2023

Socio-environmental Factors Related to Prevalence of Childhood Uncontrolled Asthma in Marion County, Indiana

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This is to certify that the doctoral dissertation by

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Walden University
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Abstract

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Dissertation Submitted in Partial Fulfillment

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Public Health

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Abstract

Despite the availability of effective asthma control, the prevalence of uncontrolled asthma continues to increase worldwide, particularly among children. Marion County children experience more uncontrolled asthma than the Indiana state averages. Exposure to socioenvironmental factors may play a pivotal role in childhood uncontrolled asthma; however, there is still limited recent research about this relationship. The purpose of this study was to determine whether there is a relationship between the specific socioenvironmental factors (income, tobacco smoke, indoor mold, household pets, and pests) and the prevalence of childhood uncontrolled asthma in Marion County, IN. This study used secondary data collected between 2018, and 2020 from a previous asthma case management of 164 participants. This study used the ecological system theory model to understand the factors that put children at risk for uncontrolled asthma. Two multiple linear regression analyses were conducted to determine the relationship between these specific factors and asthma emergency department (ED) visits and between these specific factors and asthma control test (ACT) score. In the first regression model, four of the five specific factors including mold, tobacco smoke, pests, and Medicaid were statistically associated with asthma ED visits. In the second regression model, all five specific factors were statistically associated with the ACT score at $P < 0.05$. Only the variable mold was found to be a strong predictor in both regression models. Understanding the underlying factors that lead to prevalence of childhood uncontrolled asthma in Marion County may impact social change by increasing the quality of life of patients with uncontrolled asthma, their families, and the community at large.

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Dedication

I dedicate this dissertation work to my beautiful daughter, Nayla, my husband, Saley Baleida, and many friends who encouraged me and supported me through the difficult moments of my journey.

Acknowledgments

I gratefully acknowledge the support, help, effort, and guidance of my dissertation committee members: Dr. Tolu Andrea Osoba, Dr. Jeanne Connors, and Dr. Chinaro M. Kennedy. My special thanks to my committee chair, Dr. Tolu Andrea Osoba, for your support and educative guidance throughout my journey.

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Chapter 1: Introduction to the Study

Introduction

Asthma is one of the most common public health concerns affecting people of any age worldwide (Dharmage et al., 2019). Its global prevalence is increasing, particularly among children (WHO, 2021). Currently, an estimated 262 million people worldwide have asthma and 461,000 have died from asthma (WHO, 2021). According to Leung (2021), about 11–14 percent of all children have uncontrolled asthma worldwide. Uncontrolled asthma occurs when patients experience frequent and intense episodes of symptoms including coughing, chest tightness, wheezing, and trouble breathing (CDC, 2019). Leung (2021) indicated that childhood uncontrolled asthma is associated with poor quality of life, increased school absences in children and work absences in parents.

The prevalence of childhood uncontrolled asthma has been increasing in developed countries. For example, FitzGerald and Efraij (2018) showed that even in developed countries, asthma deaths are at unacceptable levels and most of all these deaths are preventable. Also, according to the Pharmaceutical Journal (2021), about 5.4 million people in the United Kingdom (UK), including 1.1 million children have asthma, and one in five of them suffer from uncontrolled asthma. Fischer et al. (2019) added that childhood uncontrolled asthma is more prevalent in less affluent countries and among disadvantaged populations of both developing and developed countries.

In the United States, about six (6) million children (1 in 12) ages 0-17 years have been diagnosed with asthma (CDC, 2018), and approximately 38.4 percent of these children have uncontrolled asthma (CDC, 2014). Smith et al. (2019) reported that uncontrolled asthma is the third leading cause of pediatric ER visits and hospitalizations. According to Perez and Coutinho (2021), minority groups and socioeconomically underprivileged populations are disproportionately affected by poorly controlled asthma. In 2019, more than 3,000 Americans died from uncontrolled asthma (Perez & Coutinho, 2021).

In Indiana, a 2019 report indicated that about 10 percent of children, ages 5-17 years were diagnosed with asthma (ISDH, 2019); and over 15,000 children with asthma live in Marion County, Indiana (MCPHD, 2014). In their study, Yuknis et al. (2018) showed that the most common pediatric emergencies in ambulatory settings are due to chronic respiratory diseases. Additionally, the poverty level in Marion County is higher than the Indiana state averages (IU Health, 2018). Milligan et al. (2016) reported that childhood uncontrolled asthma is commonly seen among socioeconomically underprivileged children, often living in inner cities with high levels of poverty. Furthermore, exposures to environmental factors such as cockroaches, rodent, mold, and indoor air pollution are extremely associated to uncontrolled asthma (Milligan et al., 2016).

Although existing studies have shown an association between household environmental factors, income, and uncontrolled asthma in children, there are still some gaps in knowledge. For instance, in their study, Pijnenburg et al. (2015) reported that unfavorable socioeconomic status and psychosocial factors (e. g., experience of stress or trauma) are potential risks of uncontrolled asthma. Still, Pijnenburg et al. (2015) also showed that there is a current lack of literature that supports the possible ways of monitoring these factors during childhood. Additionally, in another study, Teixeira, and Zuberi (2018) showed that children who grew up in poor neighborhoods are more likely to suffer from chronic health conditions such as asthma. Yet, Teixeira and Zuberi (2018) added that there remained a gap in the research on how specific environmental exposures in poor neighborhoods affect asthma. This current study can help to better understand the underlying factors that lead to poorly controlled asthma in children and develop effective interventions and guidelines for effective asthma control. This is also critical to improve asthma care management, decrease health care costs, and improve the quality of life of patients with asthma, their families, and the community at large.

The following are the major sections of this chapter 1. First, I provide the background information about the prevalence of childhood uncontrolled asthma in the United States and Marion County, Indiana. Next, I provide the problem statement including the research gap, the research problem. I then explain the purpose of this research followed by research questions and hypotheses. I explain the theoretical framework and the nature of the research. I provide definitions of keywords and phrases that I use frequently in this paper. I also describe the assumptions, scope and delimitations, limitations, and significance sections of the research. I close chapter 1 with a summary section.

Background

There is concern that the prevalence of childhood uncontrolled asthma is still higher despite effective asthma control strategies. Kansen et al. (2020) reported that several factors linked to childhood uncontrolled asthma have been previously described such as parental education level, income, exposure to secondhand smoking, household pets, pests, indoor mold, and poor adherence to treatment. Understanding the current prevalence of childhood uncontrolled asthma and the associated underlying factors is needed to better achieve adequate asthma control in children with uncontrolled asthma (Kansen et al., 2020).

In the United States, in 2017, three (3) million asthma exacerbations were registered among children aged 0-17-year-old, leading to 626,923 ER visits and 75,905 hospitalizations (Leung, 2021). Childhood uncontrolled asthma causes significant health and economic burden to families and society, since it is associated with increased use of ER visits, hospitalizations, and school absenteeism (CDC, 2014). According to Leung (2021), in the United States, uncontrolled asthma expenses cause significant economic burdens including 10 million missed school days, and $726.1 million parental missed workdays.

The prevalence of children with uncontrolled asthma is higher in Marion County than the Indiana state averages. According to a 2017 report, the rates for asthma hospitalizations for Marion County were higher than the Indiana state averages (ISDH, 2017). Additionally, the Ambulatory Care Sensitive Conditions (ACSC) rates for asthma in younger populations were 30 % higher for Marion County than the Indiana averages (IU Health, 2021). Based on the 2018 community health needs assessment, Marion County ranked the least favorable (92 out of 92 counties) counties in the state of Indiana in reference to overall health outcomes (IU Health, 2018). The total population for Marion County is 977,203 as of 2020. According to the 2021 census bureau, Marion

County is composed of the five largest ethnic groups. These include 1) White (Non-Hispanic) 63.5%; 2) Black or African American (Non-Hispanic) 29.1%; 3) Hispanic or Latino 10.9%; 4) Asian (Non- Hispanic) 3.8%; and 5) two or more races 3 % (Unites States Census Bureau, 2021).

In addition, data showed that the poverty level of children living in Marion County is higher (30 %) than the Indiana state and national averages (IU Health, 2018). Studies have shown that uncontrolled asthma has been widely associated with poverty. For instance, in their study, Teixeira and Zuberi (2018) showed that growing up in poor neighborhood increases the risk of developing chronic health conditions such as asthma in part because of multiple negative environmental exposures. Another study found that low-income people, poor minorities, and children living in poor neighborhoods, suffer a disproportionately higher morbidity and mortality rate because of uncontrolled asthma (Nunes et al., 2017).

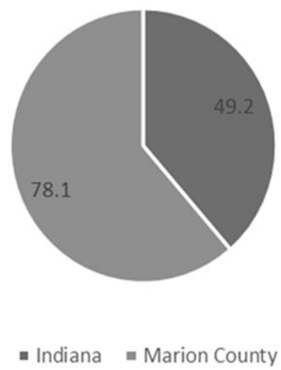
Furthermore, in their study, Leynaert et al. (2019) showed that exposure to environmental factors, combined with lifestyle factors (such as psychological stress, cigarette smoking) are likely to explain such a rapid increase of asthma prevalence since the early 1970s. Moreover, Urquhart and Clarke (2020) reported that the high prevalence of uncontrolled asthma and the disparity in asthma related emergency room visits among minority children illustrate the need for further research in understanding the mechanisms causing the continuing existence of these health discrepancies.

Problem Statement

Asthma continues to be a public health problem. According to a 2019 report, 10.0% or approximately 506,500 of Indiana populations are currently affected by asthma (ISDH, 2019). Additionally, during 2017, an estimated 27,166 emergency room (ER) visits were reported with a principal diagnosis of asthma, and nearly 28.4 % of asthma ER visits were for children (0–17 years) (ISDH, 2019). Graph 1 below shows that uncontrolled asthma related ER visits is higher (78.1 per 10,000 residents) in Marion County compared with the state averages (49.2 per 10,000 residents) (ISDH, 2017). Furthermore, asthma hospitalization rates for Marion County children under age 17 were 56% higher than the Healthy People 2020 objective (MCPHD, 2014). The growing number of hospitalizations for asthma may indicate an increase in poor disease control and/or the consequence of poverty (Serebrisky & Wiznia, 2019). According to the Indiana State Department of Health (ISDH) (n.d.) about one (1) in ten (10) Indiana children aged 0-17 currently have asthma. Whereas in Marion County, one (1) in five (5) children currently have asthma, twofold as greater as in the State (Rudavsky, 2014).

Figure 1

Uncontrolled Asthma Related ER Visit per 10,000 Residents 2017 (ISDH, 2017)



Research Gap

Although previous studies have investigated childhood uncontrolled asthma in Indiana, there is a lack or limited recent research about the relationship between socio-environmental factors and the prevalence of childhood uncontrolled asthma in Indiana and particularly in Marion County. Krupp et al. (2018) conducted research on Indiana children with uncontrolled asthma from 2000 through 2014. However, their study focused on outcomes and cost-effectiveness of a pediatric High-Risk Asthma clinic. Also, Maue et al. (2019) conducted research on childhood uncontrolled asthma in Indiana. Yet, their research focused on implementing Respiratory Therapist-Driven continuous Albuterol to lower the duration of treatment without increasing the side effects. In another study, Krupp et al. (2017) performed research on childhood uncontrolled asthma in Indiana. Still, their work focused on establishing a multifaceted quality improvement project with the goal of lowering the 30-day inpatient asthma readmission rate.

Additionally, the majority of studies related to socio-environmental factors and the prevalence of childhood uncontrolled asthma has been done in different geographic areas or different communities and the results can only be applied to a very narrow population or in a very specific situation. For instance, Kinghorn et al. (2019) examined socioeconomic and environmental risk factors for childhood asthma development in an American Indian Community. In another study, Dharmage and others (2019) studied epidemiology of asthma in both children and adults, whereas my study focuses only on children aged 0-17. Lowe et al. (2018) also conducted a study to determine the environmental factors that may contribute to increased asthma prevalence and severity among Navajo children living on the reservation.

Furthermore, there is still a controversial debate about the relationship between childhood uncontrolled asthma and socioenvironmental factors (including income, tobacco smoke, indoor mold, household pets, and pests). Various studies found an association between socioenvironmental factors and prevalence of childhood uncontrolled asthma (Ali et al., 2021; Dharmage et al., 2019; Pijnenburg et al., 2015). Whereas other studies found limited or no association between these specific factors and uncontrolled asthma in children (Teixeira & Zuberi, 2018; Pijnenburg et al., 2015; Dick et al., 2014).

Research Problem

The specific research problem I need to address through this study is to determine whether there is a relationship between socio-environmental factors and prevalence of uncontrolled asthma in children (0–17-year-old) residing in Marion County, Indiana.

Examples of socio-environmental factors include income (social), and indoor mold, tobacco smoke, pests, and household pets (environmental). As discussed above this relationship has not been recently investigated in Indiana and Marion County.

Purpose of the Study

The purpose of this study is to determine whether there is an association between socio-environmental factors and prevalence of uncontrolled asthma in children (0–17-year-old) residing in Marion County, Indiana. The dependent variable for this study is the prevalence of uncontrolled asthma in children residing in Marion County Indiana. Uncontrolled asthma can be measured by using the number of asthma emergency room (ER) visits, hospitalization (CDC, 2019), and Asthma Control Test (ACT) score (GSK Pharmaceutical, 2017). The Independent (predictor) variables include specific factors such as income, indoor mold, environmental tobacco smoke, pests, and household pets. Children's age, gender, race, and ethnicity represent the covariates for this study.

Research Questions and Hypotheses

Research Question 1: Is there an association between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 2: Is there an association between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 3: Is there an association between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 4: Is there an association between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 5: Is there an association between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Null Hypothesis (H0): There is no statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Variables

Independent Variables

1. Income: is measured by using Medicaid status: 1 = Yes   0 = No
2. Environmental tobacco smoke: 1 = Yes   0 = No
3. Indoor mold: 1 = Yes   0 = No
4. Household pets: 1 = Yes   0 = No
5. Pests: 1 = Yes   0 = No

Dependent Variables

The dependent variable is the prevalence of uncontrolled asthma in children residing in Marion County Indiana. It is measured by two dependent variables, the number of asthma ER visits within the last 3 months and the Asthma Control Test (ACT) score.

1. Number of asthma ER visits within the last three (3) months
2. ACT Score

Covariates

To address potential confounding factors, covariates in this study include age, gender, race, and ethnicity.

1. Age
2. Gender
3. Race/Ethnicity

Theoretical Framework

The theoretical base of this study is the ecological systems theory (EST), developed by Urie Bronfenbrenner in the 1970s (Härkönen, 2007). This theory focuses on the development of a child within his/her surrounding environment. There are various aspects in the development of a child's life that interact with and impact the child. Urie Bronfenbrenner divided the child's environment into five different levels. 1) Microsystem represents the child's direct environment (e. g., child's immediate family, neighborhood, and school); 2) Mesosystem represents the connections between family, neighborhood, and school; 3) Exosystem represents the child's indirect environment (e. g., economic system, government agency); 4) Macrosystem represents the social and cultural values, beliefs); and 5) Chronosystem represents changes overtime in child's life (Raymond et al., 2021). The EST was later revised by Bronfenbrenner (1994), and instead was named the "Bioecological model".

The EST takes into consideration the complex interplay between child, relationship, community, and societal factors, each influencing a child's development (CDC, 2021). Studies have shown that unfavorable socioeconomic conditions and psychosocial factors may increase the risk of uncontrolled asthma (Pijnenburg et al., 2015). Additionally, Wright et al. (2008) suggested that the social, political, and economic forces that result in marginalization of certain populations in disadvantaged neighborhoods and communities may increase exposure to the known environmental risk factors to asthma.

EST has been widely used in health and psychology research, particularly in the research of child's development. This theory can explain how human development is affected by multiple types of environmental systems (Ettekal & Mahoney, 2017). The Centers for Disease Control and Prevention (CDC) provide valuable information about the use of EST model in prevention efforts for any health or disease concerns (Leung, 2021). For instance, in violence prevention research, CDC used EST model to better understand the factors that put the individual at risk of violence and the impact of possible prevention strategies (CDC, 2021). In addition, Cramer, and Kapusta (2017) reported that EST has been significantly applied to a range of health issues and prevention programs such as health literacy and vaccine usage.

Parents and guardians of children with uncontrolled asthma may not be aware of the impacts of socioenvironmental factors on their children's health conditions. The EST constructs may therefore provide an understanding of how the child's development can be influenced by his or her surrounding environment (Ettekal & Mahoney, 2017). Therefore, this current study intends to explore the relationship between the specific socioenvironmental factors and prevalence of childhood uncontrolled asthma in Marion County, Indiana.

Nature of the Study

This is a quantitative study with a cross-sectional research design approach using secondary data from previous asthma case management of children with poorly controlled asthma living in Marion County, Indiana. This research design allows researchers to evaluate theories and make a valid conclusion regarding relationships among independent and dependent variables. To determine the relationship between independent variables (predictors) and dependent variables, a multiple regression analysis will be integrated. Using multiple regression analysis could allow us to determine how well multiple independent variables predict the value of a dependent variable.

Definitions of Keywords and Phrases

Uncontrolled Asthma: is characterized by frequent and intense episodes of symptoms including coughing, chest tightness, wheezing, and trouble breathing (CDC, 2019).

Childhood Uncontrolled Asthma represents a heterogeneous group and a clinical and therapeutic challenge that requires a multidisciplinary assessment (Licari et al., 2018).

Prevalence of Childhood Uncontrolled Asthma: The total number of cases of uncontrolled asthma existing in children (0–17-year-old) at a specified point in time (CDC, 2012). The prevalence of childhood uncontrolled asthma represents the dependent variable for this study and is being measured by using the number of asthma ER visits within the last 3 months, and Asthma Control Test (ACT) score.

Number of asthma ER visits: three or more (≥ 3) asthma ER visits /year or one or more (≥ 1) asthma ER visits in the last three months are considered for uncontrolled asthma (AL-Jahdali et al., 2012).

Asthma Control Test (ACT): A patient self-administered tool for identifying those with uncontrolled asthma. The scores range from 5 to 25 with higher scores reflecting greater asthma control. An ACT score of 19 or below represents uncontrolled asthma (Soler et al., 2018).

Socioeconomic Factors: social standing or class of an individual or group. They include employment, education, and income (APA, 2019).

Income: annual household income, measured by using the child's Medicaid Status:

1 = Yes (child has Medicaid because parent's income is low).

0 = No (child does not have Medicaid because parent's income is high).

Medicaid: federal and state program dedicated to providing health coverage to people with low-income (CDC, n. d.).

Environmental Factors: represent external influences that can affect an individual's health and wellbeing. They affect large groups that share common living or working spaces (Woolf & Aron, 2013).

Environmental tobacco smoke (ETS) or exposure to secondhand smoke is an exposure to smoke from burning tobacco products, such as cigarettes, cigars, or pipes (CDC, 2021a).

Indoor mold: organisms called fungi or mildew that produce allergens and irritants (EPA, 2021a). As molds grow indoors, the potential human health effects are a concern.

Household Pets or domestic pets: animals that are kept by a household either inside or outside and may be raised for domestic purposes. Dogs and cats represent the most popular household pets in the United States (Jacobson and Chang, 2018)

Pests: such as cockroaches, mice, rats, and bed bugs are unwanted invaders that could make living in a home uncomfortable, and even dangerous. Pests can cause health problems such as asthma and allergies among others (EPA, 2021b).

Lifestyle factors: modifiable habits and behaviors of life that can significantly influence an individual's overall health and well-being (Sharma et al., 2013).

Asthma Exacerbations: Episodes of progressive increase in shortness of breath, cough, wheezing, or chest tightness requiring an urgent treatment to prevent a serious outcome (Fuhlbrigge, 2012).

Asthma Case Management: Collaborative process of working with clients, families, health care providers, and other health and human service professionals toward the goal of meeting clients and families' comprehensive health needs (CMSA, 2016). The asthma case management activities at Marion County Public Health Department include the following:

- Coordinate and monitor activities with Indoor Air Quality, Environmental Health Specialist, and Community Based Care to ensure comprehensive care to clients.
- Conduct home environmental assessment to identify possible triggers.
- Provide interventions including education, referrals, and tool kit items.
- Follow up to determine application of interventions, barriers, additional needs, and progress toward control.

Assumptions

This research uses secondary data to answer the research questions described above. The research questions for this study involve data on specific factors such as income, environmental tobacco smoke, household pets (dogs, cats), indoor mold, and pests (cockroaches and /or mice). This research intends to use secondary data from a previous asthma case management of children aged 0–17-year-old from a local public health department. Therefore, this research makes the following assumptions. First, this research assumes that the primary data was collected using valid instruments (the Environmental Protection Agency [EPA] Asthma Home Environment Checklist form and the Asthma Control Test form) and by adhering to ethical and quality standards required by the Marion County Public Health Department policies.

Second, the asthma case management program receives uncontrolled asthma referrals from the primary care providers. This implies that those children with uncontrolled asthma are being seen by health care providers on a regular basis and continue to have asthma exacerbations. According to Stridsman et al. (2021), if adherence to asthma treatment is confirmed, and the patient still has poor asthma control, taking more action to improve treatment should be considered. Therefore, I assume that childhood uncontrolled asthma is not only related to non-compliance with treatment and to prescription costs, but also to other factors such as income, environmental tobacco smoke, indoor mold, pests, and household pets.

Scope and Delimitations

This study intends to use secondary data collected between January 2018 and December 2020 from a previous asthma case management of children with uncontrolled asthma in Marion County, Indiana. Data was collected using Asthma Home Environment Checklist (EPA, 2013) and the Asthma Control Test (ACT) form (GSK Pharmaceutical, 2017). In addition, there are three different ACT forms used by the asthma case management program to collect data. These include the ACT form (0–5-year-old), ACT form (4–11-year-old) and ACT form (12-year-old and older).

The study participants are children (0–17-year-old) with uncontrolled asthma residing in Marion County, Indiana from January 2018 to December 2020. The asthma case management program enrolled only children between the age of 0 to 17 years with uncontrolled asthma and whose parents agreed to participate in the program. The asthma case management program receives referrals from health care providers, particularly from pediatric high risk asthma clinics. Asthma case management activities help pediatric patients and their parents or guardians to proactively control asthma through comprehensive interventions. According to Burke et al. (2016), when implementing effectively, asthma case management can help pediatric patients make significant improvements in health, including reduced ER visits and unnecessary hospitalizations.

Furthermore, the current literature used in this study was mainly published within the last 5 years. A publication date between 2016 and 2021 was ideal, but I include older literature due to limited recent data. Also, I use recent reports and data from federal, state, and local agencies. These included the Centers for Disease Control and Prevention (CDC), Environment Protection Agency (EPA), Indiana Department of Health (IDOH), and Marion County Public Health Department (MCPHD).

Limitations of the Study

This is a study to determine whether there is an association between the specific socioenvironmental factors and prevalence of uncontrolled asthma in children between the ages of 0 and 17 years. Thus, the findings and interpretation of the result of this study may not apply to the adult population. Also, this study is designed as a cross sectional research design; therefore, sampling bias due to some people within a target population are more likely to be selected for inclusion than others. For instance, children with well controlled asthma are not included in the asthma case management program. Besides, this study is limited to children living in Marion County Indiana which may limit the generalizability of the results.

Significance of the Study

The findings of this research may indicate where to focus efforts to build healthier environments and communities to bring down asthma rates and deaths. The findings of this study can also help understanding the role of income and specific environmental factors on uncontrolled asthma in Marion County, Indiana. This study also might bring the following positive social changes:1) improve asthma control strategies including environmental trigger reduction, effective clinical practice guidelines, and asthma education for children, parents, and others involved in asthma care (CDC, 2018); 2) strengthen policies and procedures that ameliorate conditions and encourage health parity among minority and underserved populations is key to improve health and lower medical care expenses; 3) increase patients, and parents or guardians' awareness that asthma can be prevented and controlled rather that treating acute asthma symptoms; and 4) work in partnership with communities can have influence to lower unnecessary loss of life and improve the quality of life for patients with asthma and their families.

Summary

The prevalence of childhood uncontrolled asthma is a growing and challenging concern in developed countries. Uncontrolled asthma occurs when patients experience frequent and intense episodes of symptom flare-ups (CDC, 2019) that result in ER visits and hospitalizations. In the United States, nearly 38.4% children (0–17-year-old) suffer from uncontrolled asthma (CDC, 2014). In Indiana, in 2017, approximately 27,166 ER asthma visits were reported, and about 28.4 % of asthma ER visits were for children (0–17 years) (ISDH, 2019). Uncontrolled asthma related ER visits is higher in Marion County Indiana (78.1 per 10,000 residents) compared to the state average (49.2 per 10,000 residents) (ISDH, 2017). In addition to decreasing the patients' quality of life, uncontrolled asthma also results in considerable direct and indirect expenses to families and community. These include medical bills, missed school days in children, and missed workdays in parents (Nunes et al., 2017).

Although existing studies have investigated childhood uncontrolled asthma in Indiana, there is a limited or lack of recent studies regarding the relationship between childhood uncontrolled asthma and socioenvironmental factors in Indiana and particularly in Marion County, Indiana. This present study focuses on the specific socioenvironmental factors and their relationships with uncontrolled asthma in children ages 0-17 years. Exploring the relationship between these underlying factors and uncontrolled asthma in children is necessary to lower the burden of uncontrolled asthma on children, their families, and society at large.

In this Chapter 1, I provide an introduction in which I discuss the burden of uncontrolled asthma in children in the United States, Indiana, and Marion County Indiana. In Chapter 1, I also explain the background of the study, problem statement, research gap, research problem, the purpose of the study and the research questions and hypotheses including variables and covariates sections. Additionally, I discuss the theoretical base of this study, which is the Ecological Systems Theory (EST) (Härkönen, 2007). Furthermore, I provide the nature of the study, which discussed the type of design and research method along with the analytical approach. This is followed by a section that provided definitions of important keywords and phrases used throughout this paper. Chapter 1 ends with sections that describe assumptions, scope and delimitations, limitations, and significance of this study and its implications for positive social change.

In Chapter 2, I introduce the literature review including the literature search strategy. This section is followed by a description of a comprehensive foundation of the theoretical framework of this study. I also highlight the review of the literature section, which supports the research topic by identifying the existing gap.

Chapter 2: Literature Review

Introduction

Children with uncontrolled asthma are at greater risk for morbidity. According to Chipps et al. (2018), childhood uncontrolled asthma is a significant cause of adverse effects and morbidity, including increased asthma exacerbations, ER visits, and hospitalizations, which increase the health care expenditures. Along with breathing problems, uncontrolled asthma can lower the quality of life and impact multiple aspects of a child's life such as sleeping, daily activities, distress, and depression (Larsson et al., 2020). Also, if not treated early and well, childhood uncontrolled asthma can progressively lead to permanent lung damage (Mirra et al., 2018). In the United States, about 38.4% children ages 0-17 years have uncontrolled asthma (CDC, 2014). In Indiana, the Department of Health reported that one (1) in ten (10) children ages 0-17 years has asthma, and about 55 % of them have uncontrolled asthma (IU School of Medicine, 2013). Marion County has higher rates of childhood uncontrolled asthma compared with the state averages (ISDH, 2017).

Uncontrolled asthma has been widely associated with poverty. For instance, in their study, Pate et al. (2021) proved that discrepancies in asthma indicators still exist through poverty levels, and geographic settings. Also, Pollock et al. (2017) reported that children especially from minority and poor communities suffer from uncontrolled asthma. In another study, Xie et al. (2020) showed that there is a higher prevalence, morbidity, and mortality of uncontrolled asthma among ethnic minority children in the United States.

In Marion County, more than 30 percent of children live in poverty, a rate higher than the state and national averages (Indiana University Hospital, 2018). According to Bellin et al. (2017), socioeconomic factors (SEF) such as income, have a significant negative impact on the prevalence of uncontrolled asthma. Matsui et al. (2016) reported that exposures to indoor allergens, such as cockroaches, mice, dust mites, and household pets, significantly contributed to childhood uncontrolled asthma. Teixeira and Zuberi (2018) also showed that children living in poor neighborhoods along with multiple negative environmental exposures (such as secondhand smoking, indoor mold, cockroaches, and household pets) are more likely to develop chronic health conditions such as asthma. Still, Teixeira and Zuberi (2018) added that there remained a gap in the research on how specific environmental exposures in poor neighborhoods lead to asthma development and exacerbations.

Despite, previous studies have investigated childhood uncontrolled asthma (Kinghorn et al. 2019; Krupp, et al., 2017; Maue et al., 2019; Pijnenburg et al., 2015), there is still limited recent research about the relationship between socioenvironmental factors and prevalence of childhood uncontrolled asthma in Indiana and particularly in Marion County. For example, recent studies conducted in Indiana on childhood uncontrolled asthma have not investigated this relationship (Maue et al., 2019; Krupp et al., 2018; Krupp, et al., 2017). Additionally, most of studies related to socio-environmental factors and prevalence of childhood uncontrolled asthma have been done in different geographic areas or different communities and the results can only be applied to a very narrow population or in specific situation (Kinghorn et al., 2019; Dharmage et al., 2019; Lowe et al., 2018). Furthermore, there is still a disagreement about the relationship between socioenvironmental factors (including income, tobacco smoke, indoor mold, household pets, and pests) and childhood uncontrolled asthma. Various studies suggested that there is an association between these specific factors and prevalence of uncontrolled asthma in children (Ali et al., 2021; Dharmage et al., 2019; Kinghorn et al., 2019; Milligan et al., 2016; Pijnenburg et al., 2015). Whereas other studies found limited or no association about this relationship (Lowe et al., 2019; Dharmage et al., 2019; Teixeira & Zuberi, 2018; Pijnenburg et al., 2015; Dick et al., 2014).

This gap in the literature supported the purpose in this research, to investigate the relationship between socio-environmental factors (such as income, environmental tobacco smoke, indoor mold, household pets, and pests) and prevalence of childhood uncontrolled asthma in Marion County, Indiana. In doing so, further knowledge could be added to previous literature. This study can improve understanding of these underlying factors that lead to uncontrolled asthma in children. This study can also help increase parents or guardians' awareness about the relationship between these socioenvironmental factors and uncontrolled asthma in children.

In this chapter 2, I first discuss the origin and constructs of the Ecological Systems Theory (EST), its validity, and the raison of using the EST model as theoretical background for this study. Then I synthesize study findings and reports about what is known; what is controversial; and what remained to explore about the relationship between social factors (e.g., income) and childhood uncontrolled asthma. Next, I provide study findings and reports about what is known about the relationship between environmental factors (including tobacco smoke, indoor mold, household pets, and pests) and childhood uncontrolled asthma successively; what is controversial; and what remained to investigate. This chapter 2 ends with sections that describe a review of method, and summary and transitions to the following chapter.

Literature Search Strategy

Database Search and Keywords

The databases searched include Science Citation Index; Science Direct; MEDLINE; PubMed; PLOS ONE; CINAHL Plus as well as Thoreau multidata base search accessed through the Walden University Library. I also use Google Scholar to access some of the cited articles. Keywords and phrases used to identify these articles included "*uncontrolled asthma* AND *child*", "*socioeconomic factors* AND *uncontrolled* AND *asthma*", "e*nvironment* OR *socio* AND *uncontrolled* AND *asthma",* "*indoor environment* AND *childhood* AND *uncontrolled",* "*Prevalence of childhood asthma* AND *income",* "*Socioenvironmental* AND *uncontrolled* AND *asthma*", "*child* OR *pediatric* AND *asthma*", "*ecological systems theory* AND *uncontrolled asthma*", "*ecological systems theory* AND *child* AND *asthma*". I use several combinations of these keywords and phrases using "AND" and "OR" as connectors.

Scope of Literature Review

The articles I use for this review were recent peer-reviewed articles, published between the years 2016 and 2021, on social factors, indoor environmental factors, and uncontrolled asthma in children. Still, I also use recent reports and information from federal, state, and local agencies. These include the Centers for Disease Control and Prevention (CDC), Environment Protection Agency (EPA), Indiana Department of Health (IDOH), and Marion County Public Health Department (MCPHD). A publication date between 2016 and 2021 is ideal, but I include older literature due to limited recent data.

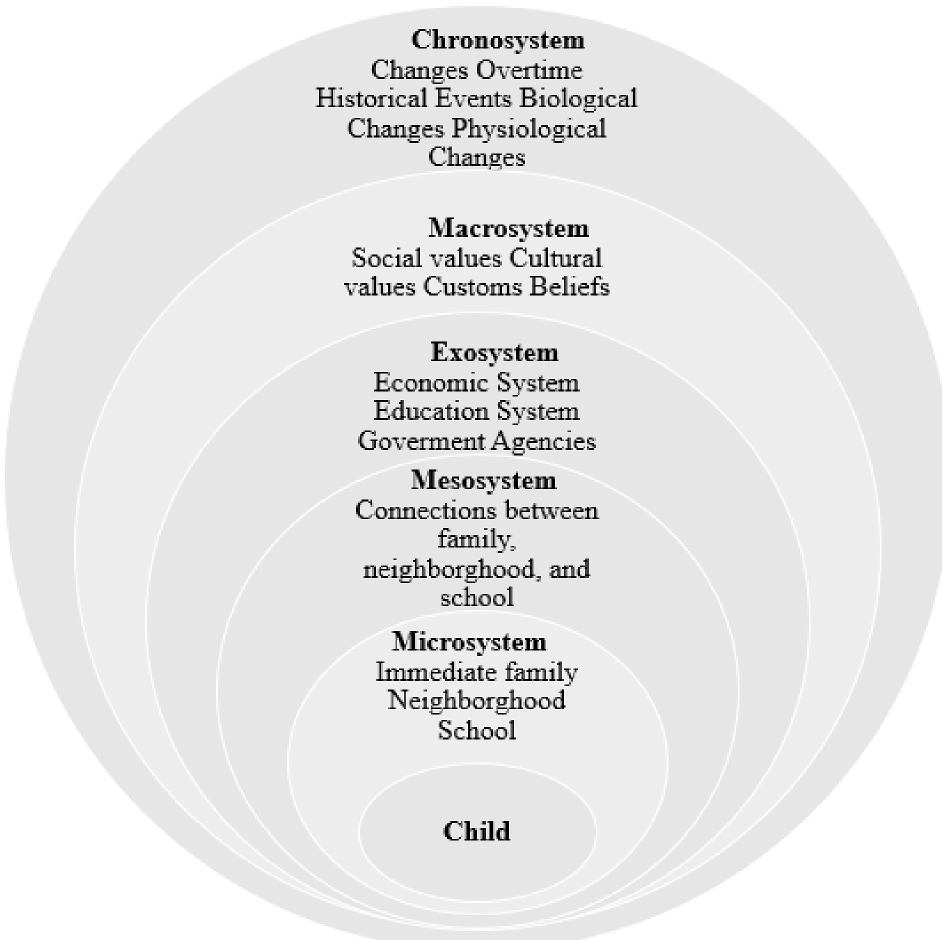
Theoretical Foundation

Origin and Constructs of the Ecological Systems Theory

This research applies a theoretical model grounded by the ecological systems theory (EST) to explore the relationship between socioenvironmental factors and prevalence of childhood uncontrolled asthma in Marion County, Indiana. EST was developed in 1979 by Urie Bronfenbrenner, who believed that a developing child's life is influenced by everything around his environment (Härkönen, 2007). Applying EST model in this study can help better understand the relationship between income, household environmental factors (including environmental tobacco smoke, indoor mold, household pets, and pests), and prevalence of childhood uncontrolled asthma. According to CDC (2021b), EST model focuses on the nature of individuals' connections with their physical and sociocultural environments. The five ecological systems include the microsystem (child's direct environment), mesosystem (child's connections), exosystem (child's indirect environment), macrosystem (social and cultural values), and chronosystem (changes over time) (Härkönen, 2007).

Figure 2

Ecological Systems Theory



Note: Adapted from Walker, T. (2016). Ecological Systems Theory

Validity of Ecological Systems Theory

The validity of the ecological systems theory (EST) has been assessed in many reviews (Burns et al., 2015; Eriksson et al., 2018; Campbell et al., 2010; Tzeng & Gau, 2012). In addition, EST model focuses on a scientific approach emphasizing the interrelationship of different processes and their contextual variation (Darling, 2007). For example, one major thrust of the EST model was on the understanding of genetic influences on development. Furthermore, a study by Weinstein et al. (2019) showed that EST was an effective and well validated model for understanding the relationship between parent, child, and environmental factors in the transmission of asthma risk. Moreover, Okamoto et al. (2006) demonstrated that EST approach takes into consideration sociocultural prevention interventions, by supporting the social and ecological validity of those interventions.

Use of Ecological Systems Theory

The EST model has been widely used in previous studies for childhood asthma and poorly controlled asthma in children (Creese et al, 2021; Tzeng & Gau, 2012; Jeong & Arriaga, 2009). In addition to an increasing use of EST model, empirical evidence supported how the theory describes and explains a child's development (Soyer, 2019). Furthermore, according to Okamoto et al. (2006), multiple social sciences (such as public health, education, sociology, and psychology) successfully applied EST in health promotion interventions.

Rational of Using Ecological Systems Theory

The concepts in EST model allow for identification and exploration of relevant variables that contribute to uncontrolled asthma in children. This theory assumes that the child's development is impacted by multiple levels of the surrounding environment, from direct environment of family and school to large cultural values, laws, and customs. Using a five-level EST model (**Figure 2)** can help better understand the relationship between socioenvironmental factors and prevalence of childhood uncontrolled asthma and the effect of prevention approaches. EST displays the multilevel factors that affect the development of a child's life.

First, the microsystem level may involve interactions between a child, his direct family, neighborhood, and school (Walker, 2016). Assorted studies have shown that children living in low-income neighborhoods have higher prevalence of poorly controlled asthma with increasing ER visits and hospitalization rates (Kuti et al., 2017; Milton et al., 2004). Dharmage et al. (2019) reported that multiple adverse environmental exposures (such as air pollution, pollens, mold, and other allergens) greatly contributed to poorly controlled asthma. In this study, the specific factors to be addressed at the microsystem for a child with uncontrolled asthma include parents' income status, environmental tobacco smoke, indoor mold, household pets and pests. The existence of these factors in the child's microsystem may increase ER asthma visits and hospitalization rates, which are significantly associated to childhood uncontrolled asthma (Smith et al., 2019).

Second, the mesosystem level of EST represents the linkages between the child's different microsystems (family, school, and neighborhood) (Walker, 2016). This level shows how parents' asthma knowledge and support may affect a child's asthma. For instance, a child's parents and health care provider may interact regarding the child's poorly controlled asthma status and identify effective strategies for asthma control (Horner & Brown, 2015). Still, parents may also be responsible for environmental triggers (such as secondhand smoke, household pets) that can exacerbate child's asthma symptoms (Jeong & Arriaga, 2009). According to Indiana University Hospital (2018), smoking rates in Indiana and Marion County are comparatively high, including among pregnant women and lower-income neighborhoods. In addition, in 2016, nearly 22.2 % of Indiana children ages 0-17 are exposed to environmental tobacco smoke (America's Health Rankings, 2021).

Third, the exosystem level involves external environmental settings (such as parent's workplace, government agency) that may indirectly affect the child. According to Jeong and Arriaga (2009), social factors indirectly associated to the child are components of the exosystem. For instance, if parents have adequate social economy, this may have a positive effect on the child's health (Tzeng & Gau, 2012). On the contrary, if parents have low-income status, that may have negative effects on the child's health. According to Bellin et al. (2017), social factors such as income have a significant effect on the prevalence of childhood uncontrolled asthma. The exosystem may also reflect government agency's involvement such as EPA regulations to help reduce air pollution in poor neighborhoods and build a healthier environment. That may have a positive impact on the child's health.

Fourth, the macrosystem level involves many factors such as social and cultural values. These things can also affect a child either positively or negatively. This level may depict parental knowledge and beliefs about the relationship between socioenvironmental factors and childhood uncontrolled asthma. Therefore, asthma control may be profoundly impacted by cultural beliefs (Tzeng & Gau, 2012).

The last EST level is the chronosystem, which involves implications of long-term asthma management since asthma is a chronic disease (Jeong & Arriaga, 2009). Asthma symptoms are better controlled after children and their parents or guardians invest greater effort in understanding asthma control procedures. Using this framework for children with uncontrolled asthma is useful because each level interacts with the others and highlights the importance of evaluating children in multiple environments. This can help understanding the relationship between socioenvironmental factors and childhood uncontrolled asthma.

The key reason for applying the EST model to answer my research questions is that framework can help find influencing factors of childhood uncontrolled asthma and recommend potential interventions for effective asthma control. Understanding the factors that may increase the prevalence of childhood uncontrolled asthma is critical to developing effective prevention strategies. Similarly, Nuss et al. (2016) used the EST model to explore the factors that impact asthma outcomes for students with uncontrolled asthma and found the model very useful as it provided a comprehensive approach for asthma control and prevention. Glanz et al. (2015) also reported that EST model is useful in research that explores different levels of influence on health behaviors, at community, environmental, and policy levels. This is critical in understanding the range of factors that put individuals at risk of poorly controlled asthma.

Social Factors and Childhood Uncontrolled Asthma

Income

Findings from previous literature have shown that socially underprivileged children with uncontrolled asthma have higher asthma morbidity (Kopel et al., 2014). However, significant inconsistencies in asthma control status have been reported among children with different socioeconomic status (SES) (Harris et al., 2014). In their study, Zhang, and Xiang (2019) showed that people with high income status usually have better health related quality of life which has been well supported in previous studies. Lenhart (2019) study findings showed a significant positive relationship between family income and health status of children ages 0-16 years in the United States. Also, Harris et al. (2014) reported that children from lower SES have poorer asthma control compared with children from higher SES.

In their study, Pacheco et al. (2014) reported that low-income families live in poor quality housings that can harbor indoor allergens and triggers. Sullivan, and Thakur (2020) also reported that lower socioeconomic status is linked with increased ER asthma visits and hospitalizations in developed countries such as Canada, England, and United States. Similarly, in the United States, Kopel et al. (2014) have indicated clearly that asthmatic children living in disadvantaged neighborhoods and the inner cities have elevated rates of ER asthma visits and hospitalizations. In another study, Kozyrskyj et al. (2010) showed that chronic exposure to a low-income environment from early life was linked to asthma development and exacerbations. Hollenback et al. (2017) reported that people of low income and people of color are disproportionately experiencing higher rates of persistent health conditions including prevalence of poor controlled asthma. Also, Louisias and Phipatanakul (2017) demonstrated that black race and low-income housings are risk factors for prevalent poor controlled asthma linked with increased ER asthma visits and hospitalizations.

Furthermore, Nunes et al. (2017) showed that low-income populations, poor minorities, and children living in poor neighborhoods suffer a disproportionately elevated morbidity and mortality due to asthma. Similarly, Diep et al. (2019) reported that underprivileged, and minority children with asthma experience more exacerbation of symptoms, more frequent ER visits and hospitalizations, more activity restriction, and more school absences. According to Perez and Coutinho (2021), perceived discrimination in asthma is associated with more frequent asthma-related ER visits in children of minority populations. Oland et al. (2017) showed that increased stress, such as family conflict, violence, low-income housing, and dangerous neighborhoods are associated with uncontrolled asthma in children living in low-income households. Although considerable studies showed an association between low-income status and prevalence of uncontrolled asthma in children, other studies showed contrary results.

Unlike studies that demonstrated an association between low-income populations and prevalence of childhood uncontrolled asthma; Kant (2013) found no significant impact of socioeconomic status in childhood on the prevalence of asthma. Kant (2013) also added that the higher prevalence of asthma was found in developed than in developing countries, and in low income compared to high income population in developed countries indicated differences in lifestyles. Similarly, in their study, Nunes et al. (2017) found that asthma prevalence was higher in children with high income families and that asthma severity was higher among the most disadvantaged. Furthermore, Kozyrskyj et al. (2010) found the association between SES and childhood uncontrolled asthma less strong and in fact, contradictory.

In another study, Jabre et al. (2020) reported that the impacts of poverty on the underlying factors of uncontrolled asthma among low-income children with asthma is not well understood. Similarly, Pijnenburg et al. (2015) reported that although adverse socioeconomic conditions may increase the risk of poorly controlled asthma, there is a current lack of literature that supports the possible ways of monitoring these factors during childhood. Cruz et al. (2010) also indicated that the impact of poverty on childhood asthma exacerbations is not fully understood and deserves further research. With the ongoing controversial debate about the relationship between social factors such as income and prevalence of childhood uncontrolled asthma, further investigation is needed to explore this relationship.

Environmental Factors and Childhood Uncontrolled Asthma

Environmental Tobacco Smoke

Tobacco use is among the most significant community health needs in Marion County and across Indiana (Indiana University Hospital, 2018). According to the Indiana State Epidemiological Outcomes Workgroup (2016), smoking rates in Marion County and Indiana are comparatively higher (30.8%) than the national median rates (24.6%). In addition, in 2016, nearly 22.2 % of Indiana children ages 0-17 are exposed to environmental tobacco smoke (America's Health Rankings, 2021). Exposure to environmental tobacco smoke has been reported to increase asthma exacerbations and poorly controlled asthma in children (Neophytou et al., 2018). According to Sheehan, and Phipatanakul (2015), even passive secondhand smoke leads to increased asthma exacerbations and decreased response to treatment.

In their study, Jassal et al. (2021) reported that up to 70% of low-income children with asthma are exposed to tobacco smoke exposure, and one in six children are exposed to in-home smoke. In another study, Tower et al. (2019) showed that indoor cigarette smoke exposures contributed to persistent high levels of prevalence of childhood uncontrolled asthma in low-income families. Similarly, Burbank et al. (2018) also suggested that environmental tobacco smoke is linked to frequent asthma symptoms, decreased response to treatment, increased asthma exacerbations, and increased ER asthma visits and hospitalizations. In another study, Hollenback et al. (2017) reported that exposures to secondhand smoking (SHS) may increase exacerbation of symptoms in children with asthma. According to Neophytou et al. (2019), secondhand smoke exposure is risky at any level. For instance, maternal smoking during pregnancy is a risk factor related to asthma development and exacerbations in children. Ali et al. (2021) added that environmental factors including prenatal exposures, air pollutants, and tobacco smoke exposures play a pivotal role in childhood asthma development and exacerbations.

Unlike other studies that demonstrated a clear link between environmental tobacco smoke and prevalence of uncontrolled asthma in children; Milanzi et al. (2017) found no association between secondhand smoking exposure and increased risk of asthma exacerbations in children at ages 4 to 17 years. Similarly, Hollams et al. (2014) reported that although maternal smoking during pregnancy is a known risk factor for asthma in children, the exact mechanisms through which it affects asthma are not clearly understood. Also, Milanzi et al. (2017) reported that previous studies have investigated the association of pre and postnatal tobacco smoking exposure on childhood asthma but found some inconsistencies in the results. Therefore, more research could explore the relationship between environmental tobacco smoke and prevalence of uncontrolled asthma in children.

Indoor Mold

Previous scientific studies have linked mold to worsening asthma symptoms. Indoor mold has been reported to increase the development and exacerbations of asthma in children (Xiao et al., 2021). In their article, Byeon et al. (2017) found a strong association between indoor mold allergens and increased exacerbation of asthma symptoms. In addition, Byeon et al. (2017) added that indoor mold allergen represents a risk factor for life-threatening conditions. Similarly, Caillaud et al. (2018) found that visible mold and mold odor were strongly associated with the development and exacerbations of asthma symptoms in children. In another study, Larsson et al. (2011) found an association between indoor moldy odor and asthma exacerbations in children. Similarly, Simões et al. (2012) found some evidence that asthmatic children exposed to certain indoor molds were at increased risk of asthma exacerbations. Furthermore, Dharmage et al. (2019) found that environmental factors such as pollens, indoor mold, and other aeroallergens increasingly contributed to asthma exacerbations.

On the other hand, EPA (2021a) reported that mold is usually not a problem indoors, unless mold spores begin growing on a damp spot. Similarly, in their research, Hardin et al. (2003) did not support the suggestion that inhaled mycotoxins (produced by indoor molds) in home adversely affected human health. In another study, Dick et al. (2014) reported a limited or insufficient evidence of an association between molds and uncontrolled asthma. In addition, EPA (2016) showed that the role of both outdoor and indoor mold in adverse health effects is not always clear and still controversial. Although, the relationship between indoor mold exposures and uncontrolled asthma in children has been reported in several studies, still there are no consistent reports on this aspect in the literature (Simões et al., 2012). Therefore, more research is needed to explore the relationship between indoor mold and prevalence of childhood uncontrolled asthma.

Household Pets (Cats and/or Dogs)

There is a controversial debate about the relationship between household pets (cats or dogs) exposure and childhood asthma development and exacerbations. It was commonly believed that household pet exposure increases the risk of childhood asthma development and exacerbations. However, studies have shown contradictory results illustrating both increased risks, and decreased risk of household pet exposure on asthma development and exacerbations (Stokholm et al., 2017).

On the one hand, Luo et al. (2018) found that having pets (dogs or cats) in the home was clearly associated with development and exacerbations of asthma in children. Similarly, Gergen, et al. (2018) also reported that higher exposure to dog and cat allergens among asthmatic patients is linked to increased asthma exacerbations. In another study, Butt et al. (2012) found that household pet allergens may increase morbidity, particularly in asthmatic patients, by causing and exacerbating asthma symptoms. In their article, Bornehag et al. (2003) also reported that the greater number of various types of pets in the home environment, the greater risk for children to develop asthma and asthma exacerbations.

On the other hand, Medjo et al. (2013) found no association between keeping pets (dogs or cats) in the home and increased risk of asthma development and exacerbations in children. Similarly, Lødrup Carlsen et al. (2012) demonstrated that household pets (such as dogs or cats) did not seem to either increase or decrease the risk of increasing asthma symptoms in children. In another study, Lodge et al. (2012) reported that exposure to cats or dogs in children's early life decreased the risk of developing respiratory problems including allergic rhinitis and asthma. Similarly, Wegienka et al. (2010) indicated that children exposed to indoor pets in early life had lower risk of asthma development and exacerbations. Additionally, in their study, Dick et al. (2014) showed a limited or insufficient evidence of an association between dog allergens and uncontrolled asthma. Therefore, further research is needed to explore the relationship between household pets and prevalence of childhood uncontrolled asthma.

Pests (Cockroaches and/or Mice)

Exposure to cockroaches and/or mice is common in the inner cities, specifically in low-income neighborhoods. In their study, Milligan et al. (2016) showed that with the greater time spent in the home (more than 90 %), indoor exposures (such as cockroaches, mice, and air pollution) may play a critical role in childhood uncontrolled asthma in urban areas. Similarly, Kinghorn et al. (2019) also demonstrated that poor living conditions, along with housing pest infestations (with mice and cockroaches) may aggravate asthma symptoms in children. In another study, Grant et al. (2017) reported that indoor allergens such as cockroach and mouse allergens are greatly associated with uncontrolled asthma among low-income, inner cities children and adolescents.

Furthermore, findings from previous literature showed that indoor allergens (including rodents, cockroaches, and pet allergens) exposure increases the risk of asthma development and exacerbations in children (Butz et al., 2019; Naja et al., 2018).

Cockroach infestation and exposure has been reported as a major contributor to asthma morbidity in children with asthma (Werthmann et al., 2021). Do et al. (2016) showed that cockroach allergens have a greater impact on asthma morbidity. Similarly, Pomés et al. (2017) also reported significant association between cockroach allergens and high morbidity and exacerbations of disease among asthmatic patients, particularly children, living in poor neighborhoods. In a recent study, Rabito et al. (2021) found low-income families to be 12 times as likely to have high cockroach allergy compared to families with high income. Rabito et al. (2017) also added that cockroach exposures lead to asthma exacerbations, mostly in children with asthma living in disadvantaged neighborhoods.

Mouse infestation is frequent in many low-income, poor neighborhoods in the United States, and has been linked to poor asthma control in children with asthma (Wurth et al., 2017). In their study, Sheehan, and Phipatanakul (2015) found a significant association between mouse allergens, and uncontrolled asthma more than cockroach allergens among inner-city children. Similarly, Matsui (2013) showed that rodent allergens have been found predominantly in poor housings and have been greatly associated with asthma morbidity among children with asthma.

On the other hand, according to Dharmage et al. (2019), while some significant environmental factors (such as cockroaches, mice, and other allergens) that trigger asthma are well documented, further research is needed to define the role of environmental exposures in the development of asthma in both children and adults. Similarly, Ahluwalia et al. (2013) argued that although previous studies showed cockroach and mouse allergens as major contributors of asthma morbidity in inner city children, it is still not clearly understood whether both allergens are clinically significant in specific inner-city communities. Furthermore, Do et al. (2016) reported that although cockroach exposure is an important risk factor for the development and exacerbations of asthma, the underlying mechanisms are still unclear. Similarly, Kanchongkittiphon et al. (2015) reported less consistent findings between exposure to cockroach allergens and asthma exacerbation in children. Therefore, further research on distinguishing pest (such as cockroach and mouse) allergen and exploring the mechanisms through which it affects asthma will add value to the existing literature investment.

Summary and Transitions

In chapter two, I review the literature about specific factors related to the prevalence of childhood uncontrolled asthma. The aim and importance of the literature review is to gain an understanding of current literature and identify possible gaps in the literature for further research. I use database search to identify articles. After identifying articles, I summarize the review in two main categories. First, social factors (income) and childhood uncontrolled asthma. Second, environmental factors (including tobacco smoke, indoor mold, household pets, and pests) and childhood uncontrolled asthma.

Using the data search strategy, I identify various articles surrounding uncontrolled asthma in children and socioenvironmental factors. However, within the articles identified, most of the studies have been done in different geographic areas or different communities and the results can only be applied to a very narrow population or in specific situations. Additionally, there were lot of inconsistencies in the outcomes, which resulted in conflicting information about the relationship between childhood uncontrolled asthma and socioenvironmental factors.

Although previous studies have investigated the relationship between socioenvironmental factors, and uncontrolled asthma in children; there is a lack or limited recent research in this area in Indiana and particularly in Marion County. In addition, Teixeira, and Zuberi (2018) reported that there remained a gap in the research on how specific environmental exposures in poor neighborhoods affect asthma. Furthermore, Silverwood et al. (2019) reported that some risk factors for asthma have not previously been studied together in the same analysis, therefore, some of the observed relationships may be somewhat due to confounding by other risk factors. Therefore, further research in this area is useful to offer novel insights into the relationship between socioenvironmental factors and childhood uncontrolled asthma.

Chapter 3 includes the following sections: introduction, the research design and rationale, the study populations, the sampling criteria, methods for data collection, the instrument used, the statistical analysis approach, the ethical factors, the limitations of the study and the summary. Overall, chapter 3 describes the important techniques for conducting the study.

Chapter 3: Research Method

Introduction

The aim of this study is to explore the impact of socio-environmental factors on the prevalence of uncontrolled asthma in children (0–17-year-old) residing in Marion County, Indiana. Research design represents a plan or method of study that explains the nature of the study and shows the connection between the research questions and the design (Jongbo, 2014). The method section addresses important information such as the study populations, methods for data collection, the data source, the sampling criteria, and the data analysis approach. It provides enough information about the research process and why the research is relevant. Abutabenjeh & Jaradat (2018) added that a research methodology explains the steps researchers may employ to collect and analyze data. Therefore, in this chapter I describe the research design, the methodology, including the study participants, the data sources, data collection, the sampling method used, the rationale of using sampling method, the variables, and the data analysis plan. I also describe threats to validity and ethical considerations of the study.

Research Design

The research design for this study is quantitative, cross-sectional research to explore the relationship between socioenvironmental factors and prevalence of childhood uncontrolled asthma in Marion County, Indiana. The selected design is appropriate for the study because it allows researchers to investigate the relationships between risk factors, determinants, and outcomes (such as diseases) within a defined population (Zangirolami-Raimundo et al., 2018; Kesmodel, 2018). This design also helps researchers to evaluate theories and make better decisions about relationships between independent and dependent variables (Bartram, 2021).

Previous studies showed that cross sectional design is the most common used to explore information about the relationship between certain factors and childhood uncontrolled asthma (Al-sheyab & Alomari, 2020; Pollock et al., 2017; Xie et al., 2020; Al-Zahrani et al., 2015; Sullivan & Thakur, 2020). Moreover, cross-sectional design has been applied to evaluate the gap in knowledge in asthma management among health care providers and patients with asthma as well (Dahmash, 2021; Braido et al., 2013).

The dataset for this study is extracted from records of asthma case management program that focused on the impacts of socioenvironmental factors on childhood uncontrolled asthma in Marion County Indiana. This study intends to use a secondary analysis method to case management records of children with uncontrolled asthma in Marion County between January 2018 and December 2020. The dependent variable for this study is the prevalence of uncontrolled asthma in children residing in Marion County Indiana. The dependent variable is measured by using the number of asthma emergency room (ER) visits within the last 3 months (≥ 1 asthma ER visit in the last three months) and Asthma Control Test (ACT) score.

The independent variables for this study are classified as social factors (income) and environmental factors (including environmental tobacco smoke, indoor mold, household pets, and pests). The covariates for this study include age, gender, race, and ethnicity. According to Groenwold et al. (2011), these covariates are also known as potential confounding variables for the outcome variable.

Research Questions/Hypotheses

The aim of this study is therefore to find the most value answers to the following research questions and to refute the corresponding null hypotheses:

Research Question 1: Is there an association between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 2: Is there an association between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 3: Is there an association between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 4: Is there an association between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.?

Null Hypothesis (H0): There is no statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 5: Is there an association between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Null Hypothesis (H0): There is no statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Methodology

Study Participants

The participants for this study include children with uncontrolled asthma living in Marion County, Indiana and who were enrolled in the asthma case management program under regular pediatric care. For this study, 164 participants between the ages of 0 and 17 years are considered for analysis. The rationale for using this population is that children between the age of 0-17 are commonly reported to have poorly controlled asthma (ISDH, 2019; MCPHD, 2014). Additionally, the Ambulatory Care Sensitive Conditions (ACSC) rates for asthma in younger populations were 30 percent higher for Marion County than the Indiana averages (IU Health, 2021). The exclusion criteria include children with well controlled asthma [ACT score > 19] (Banjari et al., 2018); children ages 18 and older;

children not residing in Marion County Indiana; and children who were not included in the asthma case management program.

Sampling Methods

This study intends to use a convenient sampling method with the following eligibility criteria: (1) children with uncontrolled asthma who were diagnosed by a pediatric pneumologist; (2) children of age 17 or younger; (3) children under the case management program at the local health department; 4) children who were living in Marion County, Indiana; and (5) children who were under regular pediatric care.

The Rationale of the Sampling Method

The asthma case management program uses a convenience sampling method to recruit children with uncontrolled asthma who frequently visited the ER because of their asthma. The reason for using convenient sampling in this study is that this model works appropriately in circumstances where data are collected from individuals in easily accessible settings such as in homes, and clinics. Previous studies successfully used convenience sampling methods in children with poorly controlled asthma and increased ER visits and hospitalization rates (Bellin et al., 2017; Banjari et al., 2018; Molis et al., 2006).

Power Analysis

The calculation or justification of sample size is one of the major steps in designing a study protocol (Pourhoseingholi et al., 2013; Kadam & Bhalerao, 2010). An a-priori power analysis can be applied to calculate the average sample size needed for a study. According to Kang (2021), using the G*Power software can help estimate the sample size and power for various statistical procedures including F, t, and $\chi2$ tests. To evaluate the relationship between socio-environmental factors (e. g., income, tobacco smoke, indoor mold, household pets, and pests) and prevalence of childhood uncontrolled asthma, multiple regression analysis will be conducted to answer the research questions.

Using the G*Power 3.1.9.4., I selected F-tests as the test family and linear multiple regression: fixed model, R2 increase as the statistical test. Conventionally, a power of 0.8 (80%) and α of 0.05 are commonly used (Das et al., 2016). Generally, a minimum power of 0.80 (80 %) is required for a study. In this study, with 5 independent or predictor variables, a minimum sample size of 70 participants for a small effect size of 0.2 and significance level (α) of 0.05, is desired to achieve a power of 80%. Similarly, in their study, Cilluffo et al. (2022) indicated that with a small effect size of 0.2 and α of 0.05, a sample size of 103 participants was needed to get a statistical power of 80%.

Data Collection

The data collection instruments used by the asthma case management program include the U.S. Environmental Protection Agency [EPA] Asthma Home Environment Checklist (EPA, 2013), and the Asthma Control Test (ACT) form (GSK Pharmaceutical, 2017). The home environmental checklist form includes questions to identify possible asthma triggers such as pests (cockroaches and rodents), combustion sources, mold, dust mites, warm-blooded pets, and secondhand smoking. Previous studies found the home environmental checklist questionnaire as a comprehensive assessment tool (Turcotte et al., 2020; Shani et al., 2015; Turcotte et al., 2014).

Asthma control test (ACT) is a validated instrument used by both the patient and health care provider to evaluate general asthma symptoms. It classifies the patient as having well controlled asthma [with ACT score > 19] or uncontrolled asthma [with a score ≤ 19] (Banjari et al., 2018). ACT has been extensively applied in childhood uncontrolled asthma research and was clinically validated against other measurements such as spirometry and specialist assessment (van Dijk et al., 2020; Turcotte et al., 2020). In addition, the National Institutes of Health (NIH) acknowledged the use of ACT since its 2007 guidelines for the diagnostic and management of asthma. ACT also provides patients with asthma and their health care providers with a valuable measure to help determine effective strategies for asthma control (van Dijk et al., 2020; Turcotte et al., 2020; Banjari et al., 2018). Furthermore, the asthma case management program uses three different ACT forms based on the patients' age. These include the ACT form (0–5-year-old), ACT form (4–11-year-old) and ACT form (12-year-old and older).

Data Sources

Secondary data, collected by Marion County Public Health Department, Indiana, were used in this study. The data for this study consisted of records of previous asthma case management of children with uncontrolled asthma collected in Marion County, Indiana, between January 1st, 2018, and December 31st, 2020. The original dataset for this study has been collected on children with poorly controlled asthma including their home environment during an initial home assessment in Marion County, Indiana. The initial asthma home assessment was scheduled after the asthma case management program received asthma referrals from health care providers. Most of these referrals came from pediatric high risk asthma clinics. The asthma case management program also received asthma self-referrals during community events such as health fairs, and school events. According to Cheng and Phillips (2014), the secondary analysis of existing data has increasingly become a widespread method of improving the effectiveness of health research organizations.

Variables

This study intends to use three types of variables including dependent, independent and covariates. The dependent variable is "the prevalence of uncontrolled asthma in children living in Marion County, Indiana" which is measured by using the number of asthma ED visits within the last three months and asthma control test (ACT) score (Table 1). The independent or predictor variables are classified into two categories, social factors (Table 2), and environmental factors (Table 3). All independent variables are selected based on their substantial relationship with childhood uncontrolled asthma reported in previous studies. All independent variables (including income, environmental tobacco smoke, indoor mold, household pets, and pests) are explored to evaluate their relationship on the following dependent variables: number of asthma ED visits within the last three months, and asthma control test (ACT) score. The independent variable, social factors represent the parent or guardian's income, which is measured by using the participant's Medicaid Status: 1 = Yes   0 = No. Table 4 below shows the selected covariates including the participant's age, gender, race, and ethnicity.

Table 1

Dependent Variables

Variable	Data type	Home Assessment Questions	Data Value
ER Asthma visits	ratio	How many times did you take the child to ER in the last 3 months	number
ACT score	ratio	See ACT forms (questionnaire)	score

Table 2

Independent Variable for Social Factors

Variable	Data type	Home Assessment Questions	Data Values
Income	Nominal	Does the child have Medicaid	Yes /No

Table 3

Independent Variables for Environmental Factors

Variable	Data type	Home Assessment Questions	Data Values
Tobacco Smoke	Nominal	Does anyone smoke in the house or car?	Yes /No
Indoor Mold	Nominal	Do you see or smell mold or mildew?	Yes / No
Household Pets	Nominal	Do you have any warm-blooded pets (cats, dogs)	Yes / No
Pets	Nominal	Is there evidence of cockroaches and or rodents?	Yes / No

Table 4

Covariates

Variable	Data type	Home Assessment Questions	Data Values
Age	Ratio	What is the child's date of birth?	years
Gender	Nominal	Is the child a girl or a boy?	Girl/Boy
Ethnicity	Nominal	Is the child Hispanic or Latino?	Yes / No
Race	Nominal	What is the child's race?	White African American Asian Indian American Indian Alaskan Native Other race

Data Analysis

Using SPSS Version: 28.0.1.0 (142), data analysis was performed to determine the relationship between specific socio-environmental factors (including income, environmental tobacco smoke, indoor mold, household pets, and pests) and childhood uncontrolled asthma, measured by ED visits and ACT score, while controlling for age, gender, race, and ethnicity.

According to Alexopoulos (2010), the goal in any data analysis is to extract from raw information the accurate estimation. To ensure that incomplete and duplicate records are eliminated, the dataset was cleaned before the analysis. Additionally, multiple imputation using SPSS was applied to deal with missing data (de Goeij et al., 2013). Five comprehensible research questions were answered in this study.

Research Question 1: Is there an association between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 2: Is there an association between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 3: Is there an association between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 4: Is there an association between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County Indiana, even after controlling for covariates.?

Null Hypothesis (H0): There is no statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County Indiana, even after controlling for covariates.

Research Question 5: is there an association between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County Indiana, even after controlling for covariates.

Null Hypothesis (H0): There is no statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County Indiana, even after controlling for covariates.

Statistical Analysis

Descriptive analyses were performed first to document the characteristics of children with uncontrolled asthma. These include the mean, median, mode, and standard deviation (SD) of children's characteristics. Next, prior to conducting Multiple Linear Regression (MLR) analyses, correlation analyses were performed to determine the relationship between each of the following independent variables including income, environmental tobacco smoke (ETS), indoor mold, household pets, and pests and the dependent variable, prevalence of childhood uncontrolled asthma, measured by ED-V and ACT score. Additionally, backward stepwise regression analyses were also performed to determine the best predictors for the study outcomes. Then, MLR analyses were performed to identify whether the likelihood of prevalence of uncontrolled asthma in children living in Marion County was influenced by specific factors such as income, environmental tobacco smoke, indoor mold, household pets, and pests. MLR is appropriate for dependent variables that are continuous (e.g., number of asthma ER visits within three months and score of ACTs) and the independent variables that are categorical (Ali & Younas, 2021). MLR is commonly performed to predict the value of a variable based on the value of two or more other variables (Frankfort-Nachmias et al., 2020).

To perform each type of statistical test, several measures should be taken to ensure assumptions were met. According to Uyanık, and Güler (2013), assumptions of multilinear regression analysis including normality, linearity, no extreme values, and missing value analysis should be examined. For instance, between the outcome variable and the independent variables, there must be a linear relationship. According to Moore et al. (2013), scatterplots can demonstrate whether the relationship between the outcome variable and the independent variables is linear or curvilinear.

Threats to Validity

The validity is the extent to which the outcomes of a research are expected to be true without any bias (Khorsan & Crawford, 2014). In quantitative research, validity is a concept that is often used to discuss the reliability of measurements. It describes how well an instrument does what it is intended to do (Andrade, 2018). A good research study should be strong in both internal and external validity. Both internal and external validity are concepts that indicate whether or not the research findings are reliable and meaningful (Patino & Ferreira, 2018). Internal validity explores whether the way a study was performed generates trustworthy answers to the research questions in the study (Andrade, 2018). Also, internal validity of a study is a process to ensure modifications or changes in the dependent variable are due to the independent variable, not other confounding variables. Whereas, external validity concerned the generalization of the study, whether the same outcomes of a particular study can be observed in other situations (Khorsan & Crawford, 2014).

Internal validity can be compromised by several factors such confounding, measurement error, information bias, and selection of the study participants (Patino, & Ferreira, 2018; Tripepi et al., 2010). This study uses validated instruments or measurements including asthma control test (ACT) and U.S. home environmental checklist questionnaire. This study also uses the inclusion and exclusion criteria to select its participants. According to Khorsan and Crawford (2014), the selection criteria play a fundamental role in minimizing confounding variables (internal validity). To determine strong internal validity, investigators need to reduce confounding variables which are unfavorable variables that affect the relationship between independent and dependent variables (Kaya, 2015).

External validity can be impacted by several threats that can affect researchers' confidence in generalizing the study outcomes. These include populations, settings, and times (Khorsan & Crawford, 2014; Steckler & McLeroy, 2008). Since one of the primary objectives of studies that implement quantitative research designs is to generalize to populations and settings; one major threat is the selection bias which can result during participants' selection (Khorsan & Crawford, 2014). In this study, the sampling method was not randomly selected and therefore, less representative.

Ethical Factors

All researchers are bound by ethical rules. This research involves children who may be particularly vulnerable and necessitates special considerations in the design and conduct of the research. One important consideration is the type of parental consent processes that should be used in research with children (Crane & Broome, 2017). In addition, the sociocultural background of the study participants should be considered in assuring confidence that all components of informed consent are met (Kadam, 2017).

This study uses secondary data from a previous asthma case management of children with uncontrolled asthma. All study participants' information is protected in an encrypted electronic file and requires a password to get access. Secondary data vary in terms of the extent of identifying information in it. According to Tripathy (2013), if the data contains identifying information on participants or information that could be linked to identify participants, a complete review of the proposal will be made by the board. The original dataset that contains records of children with uncontrolled asthma covers the following information: children’s full name, date of birth, gender, race, ethnicity, address, county of residence, parent or guardian’s full name and phone number. These identifiers are protected under the health insurance portability and accountability act (HIPAA) to ensure that patient medical records and other identifiable health information are kept private and secure (Moore & Frye, 2019).

In this study, careful precautions were considered to protect children and parents' privacy and avoid causing harm to children. The following steps to reduce the risk of ethical issues include: first, obtaining Institutional Review Board (IRB) approval from both Walden University and Marion County Public Health Department (MCPHD). Second, removing identifying information in the study dataset such as children’s full name, date of birth, address, parent, or guardians' names and contact information. Therefore, de-identification can reduce the privacy risk associated with collecting, or handling information (Garfinkel, 2015). In this study, however, participants age, gender, race, and ethnicity were used thoughtfully because they were important to answer the research questions.

Summary

This chapter discusses the research design, the methodology including study participants and sampling method, data sources, data collection, variables, data analysis plan as well as threats to validity and ethical considerations of the study. This study intends to use secondary data collected from a previous asthma case management of children with uncontrolled asthma residing in Marion County, Indiana. The data were collected between January 1st, 2018, and December 31st, 2020. The sampling method criteria and description of data collection considered were used by the asthma case management program in Marion County, Indiana.

The dependent variable is the prevalence of uncontrolled asthma, measured by asthma ED visits and ACT score, in children residing in Marion County, Indiana. The independent variables of this study are the specific socio-environmental factors including income, environmental tobacco smoke, indoor mold, household pets, and pests. Multiple linear regression analysis will be conducted to analyze the data.

In terms of ethical consideration, such as obtaining parental consent and respecting children's confidentiality, this study will obtain Institutional Review Board (IRB) approval from both Walden University and the Marion County Public Health Department (MCPHD). Overall, this chapter discussed the methods to answer the five research questions. In the next chapter, I will discuss the study results.

Chapter 4: Results

Introduction

This study intended to explore the relationship between socio-environmental factors and prevalence of childhood uncontrolled asthma in Marion County, Indiana. The prevalence of childhood uncontrolled asthma was measured by using the number of asthma emergency department (ED) visits in the last three months and Asthma Control Test (ACT) score. The social factor that was explored consisted of the child's parent or guardian's income, which was measured by using the child's Medicaid status. The environmental factors that were assessed in this study included exposure to environmental tobacco smoke (ETS), indoor mold, household pets, and pests.

This study answered the following comprehensible research questions:

Research Question 1: Is there an association between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between income and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 2: Is there an association between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between environmental tobacco smoke and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 3: Is there an association between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between indoor mold and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 4: Is there an association between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between household pets and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

Research Question 5: Is there an association between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates?

Null Hypothesis (H0): There is no statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana.

Alternative Hypothesis (HA): There is a statistically significant relationship between pests and prevalence of uncontrolled asthma, measured by ED visits and ACT score, in children residing in Marion County, Indiana, even after controlling for covariates.

To answer these questions, I analyzed Marion County Public Health Department Data from a previous asthma case management record collected between January 1st, 2018, and December 31st, 2020. In this chapter, I first reviewed the purpose of the study, research questions, and hypotheses. I then explained the data collection process. Finally, I described the results of the study using tables and graphs to summarize the results of these statistical methods.

Data Collection

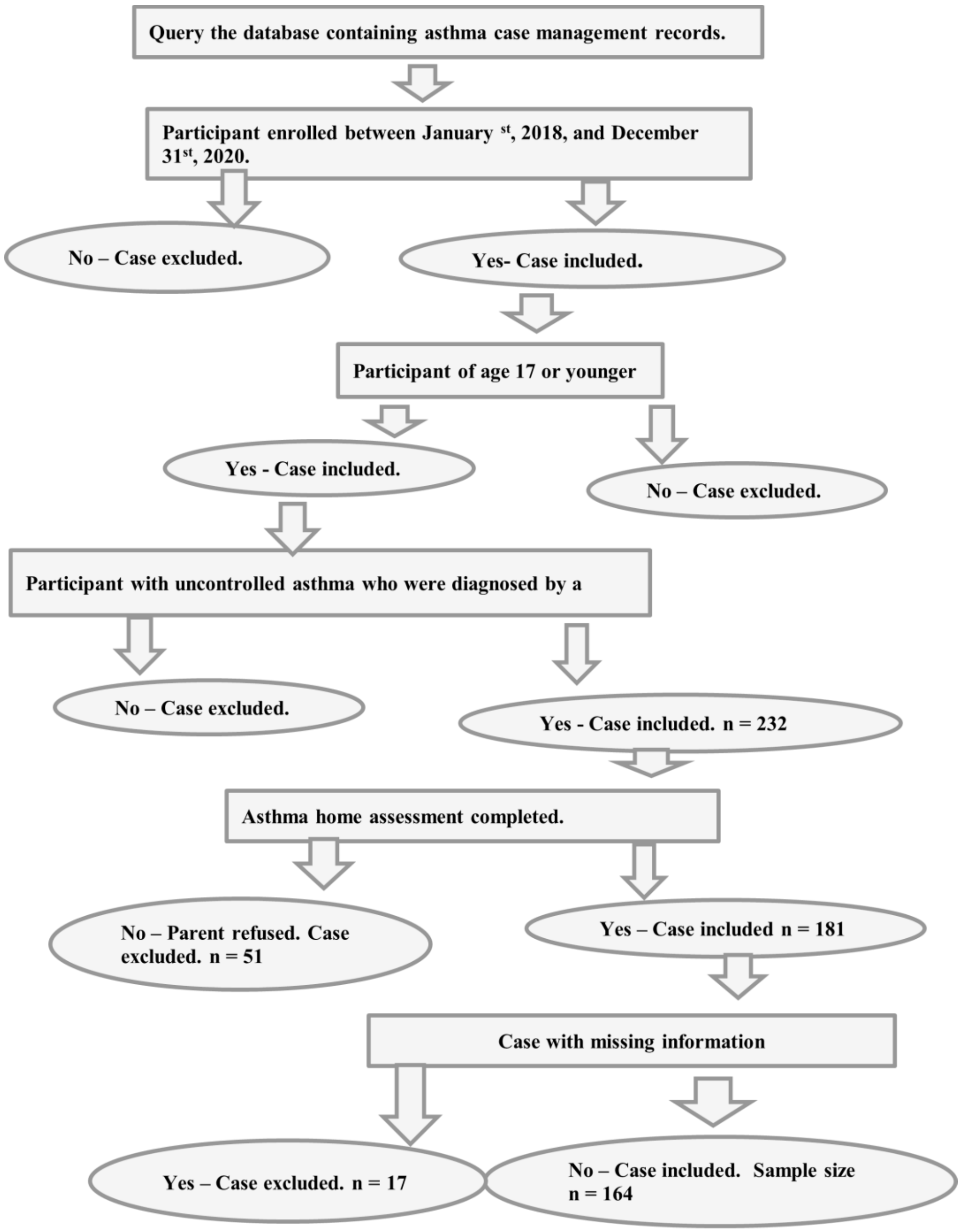
Prior to collecting and analyzing data, this study received approval from Walden University's Institutional Review Board (IRB). After the IRB approval, data from previous childhood asthma case management collected between January 1st, 2018, and December 31, 2020, were obtained from the Marion County Public Health Department. Datasets for 2 years included all eligible children enrolled in the asthma case management program in Marion County, IN.

Data Extraction and Inclusion / Selection

The method used to retrieve the data in this study is shown in **Figure 3** below. A case was excluded if any of the following was not met: 1) child's case was opened between January 1st, 2018, and December 31st, 2020; 2) child with uncontrolled asthma, diagnosed by a pediatric pneumologist; 3) child of age 17 or younger; 4) child received full asthma case management services; and 5) case file with no missing information. After excluding children that did not meet the inclusion criterion, 164 records remained viable for this research.

Figure 3

Flowchart of the Inclusion-Exclusion Process



Study Results

Descriptive Statistics

Table 5 below provides the characteristics of the study participants with the prevalence of uncontrolled asthma. Age, gender, and race/ethnicity of the participants were recorded as covariates. As shown in Table 5, the continuous covariate age was summarized using descriptive statistics including the minimum, maximum, mean age, and standard deviation. The minimum age of participants in this study was one (1) year-old and the maximum age was 17-year-old. The mean age of participants in our study was 8.1 years, with a standard deviation of 4.080 years. The gender has two groups, including Female and Male and the majority were girls (55.5%). The race has four groups including African American or Black, Asian, Hispanic, or Latino, and White groups. The Categorical and nominal study variables (e.g., race, and gender) were described using frequency distributions, including totals and percentages. The diversity among the study participants was observed, although near three-fourths (74.4%) were African American or black.

Table 5

Demographic Characteristics of Participants

Variables	Frequency	Percent	Minimum	Maximum	Mean	Std. Deviation
Gender						
Female	91	55.5	NA	NA	NA	NA
Male	73	44.5	NA	NA	NA	NA
Race						
AA	122	74.4	NA	NA	NA	NA
Asian	9	5.5	NA	NA	NA	NA
Hisp	19	11.6	NA	NA	NA	NA
White	14	8.5	NA	NA	NA	NA
Age (Years)	NA	NA	1	17	8.1	4.080

Note. ***N* = 164.** Participants were on average 8.1 years old (*SD* = 4.080). NA= not applicable

Analysis of the frequency table (Table 6) showed that most of the participants in our study had Medicaid (57.9%). Table 6 also showed that most of the study participants were exposed to environmental tobacco smoke (54.3%). Participants who were exposed to indoor mold, pests, and household pets, represented 48.8%, 40.9%, and 29.9% respectively.

Table 6

Frequency Table

	Medicaid		Smoking		Pests		Pets		Mold	
Presence	N	%	N	%	N	%	N	%	N	%
No (0)	69	42.1	75	45.7	97	59.1	115	70.1	84	51.2
Yes (1)	95	57.9	89	54.3	67	40.9	49	29.9	80	48.8
	164	100	164	100	164	100	164	100	164	100

Note: ***N = 164***

Bivariate Analyses

This study used a point-biserial correlation analysis to determine the relationship between each of the following independent variables including income, environmental tobacco smoke (ETS), indoor mold, household pets, and pests and the dependent variable, prevalence of childhood uncontrolled asthma measured by asthma ED-V and ACT score. A point-biserial correlation (rpb) is a correlation analysis used to measure the relationship between two variables when one variable is dichotomous (e.g., taking values coded 0 and 1) and the other is continuous (Kornbrot, 2014).

Number of asthma ED Visits (ED-V) vs. the Independent Variables

Using SPSS Version: 28.0.1.0 (142), a point-biserial correlation analysis was conducted to determine the relationship between each of the following independent variables including income, ETS, mold, pets, pests and the dependent variable, ED-V. Analysis of data in Table 7, Table 8, and Table 9, found no statistically significant correlation between income and number of asthma ED visits (rpb = .067, n = 164, *p* = .*391*); between pets and number of asthma ED visits (rpb = .093 n =, 164, *p = .236*); and between pests and number of asthma ED visits (rpb = .093, n = 164, *p = .237*) respectively. However, as shown on both Table 10 and Table 11, there was a statistically significant positive correlation between ETS and number of asthma ED visits (rpb = .194, n = 164, *P = .013*); and between mold and number of asthma ED visits (rpb = .177, n = 164, *p = .023*) respectively. This means that ETS and indoor mold are associated with the number of asthma ED visits.

Table 7

Correlations Analysis for Medicaid and ED-V

		ED-V	Medicaid
ED-V	Pearson Correlation	1	.067
	Sig. (2-tailed)		.391
	N	164	164
Medicaid	Pearson Correlation	.067	1
	Sig. (2-tailed)	.391	
	N	164	164

Table 8

Correlations Analysis for Pets and ED-V

		ED-V	Pets
ED-V	Pearson Correlation	1	.093
	Sig. (2-tailed)		.236
	N	164	164
Pets	Pearson Correlation	.093	1
	Sig. (2-tailed)	.236	
	N	164	164

Table 9

Correlations Analysis for Pests and ED-V

		ED-V	Pests
ED-V	Pearson Correlation	1	.093
	Sig. (2-tailed)		.237
	N	164	164
Pests	Pearson Correlation	.093	1
	Sig. (2-tailed)	.237	
	N	164	164

Table 10

Correlations Analysis for Smoking and ED-V

		Smoking	ED-V
Smoking	Pearson Correlation	1	.194*
	Sig. (2-tailed)		.013
	N	164	164
ED-V	Pearson Correlation	.194*	1
	Sig. (2-tailed)	.013	
	N	164	164

Note: Correlation is significant at the 0.05 level (2-tailed).

Table 11

Correlations Analysis for Mold and ED-V

		ED-V	Mold
ED-V	Pearson Correlation	1	.177*
	Sig. (2-tailed)		.023
	N	164	164
Mold	Pearson Correlation	.177*	1
	Sig. (2-tailed)	.023	
	N	164	164

Note: Correlation is significant at the 0.05 level (2-tailed).

ACT Score vs. the Independent Variables

A point-biserial correlation test was conducted to determine the relationship between each of the following independent variables, including income, ETS, indoor mold, pets, pests, and the dependent variable, ACT score. Analysis of the data in Table 12, Table 13, Table 14, and Table 15 showed that there was no statistically significant correlation between income and ACT score (rpb = -.140, n = 164, $p = .073$); between mold and ACT score (rpb = -.139, n = 164, $p = .075$); between pets and ACT score (rpb = -.141, n = 164, $p = .071$); and between pests and ACT score (rpb = -.043, n = 164, $p = .582$) respectively. However, as shown in Table 16, the point-biserial correlation coefficient (rbp) of ETS and the ACT score is -.167. This indicated a modest negative correlation between ETS and the ACT score at P-value = .033 (rpb = -.167, n = 164, $P = .033$).

Table 12

Correlations Analysis for Medicaid and ACT Score

		ACT score	Medicaid
ACT score	Pearson Correlation	1	-.140
	Sig. (2-tailed)		.073
	N	164	164
Medicaid	Pearson Correlation	-.140	1
	Sig. (2-tailed)	.073	
	N	164	164

Table 13

Correlations Analysis for Mold and ACT Score

		ACT score	Mold
ACT score	Pearson Correlation	1	-.139
	Sig. (2-tailed)		.075
	N	164	164
Mold	Pearson Correlation	-.139	1
	Sig. (2-tailed)	.075	

	N	164	164

Table 14

Correlations Analysis for Pets and ACT Score

		ACT score	Pets
ACT score	Pearson Correlation	1	-.141
	Sig. (2-tailed)		.071
	N	164	164
Pets	Pearson Correlation	-.141	1
	Sig. (2-tailed)	.071	
	N	164	164

Table 15

Correlations Analysis for Pests and ACT score

		ACT score	Pests
ACT score	Pearson Correlation	1	-.043
	Sig. (2-tailed)		.582
	N	164	164
Pests	Pearson Correlation	-.043	1
	Sig. (2-tailed)	.582	
	N	164	164

Table 16

Correlations Analysis for Smoking and ACT Score

		ACT score	Smoking
ACT score	Pearson Correlation	1	-.167*
	Sig. (2-tailed)		.033
	N	164	164
Smoking	Pearson Correlation	-.167*	1
	Sig. (2-tailed)	.033	
	N	164	164

Note: Correlation is significant at the 0.05 level (2-tailed).

Backward Stepwise Regression Analyses

This study used backward stepwise regression also known as “backward elimination regression” analyses to determine the best predictors for the outcomes. The covariates, age, gender, and race/ethnicity were included in the model as predictor variables to determine if the study outcomes remained even after including the covariates. A backward stepwise regression analysis is applied to eliminate the variables with coefficients that have a lower level of significance (Vu et al., 2015). The analysis process includes multiple stages and stops when each variable remaining in the equation is statistically significant.

Number of asthma ED visits (ED-V) vs. the covariates (Age, Gender, Race/Ethnicity)

Using SPSS Version: 28.0.1.0 (142), a backward elimination regression analysis was conducted to determine if there is an association between the covariates, age, gender, and race/ethnicity, (included in the model as the predictor variables) and the dependent variable, number of asthma ED visits.

Table 17

Variables Deleted/Removed

Model	Variables Entered	Variables Removed	Method
1	Race, Gender, Age[b]	.	Enter
2	.	Age	Backward (criterion: Probability of F-to-remove >= .100).
3	.	Gender	Backward (criterion: Probability of F-to-remove >= .100).

Note: a. dependent variable (ED-V); b. All requested variables entered.

The model summary table (Table 18) indicated that the adjusted R-squared values of .014, .019, and .016, in all stages 1, 2 and 3 respectively showed a weak effect of the predictor variables, race, gender, and age on the dependent variable, ED-V.

Table 18

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.179[a]	.032	.014	.946	.032	1.759	3	160	.157
2	.176[b]	.031	.019	.943	-.001	.146	1	160	.703
3	.147[c]	.022	.016	.945	-.009	1.578	1	161	.211

Note: Predictors (Constant): a – race, gender, age; b – race, gender; c – race

Analysis of the data in ANOVA Table (Table 19) showed that in all stages 1, 2, 3, there was no statistically significant effect of the predictor variables, race, gender, and age on the dependent variable, ED-V, F (3, 160) = 1.759, p = .157; F (2, 161) = 2.580, p = .079; and F (1, 161) = 3.569, p = .061 respectively. Based on these results, it can be concluded that there is no significant relationship between the predictor variables, age, gender, race, and the dependent variable, ED-V.

Table 19

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.719	3	1.573	1.759	.157[b]
	Residual	143.056	160	.894		
	Total	147.774	163			
2	Regression	4.589	2	2.294	2.580	.079[c]
	Residual	143.186	161	.889		
	Total	147.774	163			
3	Regression	3.186	1	3.186	3.569	.061[d]
	Residual	144.589	162	.893		
	Total	147.774	163			

Note: Dependent Variable (ED-V); Predictors (Constant): a – race, gender, age; b – race, gender; c – race

As shown in Coefficient Table (Table 20), in stage 1, the standardized regression coefficients (β) indicated that race (β = -.160, *p = .048*) was a significant predictor of the dependent variable, ED-V while age (β = .030, p = *.703*) and gender (β = -.101, *p = .204*) were not. In stage 2, the standardized regression coefficients (β) indicated that race (β = -.166, *p = .038*) was a significant predictor of the dependent variable, ED-V, while gender (β = -.099, *p = .211*) was not, and the variable, age was eliminated. In stage 3, the standardized regression coefficients (β) indicated that race (β = -.147, *p = .061*) was not statically associated with asthma ED-V. All the three predictor variables were eliminated. Based on these results, it can be concluded that there is no significant relationship between the predictor variables, age, gender race and the dependent variable, ED-V.

Table 20

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	4.134	.334		12.384	<.001			
	Age	.007	.019	.030	.382	.703	.051	.030	.030
	Gender	-.194	.152	-.101	-1.276	.204	-.068	-.100	-.099
	Race	-.169	.085	-.160	-1.989	.048	-.147	-.155	-.155
2	(Constant)	4.194	.294		14.250	<.001			
	Gender	-.190	.151	-.099	-1.256	.211	-.068	-.099	-.097
	Race	-.175	.083	-.166	-2.095	.038	-.147	-.163	-.163
3	(Constant)	3.870	.142		27.239	<.001			
	Race	-.155	.082	-.147	-1.889	.061	-.147	-.147	-.147

Note: Dependent Variable (ED-V)

The excluded variables table (Table 21) indicated that the variables, age, and gender did not bring additional significant information to the model in both stages 2 and 3 with *p = .703*, *p = .771* and *p = .211* (P < .005) respectively. It can be concluded that the variables age and gender are not part of the best predictor variables of ED-V.

Table 21

Excluded Variables

Model	Beta In	t	Sig.	Partial Correlation	Collinearity Statistics

						Tolerance
2	Age	.030[b]	.382	.703	.030	.958
3	Age	.023[c]	.292	.771	.023	.963
	Gender	-.099[c]	-1.256	.211	-.099	.964

Note: Dependent Variable (ED-V); Predictors (Constant): a – race, gender, b – race, gender

ACT score vs. the covariates (Age, Gender, Race/Ethnicity)

Using SPSS Version: 28.0.1.0 (142), a backward elimination regression analysis was conducted to determine if there is an association between the covariates, age, gender, and race/ethnicity, (included in the model as predictor variables) and the dependent variable, ACT score.

Table 22

Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	Race, Gender, Age[b]	.	Enter
2	.	Gender	Backward (criterion: Probability of F-to-remove >= .100).
3	.	Race	Backward (criterion: Probability of F-to-remove >= .100).

Note: a. Dependent Variable (ACT score); b. all requested variables entered

The model summary below (Table 23) indicated an adjusted R-squared value of .186 in stage 1, which means that the predictor variables, race, gender, and age explain 18.6% of the variability in the dependent variable, ACT score after controlling for the number of predictors in the model. In stage 2, the adjusted R-squared value of .189, means that the predictor variables, race, and age explain 18.9% of the variability in the dependent variable, ACT score. Stage 3 showed an adjusted R-squared value of .183, which means that the predictor variable, age explains 18.3% of the variability in the dependent variable, ACT score. Based on these results, it can be concluded that the predictor variables, race, gender, and age have a modest effect on the dependent variable, ACT score.

Table 23

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.448[a]	.201	.186	8.203	.201	13.402	3	160	<.001
2	.446[b]	.199	.189	8.187	-.002	.395	1	160	.530
3	.433[c]	.188	.183	8.219	-.011	2.249	1	161	.136

Note: Predictors (Constant) – a. Race, gender, ages; b. race, age; c. age

Analysis of the data in ANOVA Table (Table 24) showed that in all stages 1, 2, 3, there was a statistically significant effect of the predictor variables, race, gender, and age on the dependent variable, ACT score, F (3, 160) = 13.402, $p < .001$; F (2, 161) = 19.980, $p =<.001$; and F (1, 162) = 37.423, $p < .001$ respectively. Based on these results, it can be concluded that there is a significant relationship between the predictor variables, age, gender, race, and the dependent variable, ACT score.

Table 24

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2705.063	3	901.688	13.402	<.001[b]
	Residual	10765.181	160	67.282		
	Total	13470.244	163			
2	Regression	2678.471	2	1339.236	19.980	<.001[c]
	Residual	10791.773	161	67.030		
	Total	13470.244	163			
3	Regression	2527.753	1	2527.753	37.423	<.001[d]
	Residual	10942.491	162	67.546		
	Total	13470.244	163			

Note: DV: Act Score; Predictors (Constant) – a. Race, gender, ages; b. race, age; c. age

As shown in Coefficient Table below (Table 25), in stage 1, the standardized regression coefficients (β) indicated that age (β = -.457, $p < .001$) was a significant predictor of the dependent variable, ACT score while gender (β = .045, $p = .530$) and race (β = -.100, $p = .174$) were not. In stage 2, the standardized regression coefficients (β) indicated that age (β = -.454, *p < .001*) was a significant predictor of the dependent variable, ACT score, while race (β = -.108, *p = .136*) was not and the variable gender was eliminated. In stage 3, the standardized regression coefficients (β) indicated that age (β = -.433, *p < .001*) was statically associated with ACT score, and both variables gender and race were eliminated. Based on these results, it can be concluded that only the variable age was a significant predictor of the dependent variable, ACT score.

Table 25

Coefficients[a]

	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	24.216	2.896		8.362	<.001			
	Age	-1.019	.161	-.457	-6.332	<.001	-.433	-.448	-.447
	Gender	.827	1.316	.045	.629	.530	.017	.050	.044
	Race	-1.005	.736	-.100	-1.366	.174	-.020	-.107	-.097
2	(Constant)	25.562	1.945		13.143	<.001			
	Age	-1.012	.160	-.454	-6.315	<.001	-.433	-.446	-.445
	Race	-1.085	.724	-.108	-1.500	.136	-.020	-.117	-.106
3	(Constant)	23.578	1.431		16.481	<.001			
	Age	-.965	.158	-.433	-6.117	<.001	-.433	-.433	-.433

Note: DV: Act Score.

The table of excluded variables (Table 26) showed that the variables, gender, and race did not bring additional significant information to the model both on stage 2 and 3 with *P = .530*, *P = .383*, and *P = .136* (P < .005) respectively. Based on the results on Tables 25 and 26, it can be concluded that the variables gender and race were not part of the best predictor variables of ACT score.

Table 26

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
2	Gender	.045[b]	.629	.530	.050	.960
3	Gender	.062[c]	.875	.383	.069	.989
	Race	-.108[c]	-1.500	.136	-.117	.963

Note: DV: Act Score; Predictors (Constant) – a. Race, gender b. race,

Regression Analyses

Using SPSS Version: 28.0.1.0 (142), two multiple linear regression analyses were conducted to determine the relationship between the specific factors (including income, environmental tobacco smoke, indoor mold, household pets, and pests), and asthma ED visits in the last three months; and between these specific factors, and the ACT score.

Regression 1

Multiple linear regression analyses using one way ANOVA were conducted to examine whether an association existed between Medicaid status (income), smoking, pets, pests, mold, and the dependent variable, ED-V. The model summary indicated that the correlation coefficient (R) between the independent variables and the dependent variable was .405, which indicates a moderate positive relationship. The R-squared value was .164, which means that the independent variables accounted for 16.4% of the variance in the dependent variable. The model included a constant and all five independent variables as predictors. Based on these results, it can be concluded that the predictors explain a significant proportion of the variability in the ED-V, but the effect size is relatively small.

Table 27

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Medicaid, Smoking, Pets, Pests, Mold[b]	.	Enter

Note: DV: ED-V; All requested variables entered

The model summary (Table 28) indicated an adjusted R-squared value of .138, which means that the predictor variable(s) explains 13.8% of the variability in the dependent variable after controlling for the number of predictors in the model. The standard error of the estimate was .884, which represents the average distance between the actual and predicted values of the dependent variable. Based on these results, it can be concluded that the predictor variable(s) have a modest effect on the dependent variable, and there is still a considerable amount of unexplained variance in the dependent variable.

Table 28

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.405[a]	.164	.138	.884

Note: DV: ED-V; Predictors (Constant): Medicaid, Smoking, Pets, Pests, Mold

A one-way ANOVA (Table 29) was conducted to examine the relationship between the predictor variables, Medicaid, smoking, pets, pests, mold, and the dependent variable, ED-V. The results indicated a statistically significant effect of the predictor variable(s) on the dependent variable, $F(5, 158) = 6.214$, $p < .001$. The regression model accounted for a significant proportion of the variance in the dependent variable, with a regression sum of squares of 24.284 and a residual sum of squares of 123.490. The mean square for the regression was 4.857, indicating that the predictor variable(s) explain a significant amount of the variability in the dependent variable. Based on these results, it can be concluded that there is a significant relationship between the predictor variable(s) and the dependent variable, and the model provides a good fit to the data.

Table 29

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.284	5	4.857	6.214	<.001[b]
	Residual	123.490	158	.782		
	Total	147.774	163			

Note: DV: ED-V; Predictors (Constant): Medicaid, Smoking, Pets, Pests, Mold

A multiple linear regression analysis was conducted to examine the relationship between the predictor variables, Medicaid, smoking, pets, pests, mold, and the dependent variable, ED-V. The results of the analysis are presented in Table 29. The model was statistically significant, F (5, 158) = 6.214, $p < .001$, and accounted for 16.4% of the variance in the dependent variable.

As shown in the coefficients table below (Table 30), the standardized regression coefficients (β) indicated that Smoking (β = .288, $p < .001$), Mold (β = .354, $p < .001$), Pests (β = .238, $p = .003$), and Medicaid (β = .168, $p = .028$) were all significant predictors of the dependent variable, while Pets (β = .133, $p = .080$) was not, even after controlling for covariates.

The unstandardized regression coefficients (B) indicated that for every one-unit increase in Smoking, there was a predicted increase of .550 units in the dependent variable. Similarly, for every one-unit increase in Mold, Pests, and Medicaid, there was a predicted increase of .672, .460, and .324 units, respectively, in the dependent variable.

The collinearity statistics indicated that multicollinearity was not a concern in the model, with all tolerance values > .8 and all VIF values < 1.25. These results suggest that the model is a good fit for the data and the predictor variables make unique contributions to the prediction of the dependent variable.

Table 30

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	2.556	.214		11.971	<.001		
	Smoking	.550	.147	.288	3.733	<.001	.886	1.129
	Pets	.275	.156	.133	1.759	.080	.931	1.074
	Mold	.672	.154	.354	4.355	<.001	.800	1.250
	Pests	.460	.150	.238	3.068	.003	.878	1.139
	Medicaid	.324	.146	.168	2.222	.028	.920	1.087

Note: DV: ED-V

The collinearity diagnostics table (Table 31) shows the variance proportions, eigenvalues, and condition indices for the predictor variables of the regression model. The condition index measures how much the variance of an eigenvalue is affected by multicollinearity. The table indicates that there is some degree of multicollinearity among the predictor variables, as shown by the variance proportions being relatively evenly distributed across the predictor variables. However, the largest condition index is only 2.961, indicating that the degree of multicollinearity is not severe. Therefore, we can interpret the coefficients of the model with some confidence.

Table 31

Model 1 Collinearity Diagnostics[a]

Dimension	Eigenvalue	Condition Index	Variance Proportions					
			(Constant)	Smoking	Pets	Mold	Pests	Medicaid
1	3.537	1.000	.01	.02	.02	.02	.02	.02
2	.768	2.146	.00	.04	.47	.17	.03	.00
3	.672	2.295	.00	.01	.01	.16	.54	.00
4	.544	2.550	.00	.10	.26	.15	.07	.27
5	.403	2.961	.00	.54	.14	.00	.01	.35
6	.076	6.814	.99	.29	.09	.51	.33	.36

Note: DV: ED-V

Table 32 below illustrates the residuals statistics. We can see the Cook's distance values range from 0.000 to 0.039. Cook's distance is one of the most important measurements used in regression analysis to detect influential data points that may negatively affect the regression model (Zhu et al., 2012). According to Laureate Education (2016m), the Cook's distance with value 1.0 or greater are usually considered problematic. In our model, the Cook's distance values are below 1.0. Therefore, we can presume that we do not have any undue influence on this model.

Table 32

Residuals Statistics[a]

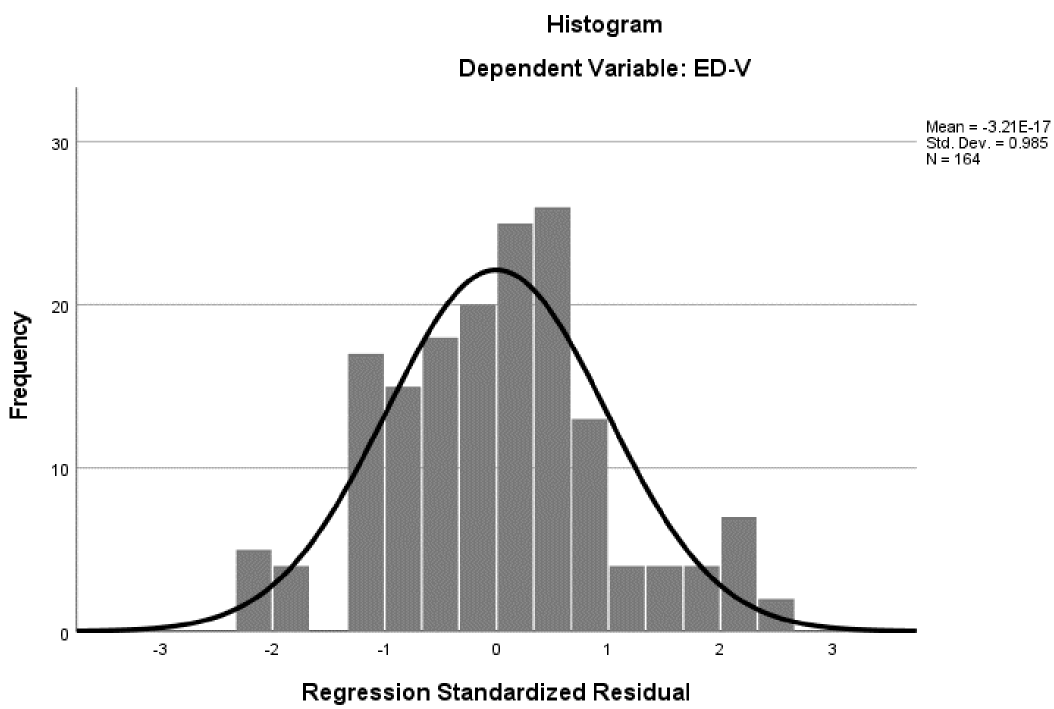
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.56	4.56	3.64	.386	164
Std. Predicted Value	-2.808	2.388	.000	1.000	164
Standard Error of Predicted Value	.146	.216	.168	.019	164
Adjusted Predicted Value	2.65	4.55	3.64	.385	164
Residual	-1.880	2.295	.000	.870	164
Std. Residual	-2.127	2.596	.000	.985	164
Stud. Residual	-2.170	2.639	-.001	1.003	164
Deleted Residual	-1.957	2.372	-.001	.904	164
Stud. Deleted Residual	-2.196	2.691	.000	1.010	164
Mahal. Distance	3.466	8.734	4.970	1.359	164
Cook's Distance	.000	.039	.006	.009	164
Centered Leverage Value	.021	.054	.030	.008	164

Note: DV: ED-V

Figure 4 below depicts a histogram of distribution of errors. Histogram, and probability-probability plot (P-P plot) are usually performed to visually assess a normal distribution (Ghasemi & Zahediasl, 2012). From the histogram in figure 4, we can see that the residuals are normally distributed and homoscedastic. Therefore, we can assume that we have met the assumption. It also indicates that the linearity and homoscedasticity assumptions are not violated by the data (Osborne & Waters, 2002).

Figure 4

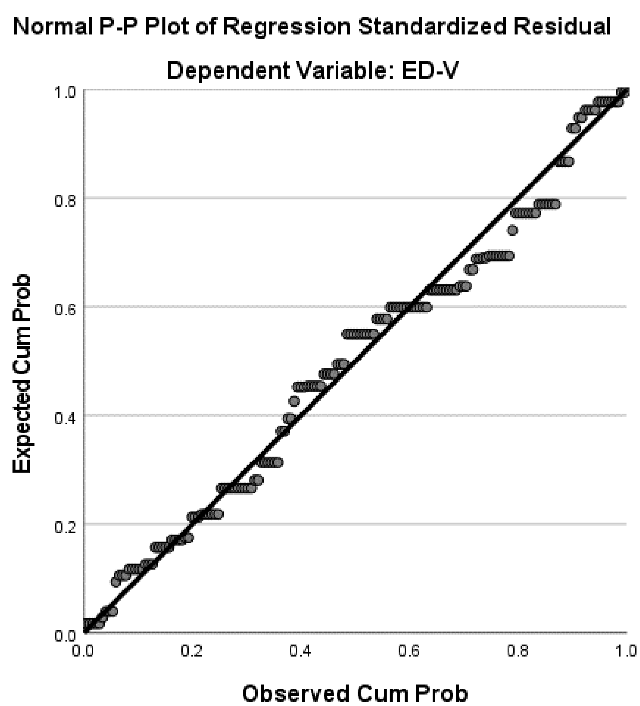
Histogram of Distribution of Errors



As shown in **Figure 5** below, we can see a scatterplot of residuals versus predicted values. It offers information about homoscedasticity, also called homogeneity of variance. Figure 5 depicts an example of a residual plot showing a clustering of residuals along the horizontal line as we move from the left to the right along the line (Ghasemi & Zahediasl, 2012). This indicates a positive relationship between the number of asthma ED visits and the specific socioenvironmental factors (income, environmental tobacco smoke, and presence of mold, and pests in the home). Figure 5 also shows that the predictor variables have a straight-line relationship with the outcome variable. This implies that the linearity and homoscedasticity assumptions are not violated by the data (Osborne & Waters, 2002).

Figure 5

Scatterplot of Residuals Versus Predicted Values



Regression 2

Multiple linear regression analyses using one way ANOVA were conducted to examine whether an association existed between Medicaid status (income), smoking, pets, pests, mold, and the dependent variable, ACT score. The model summary (Table 34) indicated that the correlation coefficient (R) between the independent variables and the dependent variable was .385, which indicates a moderate positive relationship. The R-squared value was .149, which means that the independent variables accounted for 14.9% of the variance in the dependent variable.

Table 33

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Medicaid, Smoking, Pets, Pests, Mold[b]	.	Enter

Note: DV: ACT score; All requested variables entered

The model summary table below (Table 34) shows the multiple linear regression model with constant, Medicaid, Smoking, Pets, Pests, and Mold as predictors significantly predicted ACT score, $F(5, 158) = 5.514$, $p < .001$, $R = .385$. The model accounted for 14.9% of the variance in ACT score (R square = .149). The adjusted R square (.122) suggested that about 12.2% of the variance in the dependent variable can be explained by the independent variables. The standard error of the estimate was 8.520, which indicates the average distance that the actual scores are from the predicted scores.

Table 34

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.385[a]	.149	.122	8.520

Note: a. Predictors (Constant): Medicaid, smoking, pets, pests, mold; b: DV: ACT score;

As shown in Table 35, the analysis of variance (ANOVA) revealed a significant overall effect of the predictors on the dependent variable, $F (5, 158) = 5.514$, $p < .001$. The model accounted for a significant amount of variance in the ACT scores, as evidenced by the significant regression sum of squares (SSR) of 2001.341, and an R-square value of .149. The residual sum of squares (SSE) was 11468.903.

Table 35

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	2001.341	5	400.268	5.514	<.001[b]
1	Residual	11468.903	158	72.588		
	Total	13470.244	163			

Note: a. DV: ACT score; b. Predictors (Constant): Medicaid, smoking, pets, pests, mold

The results of the regression analysis showed that the model significantly predicted ACT score, $F (5, 158) = 5.514$, $p < .001$, and the predictors accounted for 14.9% of the variance in ACT score. The coefficients (Table 36) for each predictor variable were as follows: Smoking ($\beta = -.233$, $p = .003$), Pets ($\beta = -.184$, $p = .017$), Mold ($\beta = -.313$, $p < .001$), Pests ($\beta = -.180$, $p = .023$), and Medicaid ($\beta = -.231$, $p = .003$). Collinearity diagnostics revealed that multicollinearity was not a significant issue, as all tolerance values were greater than .1 and all variance inflation factors (VIF) were less than 10. Overall, the results suggest that smoking, pets, mold, pests, and Medicaid are significant predictors of ACT score, even after controlling for covariates.

Table 36

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF

1	(Constant)	25.729	2.058		12.502	<.001		
	Smoking	-4.243	1.419	-.233	-2.990	.003	.886	1.129
	Pets	-3.634	1.506	-.184	-2.413	.017	.931	1.074
	Mold	-5.680	1.488	-.313	-3.817	<.001	.800	1.250
	Pests	-3.317	1.444	-.180	-2.297	.023	.878	1.139
	Medicaid	-4.244	1.405	-.231	-3.020	.003	.920	1.087

Note: a. DV: ACT score

Table 37

Model 1 Collinearity Diagnostics[a]

		Condition	Variance Proportions					
Dimension	Eigenvalue	Index	(Constant)	Smoking	Pets	Mold	Pests	Medicaid
1	3.537	1.000	.01	.02	.02	.02	.02	.02
2	.768	2.146	.00	.04	.47	.17	.03	.00
3	.672	2.295	.00	.01	.01	.16	.54	.00
4	.544	2.550	.00	.10	.26	.15	.07	.27
5	.403	2.961	.00	.54	.14	.00	.01	.35
6	.076	6.814	.99	.29	.09	.51	.33	.36

Note: a. DV: ACT score

Table 38 below shows the residuals statistics. In this model, the Cook's distance values range from 0.000 to 0.177. This indicates that the Cook's distance values are below 1.0. Therefore, we can presume that we do not have any undue influence on this model.

Table 38

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	8.25	25.73	15.76	3.504	164
Std. Predicted Value	-2.144	2.846	.000	1.000	164
Standard Error of Predicted Value	1.409	2.081	1.620	.178	164
Adjusted Predicted Value	7.75	23.60	15.73	3.502	164
Residual	-12.411	34.271	.000	8.388	164
Std. Residual	-1.457	4.023	.000	.985	164
Stud. Residual	-1.488	4.145	.001	1.006	164
Deleted Residual	-12.946	36.395	.024	8.766	164
Stud. Deleted Residual	-1.494	4.377	.009	1.033	164
Mahal. Distance	3.466	8.734	4.970	1.359	164
Cook's Distance	.000	.177	.008	.025	164
Centered Leverage Value	.021	.054	.030	.008	164

Note: a. DV: ACT score

Figure 6 below provides a histogram of distribution of errors. From the histogram, we can see that it is slightly skewed, but it is not significantly deviated from being a normal distribution. According to Ghasemi and Zahediasl (2012), the frequency distribution and P-P plots are used to check if the data are normally distributed. Therefore, we can presume that this distribution satisfies the normality assumption.

Figure 6

Histogram of Distribution of Errors

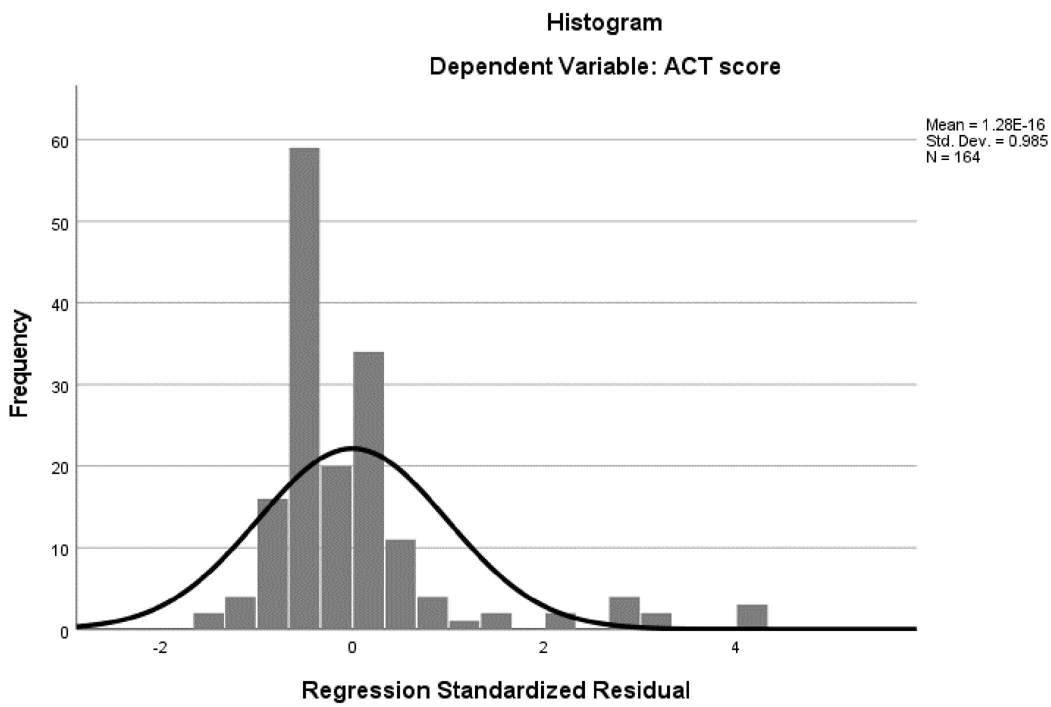
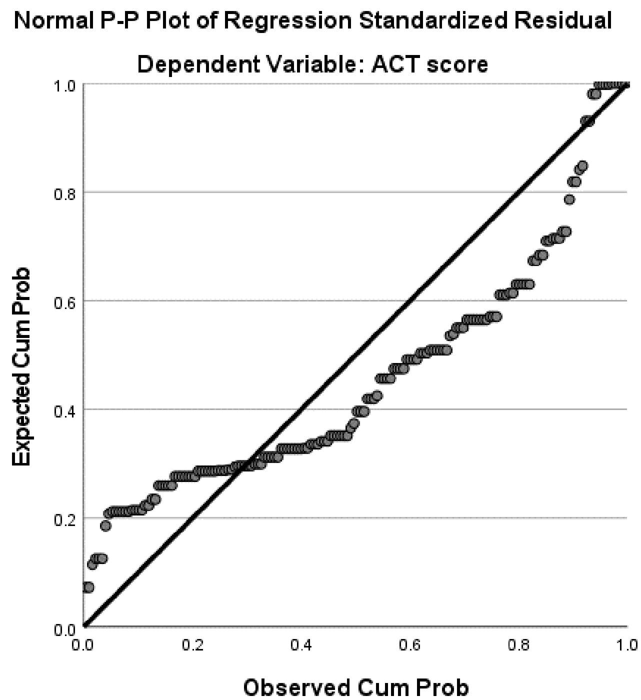


Figure 7 below depicts a scatterplot of residuals versus predicted values. Figure 7 shows an ascending direction as we move from the left to the right. This indicates a positive relationship between the ACT score and the specific socioenvironmental factors including exposure to environmental tobacco smoke, child having Medicaid, and presence of mold, pests, and pets in the home. It also indicates that the linearity and homoscedasticity assumptions are not violated by the data (Osborne & Waters, 2002).

Figure 7

Scatterplot of Residuals Versus Predicted Values



Conclusion

In chapter 4, I presented the results of statistical analyses. Two multiple linear regression (MLR) analyses were conducted to answer the five comprehensible research questions. The first MLR analysis was performed to determine if there is a relationship between the specific factors (income, tobacco smoke, indoor mold, household pets, and pests), and the number of asthma ED visits in the last three months even after controlling for covariates. The second MLR analysis was performed to determine if there is a relationship between these specific factors and Asthma Control Test (ACT) score even after controlling for covariates.

Prior to conducting MLR analyses, bivariate analyses were first conducted using a point-biserial correlation test to determine the relationship between each of the following independent variables, including income, ETS, indoor mold, pets, and pests and the dependent variable, prevalence of childhood uncontrolled asthma, measured by asthma ED-V and ACT score. Analysis of the results showed that of the five independent variables included in the model, only one variable, ETS was a significant predictor of both ED-V and ACT score. In addition, backward stepwise regression analyses were performed to determine if the study outcomes remained even after including the covariates.

The results of the first regression analysis suggested that four (4) from the five (5) independent variables (mold, ETS, pests, and Medicaid) were found to have an association with the number of asthma ED visits. Whereas in the second regression model, all the five (5) independent variables were found to have a strong association with the ACT score. Yet, of these five independent variables, only the variable, mold was found to be a strong predictor in both regression models. The next and final chapter presents the conclusion of my research.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The prevalence of childhood uncontrolled asthma continues to be a serious public health problem around the world (Serebrisky & Wiznia, 2019). Socioenvironmental factors may play a critical role in childhood uncontrolled asthma. There is however a lack of or limited recent research about this relationship. The purpose of this study was to explore the relationship between the specific socioenvironmental factors (including income, indoor mold, environmental tobacco smoke, pests, and household pets) and the prevalence of childhood uncontrolled asthma in Marion County, IN.

This is a quantitative study using secondary data from previous asthma case management records collected from Marion County children (0–17-year-old) between January 1st, 2018, and December 31st, 2020. In this study, I analyzed the relationship between income, environmental tobacco smoke, indoor mold, pests, household pets, and the prevalence of uncontrolled asthma in children. The prevalence of childhood uncontrolled asthma was measured by using the ACT score and the number of asthma ED visits in the last three months.

The environmental factors that were assessed included exposure to environmental tobacco smoke, indoor mold, household pets (dog and/or cats), and pests (cockroaches and/or mice). The social factor assessed was the parent or guardian's income which was measured by using the child's Medicaid status. Regression linear models were conducted to determine how well these specific socioenvironmental factors predicted the outcomes of ACT score and the number of asthma ED visits in the last three months. Prior to conducting regression analyses, correlation analyses were first conducted to determine the relationship between each of the independent variables and the dependent variable.

Interpretation of the Findings

Based on the results of regression analyses, it can be concluded that there are significant relationships between the independent variables and the dependent variables, even after controlling for covariates. However, based on the results of correlation analyses, only the variable, ETS predicted both ED-V and ACT score and the variable, indoor mold predicted only ED-V.

In the first regression analysis, which examined the relationship between various predictors and emergency department visits, the ANOVA showed a significant effect of the predictors on the dependent variable (ED-V). The regression model also showed a significant relationship between the predictors (constant, Medicaid, smoking, pets, pests, mold) and ED-V. The standardized coefficients indicated that smoking, mold, and pests had the strongest relationship with ED-V, while pets and Medicaid had weaker relationships. The collinearity diagnostics suggested that multicollinearity was not a major issue in the model, with all tolerance values greater than 0.1 and all variance proportions less than 0.5.

In the second regression analysis, which examined the relationship between various predictors and ACT scores, the ANOVA also showed a significant effect of the predictors on the dependent variable, ACT score. The regression model showed a significant relationship between the predictors (constant, Medicaid, smoking, pets, pests, mold) and ACT score, even after controlling for covariates. The standardized coefficients indicated that mold had the strongest negative relationship with ACT score, while smoking, pets, pests, and Medicaid had weaker negative relationships.

The collinearity diagnostics again suggested that multicollinearity was not a major issue in the model, with all tolerance values greater than 0.1 and all variance proportions less than 0.5.

Overall, these results suggest that the predictors examined in these analyses have significant relationships with the dependent variables, and that smoking, mold, and pests may have particularly strong effects on emergency department visits, while mold may have a particularly strong negative effect on ACT scores. However, further study is needed to confirm this study findings and explore potential mechanisms underlying these relationships.

Research Question One

The first question was to answer whether the parent or guardian's income can predict the prevalence of uncontrolled asthma in children residing in Marion County, IN. The results of the correlation analysis in Table 7 and Table 12 showed no statistically significant correlation between income and ED-V ($p = .391$), and between income and ACT score ($p = .073$). This means income cannot predict the prevalence of childhood uncontrolled asthma.

The results of the regression analyses in the coefficient Table 30 and Table 36 showed a statistically significant association between income and the number of asthma ED visits at $P = 0.028$ ($P < 0.05$); and between income and the ACT score at $P = 0.003$ ($P < 0.05$) respectively. These findings provide evidence that the parent or guardian's income can predict the prevalence of uncontrolled asthma in children residing in Marion County, IN.

These findings also support Nunes et al. (2017) study in which they examined asthma costs and social impact. In their study, Nunes et al. (2017) showed that low-income populations experience higher rates of morbidity and mortality due to asthma. Similarly, these study findings support Diep et al. (2019) research where they investigated the relationship between guardian's social status and asthma symptoms and management for children living in urban areas. In their study, Diep et al. (2019) reported that children from low-income families experience more asthma exacerbations, more frequent ED visits and hospitalizations, and more school absences.

This study results contradict those that were found in another study in which the guardian's social status was not associated with the prevalence of childhood uncontrolled asthma (Jabre et al., 2020). In their study, Jabre et al. (2020) found no significant impact of socioeconomic status on the prevalence of uncontrolled asthma in children. Similarly, Kozyrskyj et al. (2010) found no significant association between SES and childhood uncontrolled asthma and in fact, contradictory.

Research Question Two

The second research question of the study was to investigate whether environmental tobacco smoke (ETS) is associated with the prevalence of uncontrolled asthma in children residing in Marion County, IN. The results of correlation analyses in Table 10 and Table 16 showed a statistically significant positive and negative correlation between ETS and ED-V ($rpb = .194$, $p = .013$), and between ETS and ACT score ($rpb =$

-.167, p = .033) respectively. This means ETS can predict the prevalence of childhood uncontrolled asthma.

In the regression analyses, the coefficient Table 30 and Table 36 showed a statistically significant association both between ETS and ED-V at $P < 0.001$ ($P < 0.05$) and between ETS and the ACT score at $P = 0.003$ ($P < 0.05$) respectively. These findings provide evidence that exposure to environmental tobacco smoke was strongly associated with the prevalence of uncontrolled asthma in children residing in Marion County, IN.

The results of this study are consistent with other study findings. For instance, in their study, Sheehan, and Phipatanakul (2015) reported that even passive secondhand smoke leads to increased asthma exacerbations and decreased response to treatment. In another study, Tower et al. (2019) reported that environmental tobacco smoke exposures contributed to persistent high levels of prevalence of childhood uncontrolled asthma in low-income families. Unlike other studies, Milanzi et al. (2017) found no association between exposure to environmental tobacco smoke and increased risk of asthma exacerbations in children 4- to 17-year-old.

Research Question Three

The third research question of this study was to find whether indoor mold is associated with the prevalence of childhood uncontrolled asthma in Marion County, IN. The results of correlation analyses in Table 11 showed a statistically significant positive correlation between indoor mold and ED-V (*rpb = .177, p = .023*). Whereas Table 13 showed no significant effect between indoor mold and ACT score (*rpb = -.139, p =*

.075). Based on these results it can be concluded that indoor mold can predict the number of asthma ED visits.

The results of regression analyses in both coefficient Table 30 and Table 36 showed a statistically significant association between indoor mold and ED-V with $P < 0.001$ ($P < 0.05$); and between indoor mold and the ACT score at $P < 0.001$ ($P < 0.05$) respectively. These findings provide evidence that indoor mold has a strong association with the prevalence of childhood uncontrolled asthma in Marion County, IN.

The findings of this study support Byeon et al. (2017) research where they examined the relationship between mold sensitization and exposure and lung function impairment in children with asthma. Byeon et al. (2017) reported a strong association between indoor mold and increased asthma exacerbation in children. Similarly, Caillaud et al. (2018) found a strong association between indoor mold and development and exacerbations of asthma symptoms in children. On the contrary, a few studies conducted by Hardin et al. (2003); Simões et al. (2012); and Dick et al. (2014) did not prove the idea that indoor mold exposure is associated with childhood uncontrolled asthma. Similarly, a recent report from EPA (2021) stated that molds are usually not a problem indoors, unless mold spores begin growing on a damp spot.

Research Question Four

The fourth research question was to find whether household pets including dogs, and/or cats are associated with prevalence of childhood uncontrolled asthma in Marion County, IN. The results of correlation analyses in both Table 8 and Table 14 showed no statistically significant effect between household pets and ED-V ($rpb = .093, p = .236$)

and between household pets and ACT score (*rpb = -.141, p = .071*). This means that the presence of household pets cannot predict the prevalence of childhood uncontrolled asthma.

The results of regression analysis as illustrated in Table 30, showed no statistically significant association between household pets and ED-V with $P = 0.080$ ($P < 0.05$). Still, analysis of the data in Table 36 showed a statistically significant association between household pets and the ACT score at $P = 0.017$ ($P < 0.05$). This study findings showed contradictory results by illustrating both increased risks, and no risk of household pet exposures on the prevalence of childhood uncontrolled asthma.

On the one hand, keeping pets in the home was not associated with the number of asthma ED visits. This study results support the research of Medjo et al. (2013) in which they examined the association between keeping pets (dogs and/or cats) in the home and increased risk of asthma exacerbations in children and found no association. Similarly, in their study, Lødrup Carlsen et al. (2012) found no association between household pets (dogs and/or cats) and the risk of asthma exacerbations in children.

On the other hand, this study's findings provide statistical evidence that keeping pets including dogs and/or cats in the home was associated with decrease in the ACT score. Supporting this idea, in their study, Luo et al. (2018) reported that the presence of pets in the home was clearly associated with asthma exacerbations in children. Additionally, Gergen, et al. (2018) research investigated the impact of exposure to pets on asthma morbidity in the United Stated Population. Gergen, et al. (2018) found that higher exposure to dog and/or cat allergens among patients with asthma is associated with increased asthma exacerbations.

Research Question Five

The fifth research question was to find whether the presence of pests (cockroaches and/or mice) is associated with the prevalence of uncontrolled asthma in children residing in Marion County, IN. The results of correlation analyses in both Table 9 and Table 15 showed no statistically significant effect between pests and ED-V ($rpb = .093$, $p = .237$) and between pests and ACT score ($rpb = -.043$, $p = .582$) respectively. Based on these results it can be concluded that the presence of pests in the home cannot predict the prevalence of childhood uncontrolled asthma.

The results of the regression analyses in both Table 30 and Table 36 showed a statistically significant association between pests and ED-V at $P = 0.003$ ($P < 0.05$) and between pests and the ACT score at $P = 0.023$ ($P < 0.05$) respectively. These findings provide evidence that the presence of pests in the home was associated with the prevalence of childhood uncontrolled asthma in Marion County, IN.

The findings of this study support Grant et al. (2017) research where they examined the association between sensitization and exposure to mice and poorly controlled asthma in urban children. Grant et al. (2017) found that cockroach and mouse allergens are strongly associated with uncontrolled asthma among low-income families. Unlike other studies, Ahluwalia et al. (2013) argued that it is still not clearly understood whether the presence of cockroaches and mice in the home contributes to asthma morbidity in children living in low- income families. Similarly, in their study, Kanchongkittiphon et al. (2015) reported inconsistent findings between exposures to cockroach allergens and asthma exacerbation in children.

Limitation of the Study

This is a study to explore the relationship between the specific socioenvironmental factors and the prevalence of uncontrolled asthma in children between the ages of 0 and 17 years. Subsequently, the findings and interpretation of this study may not apply to the adult population. The sample size used in each analysis may be limited, which can affect the generalizability of the findings to other populations. This study used a convenient sampling method. According to Jager (2017), the process of convenient sampling method is often biased because the generalizability of convenience samples is unclear.

Many of the variables used in these analyses are based on self-reported data, which may be subject to biases, such as social desirability bias or recall bias. Most of the analyses are cross-sectional, meaning that they cannot establish causality between variables. Longitudinal studies would be needed to determine temporal relationships. Other variables (e.g., parental education) that were not measured or included in the analysis may have affected the results, leading to spurious associations.

The results of these analyses rely on certain statistical assumptions, such as normality and linearity, which may not be fully met in the data. Violations of these assumptions can affect the accuracy of the results. The collinearity diagnostics indicate that there may be multicollinearity among the predictor variables, which can affect the stability and interpretability of the coefficients. The analyses may be affected by measurement errors in the predictor and outcome variables, which can lead to underestimation or overestimation of the true associations.

Recommendation

Based on the limitations of the above results and the areas that need further investigation, the following research and professional practice recommendations are suggested:

Further research is needed to investigate the causal relationship between the predictor variables and the dependent variables. While the current analyses provide evidence of associations, they do not establish causality. Future studies could employ experimental or longitudinal designs to establish causal links.

Since some of the models indicated high levels of multicollinearity, future research should consider using methods such as principal component analysis or factor analysis to reduce the number of predictor variables and increase the interpretability of the models. Given the variation in the findings across the different analyses, professional practitioners should exercise caution in using the results to make decisions. Instead, they should consider the findings as suggestive and complement them with other relevant information such as professional judgment, client feedback, and previous research.

Professionals working in education, health, and social service settings should consider the potential impact of factors such as smoking, pets, pests, mold, and Medicaid on the outcomes of their clients. For example, school counselors could provide resources to help students quit smoking or deal with the negative effects of exposure to mold, while health professionals could advocate for policies that address environmental factors that impact health outcomes.

To improve the quality and generalizability of future research, researchers should use larger and more diverse samples, include a wider range of predictor variables, and employ more sophisticated statistical techniques that can account for complex relationships and non-linear effects. Additionally, researchers should strive to ensure that their studies are methodologically rigorous and transparent so that others can replicate their findings and build on their work.

Implications

The findings of this study showed an association between income, ETS, indoor mold, pests, pets, and the prevalence of childhood uncontrolled asthma (number of asthma ED visits and ACT score). Therefore, these study findings can help understanding the role of these specific socioenvironmental factors on poorly controlled asthma and identify strategies to improve the quality of life for children diagnosed with uncontrolled asthma in Marion County, IN. These study results can also be used by public health organizations to improve asthma control strategies.

The application of EST model in this study helped to identify and explore relevant variables that contribute to uncontrolled asthma in children. It also helped to better understand the relationship between income, environmental tobacco smoke, indoor mold, household pets, pests, and the prevalence of childhood uncontrolled asthma. Because EST model focuses on the nature of children's connections with their physical and sociocultural environments, most of the associations observed in our study are related to most of the five ecological systems including the microsystem, mesosystem, and exosystem.

At both microsystem and mesosystem levels, we found a strong association between most of the independent variables (including exposure to environmental tobacco smoke, indoor mold, and pests) and the dependent variable, prevalence of uncontrolled asthma, measured by asthma ED-V and ACT score, in children living in Marion County, IN. Addressing these factors at the child's microsystem and mesosystem levels may decrease the number asthma ED visits and improve the ACT score, which are significantly associated to childhood uncontrolled asthma (Smith et al., 2019).

At the exosystem level, we found an association between the social factor, income (child's Medicaid status) and the prevalence of uncontrolled asthma in children living in Marion County, IN (both with asthma ED visits and ACT score). Also, within the exosystem level, parental education is an important variable that can affect a child either positively or negatively. At the macrosystem level, social and cultural beliefs are another important point that can play a significant role in childhood uncontrolled asthma. Further research is needed to determine if there is an association between parental education, socio and cultural beliefs and the prevalence of childhood uncontrolled asthma.

Conclusion

Childhood uncontrolled asthma continues to be a public health concern. About one (1) in ten (10) Indiana children aged 0–17 experience asthma symptoms as about the same rate as the US overall [1 in 12] (CDC, 2018). Children living in Marion County, IN experience more asthma symptoms and exacerbations than the state averages. The number of asthma ED visits in Marion County, IN are significantly above the state averages (ISDH, 2017). Additionally, the levels of poverty in Marion County children are above the Indiana and national averages (IU Health, 2018). Furthermore, according to IU Health (2021), education rate in Marion County residents (75.9 %) is lower than the national averages (85.0 %).

Exposure to socioenvironmental factors may play a pivotal role in childhood uncontrolled asthma. In this study, I analyzed the relationship between the specific socioenvironmental factors (including income, ETS, indoor mold, pets, and pests) and the prevalence of uncontrolled asthma, measured by asthma ED-V and ACT Score, in children between the ages of 0 and 17 years. Based on the findings, most of the specific socioenvironmental variables tested, including income, ETS, indoor mold, and pests were statistically associated with the prevalence of childhood uncontrolled asthma at $P < 0.05$. However, only one variable, pets showed contradictory results illustrating both increased risks, and no risk of household pet exposure on childhood uncontrolled asthma.

The findings of this study contribute to the current literature, both by providing observed evidence for the relationships suggested by extant literature and by helping to better understanding the role of these specific factors on uncontrolled asthma. This study's findings can also identify strategies to improve the quality of life for patients with uncontrolled asthma, their families, and the community at large. As such, this study may constitute a basis for future study seeking for additional evidence on the relationship between keeping pets in the home and asthma ED visits in children; and between parental education and the prevalence childhood uncontrolled asthma.

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