200 + 2120 + 2211 + 2212 + 2112 + 4413] + P * [\text{Eligible lost}]}$$

Where P (Proportion) = (COIN + ACBS TERE) / (COIN + ACBS TERE + Ineligible)

[(1100+1200) + (2120 + 2211 + 2212 + 2112)] ÷ [(1100+1200) + (2120+2211+2212+2112)+4405+4700+4411+4471+2291+2290+4480+4490+4491+4412)]

Eligible lost = 2111, 2210, 2220, 2320, 2330, 3100, 3130, 3140, 3200, 3322, 3330, 4100, 4900, 4306,
5050, 5100, 5111, 5112, 5120, 5130, 5140, 5220, 5320, 5330, 5550, 5560, 3150, 3700, 4200, 4300,
4400, 4430, 4450, 4460, 4470, 4500, 4510, 5400, 5150, 5200, 5300, 5599, 5700, 5900, 5999

The Council of American Survey Research Organizations (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 numerator of the CASRO rate includes completed interviews (COIN). The denominator includes completed interviews (COIN), terminations and refusals (TERE), and a proportion of those eligible, but lost to follow-up. The proportion represents an estimate of the number of those lost to follow-up who would be expected to remain eligible if they had been contacted. The proportion of cases lost to follow-up that are estimated to be eligible is the same as the proportion of cases not lost to follow-up that are eligible. A CASRO rate below 40 should be cause for a review of data collection practices that could affect it, especially sample management and interviewer recruitment, retention, training, supervision, and monitoring". (CDC, 2014a, p.8)

ACBS CASRO Rate:
1100 + 1200
[1100 + 1200 + 2120 + 2211 + 2212 + 2112 + 4413] + P * [Eligible lost]

Appendix B: URL for BRFSS and ACBS Codebook Reports

Codebook reports	Year	Reference	URL
BRFSS	2011	(CDC, 2013d)	http://www.cdc.gov/brfss/annual_data/2011/CODEBOOK11_LLCP.pdf
BRFSS	2012	(CDC, 2013j)	http://www.cdc.gov/brfss/annual_data/2012/pdf/CODEBOOK12_LLCP.pdf
ACBS	2011	CDC, 2014a)	http://www.cdc.gov/brfss/acbs/2011/documentations/ACBS_2011_ADULT_CODEBOOK.pdf
ACBS	2012	(CDC, 2014b)	http://www.cdc.gov/brfss/acbs/2012/pdf/ACBS_2012_ADULT_LLCP_CODEBOOK.pdf

Appendix C: CDC's Email for BRFSS Data Contact

Aug 12, 2014

Flegel, David (CDC/ONDIEH/NCCDPHP) (CTR) <ijt2@cdc.gov>

Maria Ortiz, Public, CDC-INFO

Dear Ms. Ortiz,
Hello! Dave Flegel here. I am a tech writer working with BRFSS at CDC. Thank you for your question. I sent it to a few staff members here and found that data from Puerto Rico were not included with the rest of that report. You may still be able to get some data by contacting the BRFSS coordinator in Puerto Rico directly. Here is the contact info:
Project Director: Ruby A. Serrano-Rodriguez, MS, DrPH
Puerto Rico Department of Health
Puerto Rico-BRFSS
PO Box 70184
San Juan, Puerto Rico 00936-8184
http://www.salud.gov.pr/services/BRFSS/Pages/default.aspx
Phone: 787-274-7828
Fax: 787-274-7827
I hope this helps!-Dave
David Flegel, MS
Technical Writer On-site editorial contractor, Northrop Grumman
Working at the Centers for Disease Control and Prevention
Population Health Surveillance Branch
Atlanta, Ga

Appendix D: Data Use Agreement

DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of September 3, 2014 ("Effective Date"), is entered into by and between María C. Ortiz ("Data Recipient") and The Puerto Rico Asthma Project ("Data Provider"). The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research **in accord with laws and regulations of the governing bodies associated with the Data Provider, Data Recipient, and Data Recipient's educational program.** In the case of a discrepancy among laws, the agreement shall follow whichever law is more strict

1. Definitions. Due to the study's affiliation with Laureate, a USA-based company, unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the USA "HIPAA Regulations" and/or "FERPA Regulations" codified in the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable laws and regulations of the governing bodies associated with the Data Provider, Data Recipient, and Data Recipient's educational program.

3. Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** In preparing the LDS, Data Provider shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research: The Asthma Call Back Survey Data base for the years 2011 and 2012

4. Responsibilities of Data Recipient. Data Recipient agrees to:

   a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

   b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

   c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

   d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

   e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

5. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS **for its Research activities only.**

6. Term and Termination.

   a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

   b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

   c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

   d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

   e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

7. Miscellaneous.

   a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

   b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

   c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

   d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

6. Term and Termination.

   a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

   b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

   c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

   d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

   e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

7. Miscellaneous.

   a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

   b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

   c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

   d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER	**DATA RECIPIENT**
Signed:	Signed:
Print Name: Jessica Irizarry-Ramos	Print Name: María Ortiz
Print Title: Chronic Disease Director	Print Title: Walden Student

Appendix E: Andersen's Permission to Reprint Models

Gmail by Google

Maria Ortiz <maria.ortiz@waldenu.edu>

Re: Fwd: Andersen framework

Ron Andersen <randerse@ucla.edu> Wed, Dec 10, 2014 at 1:47 AM
To: Maria Ortiz <maria.ortiz@waldenu.edu>

Dear Maria,

You certainly have my permission to use the models in your dissertation. That's what they are there for. Best wishes for your dissertation completion and research career.

Rom Andersen

At 05:31 AM 12/8/2014, Maria Ortiz wrote:

> DearÂ Dr. Andersen:
>
> I am utilizing the Behavioral model for asthma- related healthcare utilization in my doctoral dissertation at Walden University. My document include the evolution of the model by adapting figures from the following reference:
>
> Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: Does it matter? *Journal of Health and Social Behavior*, *36*(1), 1-10. doi:10.2307/2137284.Â
>
> I am writing to you in order to obtain your permission to use these models in my document, and making reference to your original work. Thanks in advance for your answer.
>
> My best, and thanks for this great model that has been widely employed by researchers.
> --
> Maria Ortiz
> A00153777
> PHD Public HealthÂ
> Epidemiology

--
Maria Ortiz
A00153777
PHD Public HealthÂ
Epidemiology

Appendix F: Curriculum Vitae

MARÍA C. ORTIZ-RIVERA
maria.ortiz@waldenu.edu

EDUCATION

PHD PUBLIC HEALTH IN EPIDEMIOLOGY. (2009-2016)**.** Walden University. Specialization courses: Biostatistics, Environmental health, Epidemiology, Public health Informatics, Research I, Research II, Research III, Environmental and Occupational Epidemiology, Epidemiology of Infectious diseases, Epidemiology of Chronic Diseases, Social and Behavioral Epidemiology

MASTER OF SCIENCE IN ENVIRONMENTAL MANAGEMENT, MAJOR IN ENVIRONMENTAL RISK AND ASSESSMENT MANAGEMENT. (2000). School of Environmental Affairs Universidad Metropolitana, Río Piedras, Puerto Rico**.** Master Thesis: Sea turtle stranding assessment in Puerto Rico and Virgin Islands. Major Courses: Environmental Risk Assessment, Environmental Risk Management, Environmental Chemistry, Environmental Microbiology, Tropical Natural Resources, among others.

22 GRADUATE CREDITS: MASTER OF ARTS IN EDUCATION/ADMINISTRATION AND SUPERVISION. (1983-1985). Evolution, Herpetology, Ichtiology, Animal Behavior, Human Environment, Education Administration and Supervision. University of Phoenix, Residence Center, Puerto Rico**.**

BACHELOR OF SCIENCE MAJOR IN NATURAL SCIENCES. (1983). Universidad de Puerto Rico, Cayey, Puerto Rico**.** Minor in Chemistry: General, Organic, Analytical Chemistry, Biochemistry, Others: Microbiology and Immunology.

ACADEMIC EXPERIENCE

2013 to present	DEAN OF THE SCHOOL OF ENVIRONMENTAL AFFAIRS, Universidad Metropolitana (UMET), Río Piedras, PR
2008 to present	ASSOCIATE PROFESSOR, SCHOOL OF ENVIRONMENTAL AFFAIRS, UMET, Río Piedras, PR.
2005 to 2012	ASSOCIATE DEAN: SCHOOL OF ENVIRONMENTAL AFFAIRS. UMET, Río Piedras, PR. Environmental Communication and Writing, Research Proposal course, Research mentor
2007 to 2008	PI: The Environmental Science Curriculum Integration. UMET. Additional tasks.
2002 to 2008	ASSISTANT PROFESSOR: Universidad Metropolitana (UMET), Río Piedras, PR.
2001 to 2004	DIRECTOR OF UNDERGRADUATE ENVIRONMENTAL PROGRAM: School of Environmental Affairs, UMET, Río Piedras, PR.
October to December 2003	C0-PI: Academia Sabatina para Maestros en Ciencias Ambientales. UMET, Centro Universitario de Bayamón, Additional tasks.

May 1998 to Oct. 2001	DEAN ASSISTANT: School of Environmental Affairs, Universidad Metropolitana, Río Piedras, PR.
Jan. 2001 to February 2002	PROJECT COORDINATOR "Multi Hazards Assessment, Guide and Web Site", funded by Federal Emergency Management Agency (FEMA)/GAR. School of Environmental Affairs, Universidad Metropolitana, Río Piedras, PR. [Additional tasks].
August 1996 to Sept. 1997	DEAN ASSISTANT. Science and Technology Department, Universidad Metropolitana, Río Piedras, PR
January 1996 to May 1998	HEALTH AND SAFETY COORDINATOR, Department of Science and Technology, Universidad Metropolitana, Río Piedras. Develop and implement the Chemical Hygiene Plan and the Respiratory Program in science laboratories. Personnel supervision, hazardous waste and biomedical waste disposition, lab purchase orders, requisitions.
September 1984 to December 1995	BIOLOGY LABORATORY TECHNICIAN AND INSTRUCTOR, Science and Technology Department, Universidad Metropolitana, Río Piedras.
January 1983 to August 1984	ECOLOGY AND MICROBIOLOGY LABORATORY TECHNICIAN AND INSTRUCTOR, Science and Technology Department, Universidad del Turabo, Caguas.
July-October 2001 August - December 2000	PART TIME PROFESSOR. School of Environmental Affairs, UMET, Río Piedras. Conservation and Management of Marine Resources. PART TIME PROFESSOR. Science and Technology Department, Umet Río Piedras. Environmental Planning (Enmg 117) Introduction To Biological Sciences (Biol 102).
1996	PART TIME PROFESSOR: Design a Mini Course for Teaching of Natural Resources: Water, Soil and Forests. Resource Center for Sciences and Engineering (CRSI), University of Puerto Rico, Río Piedras.
1995	PART TIME PROFESSOR: Consortium for Minorities in Teaching Careers. UMET, Río Piedras Biological Sciences.
1993	FIELD LECTURER: Guánica State Forest field lecturer for elementary students, Program: Children Watching Over Our Planet Earth (SWOOPE). Colegio Universitario del Este, Carolina
1989-1993	PART TIME PROFESSOR: Course Biology in Proyecto CAUSA, Universidad Metropolitana, Río Piedras.

THESIS MENTORING:

2012 THESIS COMMITEE DIRECTOR: *Interaction Between the Dune Aphid Schizaphis Rufula and its Host-Plant Ammophila Arenaria: a Comparison of Insect Multiplication on Different Host- Plant Population*. Jeselyn Calderon Ayala.

2012 THESIS COMMITEE DIRECTOR: *Estrategias de Manejo para la Comunidad de*

Mariposas en el Área Mitigada del Antiguo Cauce del Río Bayamón en la Reserva Natural de la Ciénaga las Cucharillas. Patricia Sanz Martínez

2012 THESIS COMMITEE DIRECTOR: *Estrategias para el uso de las Cenizas Producidas en la Conversión de Residuos a Energía por la Planta Propuesta en Arecibo*. Yomaira Maldonado Cortes.

2011 THESIS COMMITEE DIRECTOR: *Plan de Acción para el Control de Fuentes Dispersas en las Instalaciones del Departamento de Transportación y Obras Públicas del Municipio de Bayamón*, Puerto Rico. Harry Marrero Philippi

2010 THESIS COMMITEE DIRECTOR: *Portal Informativo Enfocado en el Desarrollo Sustentable como Estrategia de Comunicación Ambiental utilizada por el Centro de Estudios para el Desarrollo Sustentable* (CEDES) Emma Figueroa Quiñones

2009 THESIS COMMITEE DIRECTOR: Evaluación de la Estructura y Composición Forestal de Zonas Agrícolas Abandonadas en Terrenos del Futuro Eco-Parque del Tanama. Selinette Álvarez Rodríguez

2005 THESIS COMMITEE DIRECTOR: *Implementations of the Oswer Directive to the reuse of the Vega Baja Solid Waste Disposal Superfund Site.* Ramón Torres Ortiz.

2003 T**HESIS COMMITEE DIRECTOR:** *Assessment of the characterization and mitigation of lead paint in historic bridges in Puerto Rico.* Harry Peña Ruiz.

2002 THESIS COMMITEE DIRECTOR. *Microbiology Assessment of Bottled Water at Northwest Puerto Rico Region*. Alexandra Perez.

2001 THESIS COMMITEE MEMBER. *Assessment of Environmental Parameters (noise, temperature) at San Patricio Forest*. Janet Olmeda.

ACADEMIC CURRICULUM DEVELOPMENT

2003 DEVELOPMENT OF PROPOSAL FOR MASTER IN PLANNING IN ENVIRONMENTAL PLANNING PROGRAM. *Approved by CES in September 2005*

2001 **DEVELOPMENT OF PROPOSAL FOR BACHELOR OF SCIENCES IN ENVIROMENTAL HEALTH PROGRAM.** *Approved by CES in September 2002.* Development of Sillabus:

- SOIL QUALITY AND ENVIRONMENTAL HEALTH
- OCCUPATIONAL HEALTH AND SAFETY
- ENVIRONMENTAL ETHICS
- INDUSTRIAL HYGIENE
- HEALTH RISK ASSESSMENT

1999 **DEVELOPMENT OF PROPOSAL FOR MASTER IN ENVIRONMENTAL MANAGEMENT WITH SPECIALITY IN CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES**. *Approved by CES in August 2000*.

1998 **DEVELOPMENT OF PROPOSAL FOR ASSOCIATED DEGREE IN ENVIRONMENTAL QUALITY.** *Approved by CES in October 1999.*

ACADEMIC AND ADVISORY COMMITTEES:

2013 to present: MEMBER OF THE PRESIDENTIAL ADVISORY COMMITTEE. ANA G. MENDEZ UNIVERSITARY SYSTEM

2013-to present: MEMBER OF THE ADMINISTRATIVE COUNCIL. Universidad Metropolitana

January to September 2013: **MEMBER OF THE EXECUTIVE COMMISSION** MSCHE Periodic Review of UMET

March 2010 to May 2012: **CHAIR OF STANDARD 10 COMMITTEE**: **FACULTY FOR THE ACREDITATION OF THE MIDDLE STATE HIGHER EDUCATION.** Universidad Metropolitana

August 2001 to 2012: MEMBER ACADEMIC BOARD, Vice-chancellor for Academic Affairs. Universidad Metropolitana:

- Faculty Assessment Commission: President 2011-2012,
- Academic Programs Commission: Member 2002-03, 2003-04, 2005-06; President 2007.
- Academic Tenure Track Commission, Member 2005
- General Policy for Associate Degrees Commission: President, 2004-05
- Administrative Policies Commission: Member 2005-06

2009-2011: MEMBER OF THE DISCIPLINE COMMITTEE, Office of Student Vice-Chancellor.

2003 to 2004: ADVISORY COMMITTEE: Fellows Enhancing Science and Technology Program, National Science Foundation. School of Environmental Affairs, Universidad Metropolitana

2000-2002: EXPERTS COMIITTE FOR THE REACREDITATION OF MIDDLE STATE ASSOCIATION. Vice-chancellor of Assessment and Development. Universidad Metropolitana.

1998-1999: COMMITTEE FOR DEVELOPMENT OF "PUERTO RICO AND THE SEA". Natural Resources Environment Department (DRNA), San Juan Puerto Rico.

PUBLICATIONS AND PRESENTATIONS

Ortiz, M.C. & Morales. C. (2016). *Puerto Rico Climate Change Teaching Model*. AMS Annual Meeting, New Orleans. [Poster Presentation]

Sanz-Martínez, P., Morales-Agrinzoni, C. M., Quevedo-Bonilla, V., & **Ortíz, M. C**. (2013). Estrategia de manejo para la comunidad de mariposas en el área mitigada en el antiguo cauce de rio Bayamón de la reserva natural Ciénagas Las Cucharillas. *Perspectivas en Asuntos Ambientales*, *2*(1), 82-93.

Ortíz, M. C. (2013). Investigación participativa comunitaria en la ciénaga Las Cucharillas. *Perspectivas en Asuntos Ambientales*, *2*(1), 7-13.

Álvarez-Rodríguez, S., Vélez-Arocho, J., Conde, C., & **Ortiz, M. C**. (2012). Evolución de la estructura y composición forestal de zonas agrícolas abandonadas en terreno del Eco-parque del Tanamá, Utuado. *Perspectivas en Asuntos Ambientales*, *1*(1), 66-86.

Febres, L. M., Puente, A., Ramos, C., **Ortiz, M. C**., & González, E. (2012). Evaluación del cumplimiento de las mitigaciones requeridas por el reglamento de siembra, corte y forestación para Puerto Rico. *Perspectivas en Asuntos Ambientales*, *1*(1), 52-65

Ortiz, M. (December, 2012). Modifiable risk factors linked to adult women with asthma in Puerto Rico. RCMI International Symposium in Health Disparities, Centro de Convenciones, San Juan Puerto Rico [Poster presentation]

Ortiz, M. (September, 2012). Dissemination of knowledge from universities. *Perspectivas en Asuntos Ambientales*, 1, 7-10.

Ortiz M. (December, 2011). *Assessing women participation as environmental journalists in Puerto Rico*. Anfiteater Muñiz Soufront. Research Symposium. Universidad Metropolitana. [Oral Presentation]

Ortiz, M. (March, 2011). *Women journalist participation in Environmental Communication*. Women Forum, Convention Center [Oral presentation]

Ortiz, M. (2009). Environmental educators. *Revista Nuestra Escuela*. Publicaciones Santillana, *2*(7):14-17.

M. Ortiz. (August 2008). The impact of the program PICCA in science teachers. 2nd Conference of Biodiversity, Baños, Ecuador. [Oral presentation]

M. Ortiz. (March 2001). *Role of universities in the development of environmental policy*. 4th International Conference: The Globalization of Education. Asociación Hispana de Universidades. HACU. Hotel Herradura San José Costa Rica.

Ortiz, M., B. Pinto, K. Hall, N. Jiménez, M. Vargas, R. Boulon, E. Williams, C. Diez & A. Mignucci. (2001-02). Assessment of sea turtle stranding and mortality in Puerto Rico and Virgin Islands**.** *Revista Cupey* XV-XVI, 237-246.

Mignucci, A., M. Cardona**, M. Ortiz,** M. Rodríguez & G. López**. (**2001-2002). Marine mammal and Sea Turtle Aerial Survey over Vieques Island. *Revista Cupey* XV-XVI:225-235.

A. Alvarez, E. Carasquillo, **M. Ortiz**, D. Parés, & B. Pinto. **(**1990-1991). Restoration of Nesting Areas for Mona Iguana Island *Cyclura stejnegeri*. Sociedad Herpetológica de Puerto Rico. Report to Department of Environmental and Natural Resources, San Juan, Puerto Rico.

MEDIA AND COMMUNITY SERVICES

May 2014 to present Member of the Board of Directors of Organización Pro Ambiente Sustentable, Flue Blag.

January 2013 to present Member for the Water Resources Committee. DNER, San Juan PR
April 2013 Judge for the Conservation of the Environment Award, For Motor Co.

1998 to present Editor and Journalist of *La Regata* Newspaper. Environmental Media.

2005 to present Co-editor of the Environment- Geography Section for the Puerto Rico Encyclopedia.

Fundación Puertorriqueña de las Humanidades.

April 2005 Miembro Junta examinadora de la Agencia Estatal Aprobadora el Departamento de Educación: *Programa Calidad Ambiental en el Instituto Tecnológico de Puerto Rico Vega Baja.*

January 2003-2004 Juez de proyectos de Feria Científica Regional Arquidiócesis. Colegio Maristas.

January 2003 Member of the Committee in Environmental Education for the Municipality of Caguas.

April to June, 2003 Analysis of Environmental Issues in the *Tu Salud* Newspaper. Monthly Column.

September 2001 Environmental Press. "Cultura del Desecho". *Diálogo* Newspaper.

November 2001 Radio Interview on Environmental affairs. RADIO CATOLICA.

August to October 1999 Environmental Affairs Interviewer. Radio Program "A Juicio". WKBM RADIO.

March to July 1999 Weekly column (*Madre Tierra*) of environmental issues in *El Nuevo Día* Newspaper.

April 1999 Juez de la Feria Científica Región de San Juan.

July 1999 Colaboradora del desarrollo del libro *Puerto Rico and the Sea- 1999.*

PROFESIONAL DEVELOPMENT

May 2015: Climate Diversity Studies. American Meteorological Society, Maryland

December 2014: Academic Congress: The response of the University to the socioeconomic situation of Puerto Rico

March, 2014: La publicación: Retos a nivel internacional, Universidad de Puerto Rico, Río Piedras.

April, 2013: Universidad e Investigación en el contexto de la Unión Europea: Enfoques y Perspectivas. Universidad Metropolitana, San Juan Puerto Rico.

December, 2012: RCMI International Symposium in Health Disparities, Centro de Convenciones, San Juan Puerto Rico

March 2012: Evidence of Compliance: What is the Commission really looking for?, Sheraton Puerto Rico, Hotel y Casino.

May 2011: Retention Retreat: An aspirational model for the first year experience at UMET

April 2011: Ecopedagogy. Land Charter, UMET

April 2011: Assessment for the classroom, Centro de Estudios Graduados Título V

March 2011: Neurosicología, Centro de Estudios Graduados Título V.

March 2011: Quantitative Research Design, Centro de Estudios Graduados Título V

March 201:1 Redacción de Artículos publicables, Centro de Estudios Graduados Título V

August 2008: 2nd Conference of Biodiversity, Wild Spots Foundation, Baños, Ecuador

June 2006: Caribbean Urban Forestry Conference, US Forest Service. Carambola Resort. St. Croix.

March 2006: Primer Foro Nacional "Puerto Rico Hacia el Turismo Sostenible". Compañía de Turismo, San Juan, PR.

March 2006: Land Use Planning for Puerto Rico's Future. ULI Southeast Florida/ Caribbean Puerto Rico Convention Center.

February 2006: How to get published in academia papers. Universidad Metropolitana, San Juan PR.

June 2008 Certificate in Editorial Arts and Edition. Universidad de Puerto Rico (UPR), Río Piedras.

- General Vision of Editorial Arts
- Redaction and Style
- Editorial Skills
- Editorial Practices
- Copy Rights
- Photoshop
- Administration of Editorial Arts

December, 2005: Local Actions for the Global Water Crisis. Hotel Caribe Hilton, San Juan PR.

July, 2005: Innovative Coal Combustion Products Meeting 2005. Environmental Protection Agency.

August, 2004: 3er Seminario Ambiente Urbano para Autoridades de Gestión Ambiental en Ciudades de América Latina y el Caribe. Programa de la Naciones Unidas para el Medio Ambiente. Hotel Caribe Hilton, San Juan PR

Abril, 2004: 6th Annual Meeting of Sustainable Tourism. Habana, Cuba.

August, 25-26, 2003: Congress: Green Infrastructure and Our Parks. Centro para el Estudio del Desarrollo Sustentable. Tropimar Beach Resort & Convention Center.

September 2-6, 2002: Professional Certification: Components of Environmental Planning for Sustainable Development. Professional trip to Curitiba, Brazil.

August 2002: Dimensions of Academic Excellence in Higher Education. Research in the classroom and the impact in the institutional assessment. Hotel Wyndham, San Juan.

February 28 –March 3, 2000: 20th Sea Turtle Biology and Conservation Workshop, Orlando, Florida.

August 9-14, 1999: Professional Certificate in Planning and Management of Ecotourism, (36 hours) Universidad Metropolitana.

May 24-28, 1999: Course of Restoring the urban forest ecosystem, University of Florida, USDA Forest

Service, UPR. San Juan, Puerto Rico

1999: 3er Congress of Recycling in Puerto Rico. ICPRO. Universidad del Turabo, Caguas, Puerto Rico.

September 15- 22, 1997: First International Convention of Development and Environment. Lecturer: The roll of universities in environmental education. Habana, Cuba

1996: 6th Conference on Occupational Health and Safety of Puerto Rico, Department of Labor and Human Resources.

1995; Tropical Rain Forest and Function. CHAUTAUQUA, University of Puerto Rico.

1994; Tropical Marine Ecology, Marine Sciences. CHAUTAUQUA, University of Puerto Rico.

1991: 11th Sea Turtle Biology and Conservation Workshop, Jekyll Island, Georgia

1993: Geology of Puerto Rico. CHAUTAUQUA, University of Puerto Rico.

1990: Traineeship on Marine Mammal and Sea Turtle Health and Husbandry. CST and Fish & Wildlife Service Sirenia Project, Florida Department of Natural Resources Marine Research Institute and Miami Sea Aquarium.

AWARDS, CERTIFICATIONS & CREDENTIALS:

2016: TRAVEL AWARD- Annual Meeting of the American Meteorological Society, New Orleans

2015: TRAVEL AWARD- Climate Studies Course. American Meteorological Society.

2014: CERTIFICATION 1632180. NIH-WEB-BASED TRAINING COURSE: PROTECTING HUMAN RESEARCH PARTICIPANTS. Office of the Extramural Research, National Institute of Health.

2013-2017- CERTIFICATION OF IRB, RCR AND HIPAA, Universidad Metropolitana, San Juan, PR.

2010-2013: CERTIFICATION OF IRB, RCR AND HIPAA, Universidad Metropolitana, San Juan, PR

2007: OUTSTANDING ASSOCIATE AWARD, Universidad Metropolitana, San Juan, PR

2004: ENVIRONMENTAL QUALITY AWARD 2004, US Environmental Protection Agency.

2003: PRESS MEDIA CREDENTIAL, Department of State of the Commonwealth of Puerto Rico