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Risk Of Asthma Due To Obesity Among American Children: An Examination Of NHANES Data Regarding Childhood Obesity And Asthma

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RISK OF ASTHMA DUE TO OBESITY AMONG AMERICAN CHILDREN:

AN EXAMINATION OF NHANES DATA REGARDING CHILDHOOD OBESITY AND ASTHMA

BY

OLUWOLE THEOPHILUS SANNI

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APPROVAL PAGE

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DEDICATION PAGE

The following thesis document is dedicated to my wife, my 3 lovely sons and the rest of my family and friends for their, loyalty, encouragement, support, unconditional love and for believing in me.

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To God be the glory who has ordered every step of my life and for bringing me this far. I want to thank my wife who I fondly called "My jewel of inestimable value", my sons, Adedamola, Oluwatobi and Adebayo and the rest of my family for all their support and love. I would like to acknowledge my thesis committee, Ike S. Okosun, MS, MPH, PhD, FRSHP, FTOS and Rodney Lyn, PhD, MS for their guidance and support throughout this thesis. I would also like to thank the School of Public Health for giving me this opportunity.

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ABSTRACT

Background: Obesity and asthma are significant public health problems and epidemics among children. From 1980 to 1994 the prevalence of self reported asthma in children increased 75% while the prevalence of childhood obesity increased by 100%. Studies have demonstrated a complex, but poorly understood association between obesity and childhood asthma. This study further examines the relationship between obesity and asthma in children and adolescents.

Methods: Using secondary data from National Health and Nutrition Examination Survey NHANES 2005-2006, univariate analysis was used to examine the association between obesity and selected independent variables and current asthma status. Multivariate analysis was also used to examine the association between obesity and current asthma status. Independent t-test was used to compare mean values of continuous variables across asthma status. Finally, chi square test was used to compare categorical variables across asthma status. A p-value of < 0.05 and 95% confidence intervals were used to determine statistical significance throughout all the analyses performed.

Results: In total 3,515 cases were included in the study analysis, out of which 50% are boys and 50% are girls. Results of multivariate analysis showed that obese children had 1.64 higher odds of having current asthma (Odds Ratio 1.64, 95% CI: 1.63-1.64, p-value of <.001). Being male had 1.15 higher odds of having current asthma (Odds Ratio 1.15, 95% CI: 1.14-1.16, p-value <.001). Non-Hispanic Whites had 1.37 higher odds of having current asthma compared with Mexican American. Non-Hispanic Blacks had .77 lower odds of having current asthma compared with Mexican American (Odds Ratio .77, 95% CI: .77-.79, p-value <.001). Increasing age seems to have some slightly protective effects on current asthma (Odds Ratio .99, 95% CI: .98- .999, p-value <.001).

Conclusion: Obesity is significantly associated with current asthma status among children and adolescents. It may be beneficial to target obesity prevention in our efforts to control the asthma epidemic. Even small changes in mean population body mass index (BMI) may translate into significant increases or decreases in asthma incidence in children and adolescents.

CHAPTER I

INTRODUCTION

Background

Both obesity and asthma are significant public health problems and epidemics among children. From 1980 to 1994 the prevalence of self-reported asthma in children increased 75%, while the prevalence of childhood obesity increased 100%. Studies have demonstrated a complex, but poorly understood association between the two leading public health challenges of obesity and childhood asthma. The physical condition and body weight of asthmatic children cannot be discounted as contributing factors to poor health and disease outcomes (Romieu, 2004).

Asthma

The word "asthma" comes from a Greek word meaning "panting" (Keeney, 1964), but reference to asthma can also be found in ancient Egyptian, Hebrew, and Indian medical writings (Ellul-Micallef,1976). The International Consensus Report on the Diagnosis and Treatment of Asthma (DHHS,1992) defines asthma as a chronic inflammation disorder of the airways in which many cells play a role, including mast cells and eosinophils. In susceptible individuals this inflammation causes symptoms which are usually associated with widespread, but variable airflow obstruction that is often reversible either spontaneously or with treatment, and causes an associated increase in airway responsiveness to a variety of stimuli.

According to the Centers for Disease Control and Prevention, the prevalence of asthma among U.S. children increased from 3.6% in 1980 to 5.8% in 2003. Asthma prevalence increased from 7.3% in 2001 to 8.4% in 2010, when 25.7 million persons had asthma (Akinbami et al, 2012), for the period 2008-2010, asthma prevalence was higher among children than adults, and among multiple race, black, and American Indian or Alaska Native persons than white persons

(Akinbami et al, 2012). Asthma is the third leading cause of hospitalization among persons under 18 years of age in the United State, exceeded only by pneumonia and injuries (Heinrich. et al.2002). Increases in the prevalence of asthma of similar or even greater magnitude were reported from other countries during the second half of the 20th century.

For example, in 1964, 19% of Australian children were reported by their parents to have had asthma or wheezing at some time during their first 7 years of life; in 1990, such symptoms were reported for 46% of children. For many countries, there are no data on temporal changes in the prevalence of asthma before the 1990s. After the 1990s, estimates of temporal trends in the prevalence of asthma in several European and Asian countries are conflicting. In some populations, the prevalence of diagnosed asthma is still rising, whereas in others it appears to be stable or decreasing slightly. In the US asthma prevalence increased from 2001 to 2010 and is now at its highest level (Akinbami et al, 2012)

No single instrument can be used to identify asthma with certainty. Asthma is a clinical diagnosis made by physicians on the basis of a patient's medical history, physical examination, assessment of the reversibility of airway obstruction, and exclusion of alternative diagnoses that mimic asthma. Thus, there have been continuing difficulties not only with the diagnosis and classification of asthma, but also with determining the causes of the recent trends of increasing prevalence, morbidity, and mortality from asthma. There are also the well-known problems of measuring the prevalence of asthma or related symptoms or conditions of interest such as wheezing or bronchial hyper-reactivity. These problems are not only practical but theoretical, in that there is considerable dispute as to what asthma is and how it is diagnosed and classified , both clinically and in epidemiology studies (Samet,1987). Most definitions involve the occurrence of symptoms (e.g., reversible airflow obstruction, wheezing) over an extended period of time, rather than just on a particular day. Thus, the prevalence of asthma in a population may vary greatly depending on what operational definition is used, and what measurement techniques are employed.

Asthma is a chronic inflammatory disease of the airways in which many cellular elements play a role, in particular mast cells, eosinophils, T-lymphocytes, macrophages, neutrophils, and epithelial cells. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing , particularly at night or in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible, either spontaneously or with bronchodilator treatment. Asthma has a widespread and costly impact, particularly among ethnic minorities, low income families, and inner-city communities. Asthma cost US about $3,300 per person with asthma each year from 2002 to 2007 in medical expenses, missed school and work days, and early deaths. Asthma costs in the US grew from about $53 billion in 2002 to about $56 billion in 2007, about 6% increase (AAAAI, 2013).

Obesity

Childhood obesity is one of the most pressing public health and medical problems in the United States. In the US, prevalence rates of childhood overweight and obesity have tripled in the past 30 years (MMWR, 2011), from nearly 5% to 15% and the health implications and related medical cost of the disease are already evident. Evidence now clearly link childhood obesity with overweight or obese status in adulthood and, accordingly, with escalating rates of hypertension, diabetes, sleep apnea, stroke, myocardial infarction, and premature death (Ogden CL, et al. 2006). Annual hospital-related costs associated with treating obese children increased from 35 million dollars in 1979 to more than 127 million dollars in 1997-1999 (Wang and Dietz, 2002). Childhood obesity, defined as a body-mass index at or above the 95th percentile for children of the same age and sex; Obesity has also been defined as the accumulation of excessive adipose tissue to an extent that impairs physical as well as psychological health and well-being (Phillip, 2004), affected approximately 15 percent of children and adolescents in the period from 1999 through 2002.

Obesity has reached epidemic proportions in United States where, in 2007-2008, 34% of adults were obese and 68% were overweight (Flegal, 2010). The situation is worse in some southern states like Louisiana, Mississippi, and Alabama where almost 1 person out of 3 is obese or overweight. Obesity is particularly more common in the African-American population (44%) than in their white counterparts (33%) (Flegal, 2010). In 2007-2008, among children 2 to 5 years of age, 11% of African-Americans compared to 5.5% of whites were obese and 26% versus 9% were overweight. Children are beginning to get adult diseases. Complications of obesity are also more severe among African-Americans (Olshansky,2005). The increasing prevalence of obesity and overweight has important health and economic implications. If current trends continue, the higher prevalence of obesity may result in a decline in life expectancy in the United States (Olshansky, S. J., 2005). For the first time in US, there is a real concern that the current generation is on the track to have a shorter lifespan, and our children may not live as long as we do unless something is done to change the trend.

For children and adolescents 2 to 19 years old, overweight is defined as a body mass index (BMI) at or above 85th percentile and lower than 95th percentile (CDC, 2009). Obesity is defined as a BMI at or above 95th percentile for children of that same age and gender. A child's weight status is based on an age-and gender- specific percentile for BMI rather than by BMI categories used for adults. Classification of overweight and obesity for children and adolescents are age and gender specific because children's body composition varies as they age and varies between boys and girls (CDC, 2009). Childhood obesity is one of the most pressing public health and medical problems in the United States. In US, prevalence rates of childhood overweight and obesity have tripled in the past 30 years and health implications and related medical costs of the disease are already evident. This alarming rise in obesity rates among youth has been followed by initiatives by both the medical and public health communities to find appropriate and effective treatments as well as ways to prevent obesity.

Obesity and Asthma

Asthma in obese children may constitute a unique asthma type that is more difficult to manage. It is more resistant to available steroid treatments, requires higher medication use, and is associated with more frequent hospitalizations in comparison to asthma in normal-weight children (Beuther, 2010). It has been projected that even small changes in mean population body mass index (BMI) may translate into significant increases or decreases in asthma incidence in all ages.

Purpose of Study

Research has made the case that obesity may lead to asthma development, and at the same time, asthma may lead to obesity. There is also a number of prospective studies showing weight gain as preceding the onset of asthma. However there is paucity of studies showing the risk of asthma that is due to obesity among the American children. In this study, we aim to investigate the association between obesity and asthma in American children. We also aim to investigate if the association varies by race/ethnicity. This study will make use of secondary data from the National Health and Nutrition Examination Survey (NHANES) and SPSS statistical package will be used to analyze the data.

1c. Research Question

What is the relationship between obesity and asthma in Non Hispanic Whites, Non Hispanics Blacks, and Mexican American children.

CHAPTER II

REVIEW OF THE LITERATURE

The literature review examined risk factors for asthma and childhood obesity as well as the link between childhood obesity and asthma. This chapter is dedicated to presenting scientific literature that supports inclusion of the variables of interest in this study. This review is limited by the quality and quantity of the primary investigations.

Biology

Asthma is a chronic inflammatory disease of the airways in which many cellular elements play a role, in particular mast cells, eosinophils, T- lymphocytes, macrophages, neutrophils , and epithelial cells. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible, either spontaneously or with bronchodilator treatment(NHLBI,2007).

Childhood overweight is defined as a body mass index (BMI) at or above the 85th percentile and lower than the 95th percentile. Obesity is defined as a BMI at or above the 95th percentile for children of that same age- and gender. A child's weight status is based on an age- and gender- specific percentile for BMI rather than by BMI categories used for adults. Classification of overweight and obesity for children and adolescent are age and gender specific because children's body composition varies as they age and varies between boys and girls (CDC, 2009).

In the past, an association between high body weight and asthma has been reported in adults and pediatric population (Ford, 2005). A majority of this evidence is descriptive. Until 2006, more than 25 cross-sectional, case-control, and prospective pediatric studies supported positive association between high body weight and asthma (Ford, 2005). This association, is uniformly evident, with odd ratios of around 2.5 in general population cohorts and odds ratio of up to nine in specific subgroups (Guerra, et al ,2004). Longitudinal investigations (until 2006) agree that overweight or obese children experience more asthma symptoms when compared with normal- weight children (Gold et al , 2003). These longitudinal studies also suggest that high body weight precedes asthma or its worsening. A direct relationship between high body weight and asthma has yet to be established. Possible explanations for a relationship between a high body weight and asthma include a common genetic background, co-morbidities, mechanical changes associated with high body weight, changes in airway hyper-responsiveness, changes in physical activity and diet, increase insulin resistance, and systemic inflammation (Jones & Nzekwu, 2006).

Effects of Obesity on Patients with Asthma

The question deserves to be asked whether and how a person's asthma might be affected by excess weight. Some evidence suggests that obesity indeed affects the respiratory health status of patients with asthma. Compared with non obese asthmatic children, obese children age 4 to 9 years with asthma were more likely to use multiple medications and oral steroids, had a higher mean number of days that they wheezed, and were more likely to visit emergency department (Belamarich et al, 2000). In another study by Nathell, Jensen and Larsson (2002), 20.7% of Swedish patients with asthma on sick leave were obese on the basis of self-reported weight and height compared with 6.5% of a general population sample. The authors concluded that weight management should be part of the care of asthmatic patients.

A proposed hypothesis is that a high body weight, as a state of low-grade inflammation, exacerbates airway inflammation, which contributes to the development of asthma. A typical Western diet may act as an inflammatory stimulus. If inflammation is a mechanism linking high body weight and asthma, it is reasonable that diet plays some role. A typical Western eating pattern- high in energy-dense foods such as animal fats and processed sugars, and low in whole unprocessed plant foods-may be obesogenic due to its energy surplus but also because it produces inflammatory biochemical signals.

In 195 Swiss healthy infants (Latzin et al, 2007) who were followed from birth for 12 months every week for respiratory symptoms, birth weight was a potent predictor of wheeze (incidence risk ratio 2.67, 95% CI 1.43 to 4.98). The burden of overweight /obesity on asthma was also observed in boys but not in girls in a Brazilian birth-cohort study of 4,452 children assessed as infants and re-evaluated at age 11 years. Ford et al estimated that obesity could be responsible for around 15% to 38% of asthma cases. Visness et al (2010) found that obesity was significantly related to current asthma among children and adolescent (OR: 1.68, 95% CI: 1.33, 2.12). The association was stronger in non-atopic children (OR: 2.46, 95% CI: 1.2, 5.02) than in atopic children (OR: 1.34, 95% CI: 0.70, 2.57). Using an objective measure of atopy, it was found that excess weight in children appears to be associated with higher rates of asthma in children, especially asthma that is not accompanied by allergic disease.

Obesity affects the lungs and is very strongly associated with breathing disorders because of the mechanical effect of central body fat on airways, meaning that excessive body fat restricts the free movement of air and compresses the lungs (Kopelman, Caterson, Dietz, 2006).
Not only does excessive body fat restrict normal lung movement, research shows reduction in deep breathing associated with obesity and a sedentary lifestyle may also lead to airway narrowing (Platts-Mills et al, 1997). Such narrowing is caused by the reduction of bronchial smooth muscle expansion from a lack of deep breathing as a result of a restrictive lung pattern and obesity, thereby predisposing the child to asthma development. Evidence suggests that obesity complicates the diagnosis, treatment, and course of asthma, whereas significant weight loss results in improved pulmonary status.

Research has made the case that obesity may lead to asthma development, and at the same time , asthma may lead to obesity. Ciprandi et al (2008) demonstrated that obese children tend to have decreased pulmonary volumes while having hyper-responsiveness, making them more susceptible to developing symptoms than children who are not obese. Much of the literature focusing on the relationship between obesity, airway inflammation, and asthma has focused on the role of leptin. Leptin is important for normal lung development, serving as a critical mediator of the differentiation of lipofibroblasts to normal fibroblasts and pulmonary surfactant synthesis. However, other clinical studies in children demonstrate that the role of leptin may be independent of obesity. Guler et al (2004) demonstrated a significant elevation in serum leptin in children with asthma when compared with healthy children, despite similar mean body mass index.

Sex, Obesity, and Asthma

Whether the relationships between excess weight and asthma differ by sex has elicited a great deal of discussion. In adults one of the first prospective studies of obesity and asthma incidence by Camargo, Weiss, Zhang, Willet and Speizer (1999) was conducted in women, the study found that the BMI has a strong, independent, and positive association with risk of adult-onset asthma. Perhaps setting the stage for the debate that was to follow (Chen, Dales, Tang, & krewski, 2002). In a subsequent study from the Coronary Artery Risk Development in Young Adults Study, change in body mass index was significantly associated with asthma incidence among women but not among men. When a Canadian prospective study showed that obesity was a risk factor among men, the conventional wisdom that obesity was a risk factor among women but not among men gained foothold. And among participants in Tucson Epidemiologic Study of Airways Obstructive Diseases (Lebowitz, Knudson and Burrows, 1975), the form and strength of the associations differed between men and women. The confidence limits for the estimates overlapped considerably, however.

At least 3 other studies in adults do not support the conventional wisdom (Ford, 2005). In a birth Cohort of 4,719 Finns who were followed for 31 years, the association between obesity and asthma were not statistically different between men and women (Xu, Pekkanen, Laitinen, Jarvelin, 2002). In the Finnish Twin cohort study, risk Study, risk estimates were very similar between men and women. Finally, association between obesity and the prevalence of asthma from cross-sectional studies do not differ consistently by sex.

The first prospective study in children aged 5 to 6 years showed an association between obesity and asthma that was perhaps a little stronger in boys than in girls but unlikely to be significantly so (Chinn & Rona, 2001). In subsequent prospective study, the relative risk estimates were also higher among boys than girls, a difference that was of borderline significance. In a third study, however, risk estimates were higher among girls than boys. Gold et al (2003) suggested that adiposity in young females may be associated with lower FEV1/FVC ratio, in turn associated with increased airway collapsibility. Hormonal factors may contribute to symptoms, severity and morbidity of asthma in females (Eliasson, Scherzer , Degraff, & A.C. Jr.1986), consistent with the effects of gonadal hormones on immunity and the presence of estrogen receptors.

Thus it is far from settled that obesity is a stronger risk factor for asthma among women than men. More research will be needed to clarify the issue of whether sex modifies the association between obesity and asthma.

Asthma, and Ethnicity.

Compared with white, children of American Indian and Alaska Native descent were 1.3 times more likely and black children were 1.6 times more likely to have current asthma, whereas Asian children had the lowest prevalence. When Hispanic ethnicity was considered in addition to race, Puerto Rican children had the highest prevalence of all groups and were 2.4 times more likely to have current asthma than were non-Hispanic white children, whereas Mexican children had relatively low current asthma prevalence.

In contrast to patterns for prevalence, non- Hispanic black children’s rate of ambulatory health care use in nonemergency settings was nearly 20% lower than that of non-Hispanic white children. Racial disparities outcomes (ED visits, hospitalizations, and death) were much larger than disparities in prevalence. Non-Hispanic black children had an ED visit rate 4.1 times higher and death rate 7.6 times higher than the rates for non- Hispanic white children. For hospitalizations, for which data on Hispanic ethnicity were not available, black children had an asthma-related hospitalization rate 3.0 times higher than that of white children (Akinbami et al, 2009).

Risk Factors

Asthma

The majority of the published literature on asthma epidemiology and risk factors has focused on the identification of asthma triggers because the factors that cause asthma remain largely unknown (Taussig et al, 2003). From an etiologic stand point, asthma is a heterogeneous disease. It is useful for epidemiologic and clinical purposes to classify asthma by the principal stimuli or triggers that incite or are associated with acute episodes.

Allergens: Allergens that provoke asthma are airborne, and in order to induce a state of sensitivity, they must be reasonably abundant for considerable periods of time. Once sensitization has occurred, however, the patient can then exhibit exquisite responsivity so that minute amounts of the offending agent can produce significant exacerbation of the disease. Allergic asthma is frequently seasonal, and it is most often observed in children and young adults. A non seasonal form may results from allergy to feathers, animal danders, dust mites, molds, and other antigens present continuously in the environment.

Pharmacologic stimuli: The drugs most commonly associated with induction of acute episodes of asthma are aspirin, coloring agents such as tartrazine, beta-adrenergic antagonist, and sulfating agents. The typical aspirin-sensitive respiratory syndrome primarily affects adults, although the condition can be seen in childhood.

Environment and air pollution: Environmental factors of asthma usually related to climatic conditions that promote the concentration of atmospheric pollutants and antigens. These conditions tend to develop in heavy industrial or densely populated urban areas and are frequently associated with thermal inversions or other situations associated with stagnant air masses. In these circumstances, patients with asthma and other respiratory diseases tend to be more severely affected. The air pollutants known to have this effect are ozone, nitrogen dioxide, and sulfur dioxide. Pollens from trees and flowers in spring can also trigger acute asthma episode. Environmental tobacco smoke has clearly been established as a risk factor for asthma exacerbations (Witorsch, 2000). There is also increasing evidence that exposure to environmental tobacco smoke may contribute to the development of asthma, both in adults and children(Gold, 2000).

Occupational factors

Occupation-related asthma is an important health problem, and acute and chronic airway obstruction has been reported to follow exposure to a large number of compounds used in many types of industrial processes. Bronchoconstriction can result from working with, or exposure to, metal salts (e.g. platinum, chrome, and nickel), wood and vegetable dusts (e.g. oak western red cedar, grain, flour, castor bean, dgreen coffee bean, mako, gum acasia, karay gum, and tragacanth), pharmaceutical agents (e.g. antibiotics, piperazine, and cimetidine), industrial chemicals and plastics (e.g. toluene diisocyanate, phthalic acid anhydride, trimellitic anhydride persulfates, ethylenedianine, para phenylenediamine, and various dyes), biologic enzymes (e.g., laundry detergents and pancreatic enzymes), and animal and insects dusts, serums, and secretions. It is important to recognize that exposure to sensitizing chemicals, particularly those used in paints, solvents, and plastics, also can occur during leisure or non-work related activities.

Infections: Respiratory infections are the most common of the stimuli that evoke acute exacerbations of asthma. Well-controlled, investigations have demonstrated that respiratory viruses and not bacteria or allergy are the major etiologic factors. In young children, the most important infectious agents are respiratory syncytial virus and parainfluenza virus.

Exercise: Exercise is one of the most common precipitants of acute episodes of asthma. This stimulus differs from other naturally occurring provocations such as antigen or viral infections in that it does not evoke any long- term sequelae nor does it change airway reactivity.

Emotional stress: Abundant objective data exist which demonstrate that psychological factors can interact with the asthmatic condition to worsen or ameliorate the disease process. The pathways and nature of the interactions are complex but have been shown to be operational to some extent in almost half the patients studied. Changes in airway caliber seem to be mediated through modification of vagal efferent activity, but endomorphins also may play a role.

Obesity

When energy intake exceeds expenditure, the excess calories are stored in adipose tissue, and if this net positive balance is prolonged, obesity results; i.e. there are two components to weight balance, and an abnormality on either side (intake or expenditure) can lead to obesity.

Modifiable risk factors

Diet: A study by Moreno and Rodriguez, (2007) examined the evidence as to how 28 dietary factors contribute to obesity for adults and children. Eleven factors for which there was moderately consistent evidence of relationship with lower level of adiposity were identified; they are decrease dietary fat intake, increase total percent of carbohydrate intake, increase dietary fiber intake, increase calcium intake, increase dairy intake, increased vegetable and fruit intake, decreased sweetened beverage intake, decreased consumption of restaurant prepared foods, total dietary patterns characterized by a high intake of lower-fat foods, whole grains, fruits, vegetables, and legumes, breakfast consumption, and breast-feeding. The authors cautioned that even among these factors, there are substantial gaps in the literature, particularly related to the lack of prevention trial evidence and the limited number of studies in children.

Physical activity

Prospective studies of the impact of reduced metabolic rate on weight gain are equivocal (Bandini et al 2004). Because physical activity is modifiable, it is the target of interventions to alter energy expenditure. Television viewing has received attention in children. Hypothesized mechanism for the influence of television viewing on adiposity include the replacement of more intense physical activities, poor dietary pattern while watching television and the influence of television commercials on the foods consumed in the house (Woodward-lopez et al. 2006). Four main interrelated behavioral strategies of weight-control that are used to help families make changes are: controlling the environment, monitoring behavior, setting goals, and rewarding successful changes in behavior (Epstein, Valoski, Wing & McCurley, 1994).

Summary

A growing body of literature has reported a relationship between asthma and obesity among adults (Weiss, & Shore,2004, Ford, 2005). Studies conducted among children (Chinn & Rona, 2001), however, have produced conflicting results thus far, and further elucidation is necessary of how an association between asthma and body mass index may differ by population characteristics, such as age, gender and race/ethnicity. In addition, many studies among children have failed to assess the potential effect across the full range of BMI percentiles, including those who are underweight. A study by Bugess et al 2007, suggests that childhood adiposity may be important in the development of late-onset asthma. Therefore, attempts to reduce the burden of excess weight in society must be supported emphasizing the need to focus on children, perhaps young females particularly, in order to prevent asthma. If obesity contributes to the incidence of asthma, then the rising prevalence of childhood obesity may contribute to the ongoing asthma epidemic, and we may need to target obesity prevention in our efforts to control the epidemic.

Chapter III

METHODOLOGY

Materials and Methods

Study Design

Data were obtained from 2005-2006 NHANES. The NHANES is a nationally representative survey conducted periodically to assess the health and nutritional status of adults and children in the U.S. The primary purpose of NHANES is to determine the prevalence of major diseases and risk factors for those diseases. Details of the plan and operation of NHANES may be found online at: http://www.cdc.gov/nchs/nhanes.htm. The NHANES used a stratified, multi-stage probability sampling design. Eligible persons age 16 or older were interviewed directly, while interviews for those under age 16 were done with proxy. All persons who completed the household interview were invited to participate in the Medical Examination component of NHANES. The study protocols were IRB-approved and all participants (or their parents/guardian) gave written informed consent. The data were cleaned; relevant variables were selected and recoded. Only children from age 2 years to 19 years were included, since the focus is on childhood and adolescence.

The target population of NHANES is the civilian, non-institutionalized population of the U.S. In the 2005-2006 NHANES, 3,515 children and adolescents age 2-19 completed both the interview portion of the survey and the medical examination, and 3,515 children and adolescents had their height and weight measured.

Asthma Outcomes

Study participants were asked (by proxy if under age 16) whether a doctor or other health professional had ever told them they had asthma, whether they had experience an asthma attack in the past year, whether they had been to emergency department for asthma in the past year, whether they still have asthma. All those who answer yes to still has asthma questions are regarded as current asthma cases and were included in this study.

Weight Measurements

Body Mass Index (BMI) was calculated as weight in Kilograms divided by height in meters squared. Sex specific BMI percentile-for-age was calculated using the Centers for Disease Control and Prevention 2000 reference standards (CDC, 2007). Children between the 5^{th} and 95^{th} percentile of BMI-for-age are considered to be not being obese , and those at or above the 95^{th} percentile are considered obese, as recommended by the American Medical Association (Krebs et al.2007).

Statistical Analyses

In this analysis, after the exclusion of cases with missing data, the population of interest was reduced to 3,515 (n=3,515). I employ the following criteria when deriving the final estimation sample (see Table 1). I excluded every observation in the sample without valid measures for weight, height, BMI, race/ethnicity, gender and waist circumference. The demographic characteristics of those excluded from the study are not different from that of those included. Current asthma status is defined as only those that answered yes to the question ‘do you still have asthma’ all other cases were regarded as no asthma status. In this analysis those that were at or above 95 percentile of BMI were regarded as obese, while those who were below 95 percentile are regarded as not being obese. No differentiation was made between normal weight and overweight. A study by Green (2012), found overweight as not significantly associated with prevalence of asthma.

Univariate analysis was used to examine the association between obesity and other selected independent variables and current asthma. Multivariate analysis was used to examine the association between obesity and current asthma status. Independent t-test was used to compare mean values of continuous variables across asthma status. Finally, Chi square test was used to compare categorical variables across asthma status. All analyses were performed using the survey sampling weights and SPSS statistical package. 95% Confidence Interval and p-value <0.05 were used to determine statistical significance.

Chapter IV

RESULTS

Sample Demographics

The total sample of NHANES respondents that met the study eligibility criteria was 3,515 out of which 50% are boys and 50% are girls. The demographic characteristics of the respondents who were included in the study with respect to age, ethnicity, gender, asthma and obesity are presented in Table 1. Thirty six percent (36.9%) of the participants identified themselves as Mexican-Americans, 28.4% as Non-Hispanic Whites and 34.8 as Non-Hispanic Blacks. According to the definition of asthma used for this study 13.4% of participants self reported current asthma and 5% are obese.

Table 1. Descriptive statistics of categorical variables

Variables	Rates in %
Obesity	5
Asthma	13.4
Race/Ethnicity	
Mexican-American	36.9
Non Hispanic White	28.4
Non Hispanic Black	34.8
Gender	
Boys	50
Girls	50

Table 2. Comparison of selected variables across asthmatic status

Variable	Asthma	No Asthma	P-value	Comments
BMI	24.57 +/-7.41	25.07 +/-7.52	.179	Independent t-test was used to compare mean values of continuous variables across asthma status.
Weight	63.33+/-29.49	64.84+/-29.28	.299	
Waist circumference	84.60+/-22.20	85.14+/-21.96	.622	
Height	154.93+/-25.46	155.66+/-24.19	.550	
FPIR	2.13+/-1.57	2.08+/-1.50	.567	
Obesity (%)	4.7	5.0	.773	X^2- test was used to compare categorical variables across asthma status.
Race			.094	
1. Mexican-American (%)	34.5	37.2		
2. Non Hispanic White (%)	26.3	28.7		
3. Non Hispanic Black (%)	39.2	34.1		
Gender				
Boys	48.9	50.1	.635	
Girls	51.1	49.9	.635	

Table 3. Descriptive statistics of eligible youths in the study

Variable	Number	Minimum	Maximum	Mean + SD
Age in years	3515	2.00	19.00	11.44 +/-5.4
BMI (kg/m^{-2})	3515	11.98	62.08	25.00 +/-7.5
Weight (kg)	3515	9.90	180.20	64.64 +/-29.3
Waist circumference (cm)	3396	41.70	167.20	85.07 +/-22.0
Standing Height	3515	80.60	199.20	155.56 +/-24.4
Family PIR	3331	0.00	5.00	2.09 +/-1.5

Family PIR: Family Poverty Income Ratio

The results of univariate analysis of the association between each of the examined independent Variables and current asthma are shown in Table 4. The magnitude of association between the independent variables and outcome variables are quantified using odds ratio from the logistic regression models. As shown, obesity is associated with 1.37 higher odds of having asthma (Odds Ratio of 1.37, 95% CI 1.36-1.38, p-value <.001). An increasing age is associated with lower odds of current asthma (OR of .99, 95% CI .98-.992, p-value <.001). Boys have 1.12 higher odds of having current asthma compared with girls (OR: 1.12, 95% CI 1.11-1.13, p-value <.001). Non-Hispanic Whites have 1.26 higher odds of having current asthma compared with

Mexican-American (OR: 1.26, 95% CI 1.25-1.27, p-value <.001). On the other hand Non-Hispanic Blacks have lower odds of having current asthma compared to Mexican-American (OR: .77, 95% CI .76-.78, p-value <.001). Family Poverty Income Ratio is not statistically significantly associated with current asthma status (OR:1, 95% CI .99-1.01, p-value<.001).

Table 4. Univariate analysis of association between obesity and other selected independent variable and current asthma

Variable	OR	95% CI	p-value
Obesity	1.37	1.36 − 1.38	<.001
Age in years	.99	.98 − .99	<.001
Gender			
Female	1.00 − −Reference		
Male	1.12	1.11 − 1.13	<.001
Ethnicity			
Mexican-American	1.00 − −Reference		
Non-Hispanic Whites	1.26	1.25 − 1.27	<.001
Hispanic Blacks	.77	.76 − .78	<.001
FPIR	1.00	.99 − 1.01	<.170

FPIR: stands for Family Poverty Income Ratio

To determine whether the associations in the univariate model were not dependent of other covariates, multivariate logistic regression was performed with same categories of independent variables see Table 5. With the multivariate analysis obese children had 1.64 higher odds of having current asthma (Odds Ratio (OR) of 1.64, 95% CI: 1.63-1.64, p-value of <.001). The data stratified by gender (see table 4) showed that being a male had 1.15 higher odds of having current asthma (OR 1.15, 95% CI 1.14-1.16, p-value <.001). Non Hispanic whites had a 1.37 higher odds of having current asthma compared with Mexican-American. On the other hand Non-Hispanic Blacks had .77 lower odds of having current asthma compare with Mexican-American (OR.78, 95% CI: .77-.79, p-value of <. 001). Increasing age seems to have some slightly protective effect on current asthma (OR .99, 95% CI: .98-.999, p-value<.001).

Table 5. Multivariate analysis of association between obesity and current asthmatic status

Variable	OR	95% CI	p-value
Obesity	1.64	1.63 − 1.65	<.001
Age in years	.99	.98 − .999	<.001
Gender			
Female	1.00 − −Reference		
Male	1.15	1.14 − 1.16	<.001
Ethnicity			
Mexican-American	1.00 − −Reference		
Non-Hispanic Whites	1.37	1.36 − 1.38	<.001
Non-Hispanic Blacks	.78	.77 − .79	<.001
FPIR	.98	.97 − .99	<.001

FPIR : Family Poverty Income Ratio

Chapter V

DISCUSSION AND CONCLUSION

Discussion

Obesity and asthma are diseases of high prevalence with significant increases in the past 2 decades. Obesity makes the diagnosis, treatment, and course of asthma difficult, and both of these public health problems put our children at greater risk for future health problems. This analysis from a NHANES data shows that being obese is associated with 1.64 higher odds of an increased likelihood of having current asthma status compared with normal weight children and adolescents. This finding is consistent with other previous studies (Visness, et al. 2010; Borrel, et al. 2013, Green, 2012; Papoutsakis, et al. 2013; Sithole, Douwes, Burstyn, & Veugelers. 2008). It is also found that boys have a1.15 higher odds of self reporting current asthma compared to girls. Several studies in the past have found the effect of obesity on asthma to differ by gender, some studies in favor of male and some in favor of female (Kattan et al.2010; Borrell et al. 2013).

The association between obesity and asthma appears independent of socioeconomic factors using the univariate analysis see table 4. However, multivariate analysis demonstrates some protective association with Family Poverty Income Ratio (OR: .98, 95% CI .97-.99, p-value <.001). A previous study by Sithole et al.2008, showed the association between BMI and asthma to be independent of socioeconomic factors. The Family Poverty Income Ratio is the relationship of family income to the family's appropriate poverty threshold based on family size and composition. Ratios below 1 are below the poverty threshold.

The association between obesity and current asthma status differs according to the racial/ethnic group. On univariate analysis, using the Mexican American as the reference, Non-Hispanic whites have a 1.26 higher odds of obesity associated with current asthma compared with Mexican American, on the other hand Non-Hispanic blacks have a.77 lower odds of obesity associated with current asthma status see table 4 and table 5. A previous study by Borrell et al. (2013), found that the prevalence of asthma varies across racial-ethnic groups with Non-Hispanic whites having a higher prevalence of asthma compared with Mexican Americans this is consistent with my finding in this study. However, they also found that African Americans have a higher prevalence of asthma compared with Mexican Americans, this is in contrast to my finding that shows a .77 lower odds of Non-Hispanics Blacks having current asthma status compared with Mexican American.

The major strengths of this study are that the NHANES data are nationally representative and the methods employed in conducting the survey are well researched and well rehearsed. Furthermore, the sample size is large increasing the statistical power of the analyses.

One major weakness of this study is that being a cross-sectional study the association found between obesity and asthma does not prove causation. Prospective longitudinal studies will be required to prove causation. Other weaknesses are in the process of exclusion of missing data, representation and generalization of the data might have been lost. In addition being a secondary data there is limitation of variables use for control of confounding factors, Another important limitation is that BMI is not a direct measure of adiposity and cannot differentiate between lean and fat mass.

What This Study Adds to the Field

The association between obesity and asthma differs in the three racial ethnic groups as shown in Table 4. On multivariate analysis of association between obesity and current asthma status, Non –Hispanics Whites have 1.37 higher odds of having current asthma status compared with Mexican American, on the other hand, Non- Hispanic blacks have.78 lower odds of having current asthma status. Being a male had 1.15 higher odds of having current asthma.

Recommendations

Prospective longitudinal studies are needed to determine if the association between obesity and asthma is causal and if there is a time frame for being at major risk for asthma development during childhood and adolescence. The finding that Non Hispanic blacks have .78 lower odds of current asthma status needs to be further investigated as it is in contrast to findings of previous studies. The potential implications of this study are the need to promote asthma prevention and obesity prevention.

Conclusion

In this study we found that obesity is significantly associated with current asthma status among children and adolescents, the mechanisms underlying this relationship are unclear. Furthermore, the association differs among the three racial-ethnic groups in United States. These findings are consistent with previous several studies. Developing a better understanding of the relationship between obesity and asthma control among racially and ethnically diverse children and adolescents population may have important public health implications, including the development of tailored clinical and public health interventions.

Finally, interventions that aim to prevent excessive weight gain in children and adolescents are especially important to healthy development and may also help to reduce asthma and obesity related morbidity and mortality in children and adolescents. On the other hand, one cannot rule out that asthma may contribute to obesity, perhaps due to inactivity or side effects of systemic corticosteroids. The relationship between childhood obesity and asthma may not be unidirectional. Therefore, intervention efforts to prevent asthma may also be beneficial to management and prevention of obesity.

Reference

1. Akinbami, L. J., Moorman, J.E., Garbe,P.L., & Sondik E. J.(2009). Status of childhood asthma in the United States, 1980-2007. *Pediatrics*, 123: S137s.
2. Asthma Statistics (2013), *American Academy of Allergy Asthma and Immunology.* http//www.aaaai.org/asthma-statistics.aspx
3. Bandini, L. G., Must, A., Phillips, S.M., Naumova, E. N., & Dietz, W.H. (2004). Relation of Body Mass Index and body fatness to energy expenditure: Longitudinal changes from preadolescence through adolescence. American Journal of Clinical Nutrition, 80(5):1262-1269.
4. Belamarich, P. F., Luder, E., Kattan, M., Mitchell, H., Islam, S., Lynn, H., et al. (2000). (Do obese Inner-city children with asthma have more symptoms than non obese children with Asthma? *Pediatrics, 106: 1436-41.*
5. Borrell, L. N., Nguyen, E. N., Roth, L. A., Oh, S.S., Tcheurekdjian, H., et al. (2013). Childhood obesity and asthma control in the GALA II and SAGE II studies.*American Journal of Respiratory Critical Care Medicine*. 187(7): 697-702.
6. Bugess, J. A., Walters, E.H., Byrnes, G. B., Giles, G.G., Jenkins, M.A., Abramson, M. J., Hopper, J.L. & Dharmage, S.C. (2007).Childhood adiposity predicts adult-onset current asthma in females: a 25-year

prospective study. *European Respiratory journal*, 29: 668-675.

7. Camargo, C. A. Jr., Weiss, S. T., Zhang, S., Wilett, W. C., Speizer, F. E. (1999). Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. *Archives of Internal Medicine*, 159 (21): 2582-8.
8. Centers for Disease Control and Prevention (CDC*). Guide to Community Preventive Services*. Available at http://www.thecommunityguide.or/obese/default.htm.
9. Centers for Disease Control, (2007). Clinical Growth Charts. National Center for Health Statistics: Hyattsville, MD.
10. Centers for Disease Control and Prevention, (2009). Healthy weight: body mass index. http//www.cdc.gov/healthyweight/assessing/bmi.
11. Centers for Disease Control, (2011). Childhood Obesity in the United States *MMWR* 60 (02); 42-46.
12. Chen, Y., Dales, R., Tang, M., Krewski, D. (2002). Obesity may increase the incidence of asthma in women but not in men: Longitudinal observations from the Canadian National Population Health Surveys. *American Journal of Epidemiology*, 155; 191-197.
13. Chinn, S. Rona, R. J. (2001). Can the increase in body mass index explain the rising trend in asthma in children? *Thorax*, 56:845-850.
14. Ciprandi, G., Pistorio, A., Tosca, M., Ferraro, M. R. & Cirillo, I. (2008). Body

mass of asthma. *Respiratory Medicine,* 103(2): 289-295.

15. Department of Health and Human Services (DHHS) (1992). International Consensus Report on Diagnosis and Treatment of Asthma. Washington, DC: DHHS.
16. Eliasson, O., Scherzer, H. H., & Degraff, A.C. Jr. (1986). Morbidity in asthma in relation to the menstrual cycle. *Journal of Allergy Clinical immunology*, 77: 87-94.
17. Ellul-Micallef, R. (1976). Asthma: a look at the past. *British Journal of Disease Chest ,* 70: 112-6.
18. Epstein, L. H., Valoski, A., Wing, R. R., McCurley, J. (1994). Ten year outcomes of behavioral family-based treatment for childhood obesity. *Health Psychology*, 13:373-83.
19. Flegal, K. M., Carroll, M.D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 199-2008, *Journal of American Medical Association*, vol.303. No 3 pp. 235-241
20. Ford, E. S., (2005).The epidemiology of obesity and asthma. *Journal of Allergy and Clinical Immunology*, 115(5): 897-909.
21. Gold, D. (2000). Environmental tobacco smoke, indoor allergens, and childhood asthma. *Environmental Health Perspective,* 108(suppl 4):643-651.

22. Gold, D. R., Damokosh, A. L., Dockery, D. W., & Berkey, C. S. (2003) Body-mass index as a predictor of incident asthma in a prospective cohort of children. *Pediatric Pulmonology*, 36(6): 514-521.

23. Green, T.L. (2012). Examining the temporal relationships between childhood obesity and asthma. *Economics and Human Biology*. http://dx.doi.org/10.1016/j.ehb.2012.10.002

24. Guler, N., Kirerleri, E., Ones, U., Tamay, Z., Salmayenli, N., & Darendeliler, F. (2004). *Journal of Asthma Allergy Clinical Immunology*, 114: 254-259.

25. Heinrich, J., Hoelscher, B., Frye, C., Meyer, I., Wjst , M, Wichmann, H. E. (2002). Trends in the prevalence of atopic diseases and allergic sensitization in children in Eastern Germany. *European Respiratory Journal* , 19: 1040-6.

26. Jones, R. I., & Nzekwu, M.M. (2006). The effects of body mass index on lung volumes. Chest; 130(3): 827-833.

27. Kattan, M., Kumar, R., Bloomberg, G. R., Mitchell, H. E., Calatroni, A., et al. (2010). Asthma control, adiposity, and dipokines among inner-city adolescents. *Journal of Allergy Clinical Immunology*,125: 584-592.

28. Keeney, E. L. (1964). The history of asthma from Hippocrates to Meltzer. *Journal of Allergy* 35: 215-26.

29. Kopelman, P., Caterson, I., Dietz, W. (2006). *Clinical Obesity in Adults and Children*, London: Wiley-Blackwell Publishing.

30. Krebs, N. F., Himes, J.H., Jacobson, D., Nicklas, T.A., Guilday, P., & Styne, D. (2007).Assessment of child and adolescent overweight and obesity. *Pediatrics*, 120(Suppl 4): S193-228.

31. Latzin, P., Frey, U., Roiha, H. L., et al. (2007). Prospectively assessed incidence, severity, and determinants of respiratory symptoms in the first year of life. *Pediatric Pulmonology*, 42(1): 668-675.

32. Lebowitz, M. D., Knudson, R. J., and Burrows, B. (1975). Tucson Epidemiologic Study of Obstructive Lung Diseases I: Methodology and prevalence of Disease. *American Journal of Epidemiology*, 102 (2): 137-152.

33. Moreno, L. A. & Rodriguez, G. (2007). Dietary risk factors for development of childhood obesity. *Curr Opin Clin Nutr Metab Care*, 10 (3): 336-41

34. Nathell, L., Jensen, I. & Larsson, K. (2002). High prevalence of obesity in asthmatic patients on sick leave. *Respiratory Medicine*, 96: 642-650.

35. National Heart, Lung, and Blood Institute, (2007). *Expert panel report 3: Guidelines for the diagnosis and treatment of asthma*. http//www.nhlbi.nih.gov/guidelines/asthma.Accessed July 5, 2013.

36. Ogden, C. L., Carroll, M. D., & Curtin, L. R. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *Journal of the American*

Medical Association, 295, 1549-1555.

37. Olshansky, D. J., Passaro, D.J., Hershow, R. C. et al. (2005). A potential decline in life expectancy in the United States in the 21st century. *The New England Journal of Medicine*, vol. 352, no. 11, pp. 1138-1145.

38. Papoutsakis, C., Priftis, N. K., Drakouli, M., Prifiti, S., et al. (2012). Childhood overweight/obesity and asthma: is there a link? A systemic review of recent epidemiologic evidence. *Journal of the Academy of Nutrition and Dietetics*, 113: 77-105.

39. Phillip, T. J. (2004). Obesity: the worldwide epidemic. *Clinical Dermatology*,22: 276-280.

40. Romieu, I., Mannino DM, Redd SC., McGeehin M.A. (2004). Dietary intake, physical activity, body mass index, and childhood asthma in the third national health and nutrition survey (NHANES III). *Pediatric Pulmonology*. 38(1): 31-42.

41. Samet, J. M.(1987). Epidemiologic approaches for the identification of asthma. Chest, 91: 74S-78S.

42. Sithole, F., Douwes, J., Burstyn, I., & Veugelers, P. (2008). Body mass index and childhood asthma: a linear association*? Journal of Asthma*, 45: 473-477.

43. Taussig, L., wright, A., Holdberg, C., Halonen, M., Morgan, W., & Martinez,

F.(2003). Tucson Children's respiratory study: 1980 to present, Journal of Allergy Clinical Immunology, 111(4):661-675.

44. Visness, C. M., London , S. J., Daniels, J. L., Kaufman, J. S., Yeatts, K. B., Siega-Riz, A., Calatroni, A. & Zeldin, D. C.(2010). Association of childhood obesity with atopic and non-atopic asthma: Results from the National Health and Nutrition Examination Survey 1999-2006. *Journal of Asthma,* 47(7): 822-829

45. Wang, G., & Dietz, W. H. (2002). Economic burden of obesity in youths aged 6-17years: 1979-1999. *Pediatrics*, 109(5): E81-E86.

46. Weiss, S. T., Shore, S. (2004). Obesity and asthma: direction for research. *American journal of Respiratory Critical care Medicine,* 169:963-968.

47. Witorsch, R., & Witorsch, P. (2000). Review: environmental tobacco smoke and respiratory health in children: a critical review and analysis of literature from 1969 to 1998. Indoor Built Environment, 9: 246-264.

48. Woodward-Lopez, G., Ritchie, L.D., Gerstein, E.D., & Crawford, P.B. (2006). Obesity*: Dietary and developmental influences*. Boca Raton, FL: CRC Press.

49. Xu, B., Pekkanen, J., laitinen, J., Jarvelin, M. R. (2002). Body build from birth to adulthood and risk of asthma. *European Journal of Public Health*, 12:

166-170.

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