Mediating Factors in the Relationship between Sociodemographic Factors and Chronic Lower Respiratory Diseases (CLRD) among adult ACBS respondents in the United States

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I declare that this thesis is my own work and has not been submitted for the award of a higher degree elsewhere.

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LIST OF ABBREVIATIONS

ACBS	Asthma Call-Back Survey
AOR	Adjusted Odds Ratio
BRFSS	Behavioral Risk Factor Surveillance Survey
CDC	Center for Disease Control
CI	Confidence Interval
CLRD	Chronic Lower Respiratory Diseases
COPD	Chronic Obstructive Pulmonary Disease
DSS	Disproportionate Stratified Sampling
DF	Degree of Freedom
ECRHS	European Community Respiratory Health Survey
ETS	Environmental Tobacco Smoke
FPL	Federal Poverty Level
FHMREC	Faculty of Health and Medicine Research Ethics Committee
NCHS	National Center for Health Statistics
OR	Odds Ratio
PM	Particulate Matter
SEP	Socio-economic Position
SHS	Second Hand Smoke
TECH	Technical
US	United States
UK	United Kingdom
WHO	World Health Organization

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ABSTRACT

Background: Chronic Lower Respiratory Diseases (CLRD), such as asthma, chronic obstructive pulmonary disease (COPD), chronic bronchitis and emphysema are preventable diseases that constitute a serious public health concern. Estimates indicate that there is an increased prevalence of mortality from these diseases worldwide. Low socio-economic positions (SEP) and poor indoor environmental conditions have been identified as risk factors for CLRD among adults. Given the public health burden of CLRD, there is increasing interest among researchers to identify all relevant factors associated with CLRD. However, many studies identified in the literature only controlled for individual or specific risk factors and most of these studies vary in their definition of risk factors. As a result, the evidence was contradictory. Some studies reported statistical associations while other studies reported no statistical association between specific risk factors and CLRD. Also, questions remain on which risk factors mediate the relationships between socio-demographic factors and CLRD. Given this, the study will examine if indoor environmental factors and access to healthcare mediates the relationships between socio-demographic factors and CLRD among adult ACBS respondents in the United States (U.S). The study will further examine if the effects of socio-demographic factors on CLRD depend on indoor environmental factors and access to healthcare.

Methods: This study examined three different years of secondary cross-sectional data collected from adults 18 years or older by the Behavioral Risk Factor Surveillance Survey (BRFSS) and Asthma Call-Back Survey (ACBS). 15,403 participants from 2009, 17,753 from 2010 and 16,693 from 2011 were included in the study. Bivariate analyses were used to identify significant predictors, and logistic regression models were used to examine mediation and predictor-mediator interaction effects. CLRD was

the outcome of interest, socio-demographic factors were used as predictors, and indoor environmental factors and healthcare access were used as potential mediators.

Results: The bivariate analyses revealed that gender, age, marital status, education, employment status, income, mold, pest infestation, smoking indoors, being a current or former smoker, occupational exposure and medical cost were significant predictors of CLRD. The mediation tests revealed that mold, mice presence, being a current smoker, smoke indoors and occupational exposure fully or partially mediated the relationship between age, education, employment, income and current asthma. Being a current or former smoker, smoking indoors, and occupational exposure fully or partially mediated the effects of age, marital status, education, employment and income on COPD, bronchitis and emphysema. Mold and medical cost were also identified as mediators for bronchitis and mold for emphysema. These findings indicate that indoor environmental factors and medical cost, fully or partially explain the effects of socio-demographic factors on CLRD. The statistical significant predictor-mediator interaction effects revealed that the effects of gender, age, education, employment and income on the reporting of CLRD depends on mold, mice presence, being a current or former smoker, smoking indoors, occupational exposure and medical cost.

Conclusion: This is the first study to use rich cross-sectional secondary data from three different years to demonstrate that poor indoor environmental conditions and inadequate access to healthcare play a significant role in explaining the reporting of CLRD among ACBS respondents in different social, economic and demographic groups. These findings have clear implications for related public health policies. These policies should focus on creating more resources in deprived neighborhoods, improving inadequate housing conditions through housing refurbishment and ensuring adequate access to healthcare for all groups regardless of their SEP.

CHAPTER 1

This chapter provides background and rationale for the current study and a brief outline of the different theories that describe how SEP generates health inequalities. This is followed by the main aim and objectives, research questions and the study hypotheses.

1.0 INTRODUCTION

1.1 Background

CLRD such as asthma, chronic bronchitis, emphysema and COPD are respiratory tract diseases that affect the air passages such as the bronchi, nasal passages and lungs (GOLD 2006; Rabe 2008; WHO 2013). These diseases cause inflammation of the airways that result in chronic recurrent episodes of airflow shortage, which is characterized by symptoms such as coughing, breathlessness, wheezing and chest tightness among susceptible individuals (De Palo 2004; WHO 2013). Chronic respiratory tract infections are preventable and constitute a serious public health concern not just for low-income countries, but for all countries regardless of development, with most of the related deaths occurring in lower to middle-income countries (Bousquet et al., 2007).

These preventable diseases affect millions of people of all ages throughout the world, and more than 50% of individuals affected by these diseases live in deprived conditions (Bousquet et al., 2007; WHO 2013). Also, these diseases can significantly impact the quality of life and impose a substantial financial burden on families, societies and the population in general (Bousquet et al., 2007). Estimates of the World Health Organization (WHO) indicated that 235 million individuals currently have asthma worldwide; 64 million suffer from COPD with 3 million deaths per year, which equalled 5% of all global deaths in 2005 (Strong et al., 2005; WHO 2013). An increase

in the prevalence of these diseases has been linked partly to changes in SEP, access to healthcare, tobacco use and indoor environmental conditions (WHO 2002).

In the U.S., CLRD is a significant public health concern (Mannino et al., 1998; Mannino and Buist 2007; CDC 2011). Data released in 2011 showed that 11.5 million adults reported current asthma, 14.7 million reported COPD, 4.7 million reported emphysema and 10.1 million reported chronic bronchitis (CDC 2011). The frequent outcome of the diagnosis of these diseases in the U.S. is hospitalization, work disability and unemployment (Eisner et al., 2002; Thoenen 2003). Available data indicate that the average duration of hospitalization in 2005 from these diseases varied from 2.9 to 4.6 days (HCUP 2009). Data from 2009 showed that between 1997 to 2009 the number of hospital stays for COPD increased by 34% (HCUP, 2009). Data released in 2009 and 2011, indicates that there has been an increase in deaths from CLRD, such as asthma, COPD, chronic bronchitis and emphysema (Kazerouni et al., 2004; Kung et al., 2008; CDC 2009; CDC 2011). The data also revealed that deaths from these diseases rose 7.8% from 2007 to 2008, exceeding stroke as the third leading cause of premature death in the United States (Mannino and Buist 2007; CDC 2009; CDC 2011). Mannino et al. (2000), Thoenen (2003) and Greenlund et al. (2016) identified tobacco smoking, exposure to second-hand smoke, exposure to home and workplace air pollutants as important risk factors that are responsible for the increase in hospitalization and death from these diseases.

Low SEP, poor indoor environmental conditions and inadequate healthcare access have been identified as risk factors that can influence the prevalence of asthma, COPD, chronic bronchitis and emphysema among children and adults (Basagana et al., 2004; Cruz et al., 2010; Wilner at al., 2012). Many studies have investigated the impact of these risk factors on the prevalence of CLRD in children (Moorman et al., 2007; Wilner

et al., 2012). However, these risk factors are less often studied in adults. Studies that have examined the effects of access to quality healthcare on CLRD outcomes among adults are also limited. Although previous studies have examined and suggested a relationship between some of these risk factors and CLRD (Chen et al., 2002; Ellison-Loschmann et al., 2007; Eisner et al., 2011; Gershon et al., 2012; Zahran et al., 2014), there are gaps in the evidence. First, which indoor environmental factors influence the relationship between socio-demographic factors and increased risk of CLRD among ACBS respondents. Second, how these diseases are distributed among adult ACBS respondents in different social, economic and demographic groups based on their living conditions and access to healthcare.

1.2 Study Rationale

Despite rigorous epidemiological and basic research on the risk factors that may have an impact on the increased risk of CLRD. Several important questions, such as which sub-population groups are more susceptible to CLRD and which factors contribute to the exacerbation of CLRD remain and still require further investigation (Asthma 2008). Postma (2007) posits that to understand the etiology of diseases such as CLRD better; there is a need for more research among adults to explore the health effects of interrelated key social, environmental, biological and personal factors and their association with specific adult conditions such as CLRD. A review of the literature revealed that in-depth studies that have investigated the relationship between the different socio-demographic groups, indoor environmental factors, healthcare access and CLRD in an adult population are limited. The literature also revealed that most studies lack a clear theoretical concept of how social, economic and demographic factors influence respiratory health outcomes. Furthermore, many of these studies continue to control for specific or individual socio-demographic and indoor

environmental risk factors in their analyses rather than a comprehensive examination of how and which indoor environmental factors and access to healthcare influence the relationship between socio-demographic factors and risk of CLRD. Given these gaps, questions on the disparities of CLRD among adults in different social, economic and demographic group based on their living conditions and access to healthcare and which indoor environmental risk factors influence the relationship between socio-demographic factors and CLRD remain. As a result, further research is required to examine the relationship between these factors and the reporting of CLRD among adults in the U.S. In an attempt to extend our understanding of these diseases and to build on the existing body of evidence on CLRD, a secondary analysis of three different years of the existing cross-sectional datasets will be conducted. This study aims to explore the relationship between socio-demographic, indoor environmental factors, access to healthcare and CLRD among adult ACBS respondents in the U.S. Moreover, the proposed empirical examines whether the relationship between socio-demographic factors and the reporting of CLRD is mediated by indoor environmental factors and access to healthcare. The study will also examine if the relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. depends on indoor environmental factors and access to healthcare. To date, this will be the first study to use three different years of cross-sectional data to explore whether one or more indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and CLRD. Also, to determine if the effects of indoor environmental factors and access to healthcare on the reporting of CLRD vary by different social, economic and demographic groups. As noted by Schraufnagel (2010) understanding disease mechanisms, identifying high-risk

population groups and intervening to reduce environmental risk factors could significantly lessen the burden of diseases.

Several studies have established a relationship between low SEP and various respiratory health outcomes (Lantz et al., 2001; Schnitter 2004; Roos et al., 2004; Smith and Frank 2005). More than 50% of individuals affected by respiratory diseases live in deprived conditions (Bousquet et al., 2007; WHO 2013). Moreover, variations in health outcomes and mortality among individuals in different socio-economic groups have also been well established by several studies (Smith 1999; Hayward et al., 2000; Cutler et al., 2006). For example, a British Healthy Life Expectancy (HLE) study revealed that at birth professional men were expected to live 6.7 years longer than unskilled men, a similar trend was observed for women with professional women at birth expected to live 6.4 years longer than unskilled women (White and Edgar 2010). Although the evidence linking socio-economic factors and health is compelling, the question remains about why and how differences in SEP produce health inequalities (Van Oort et al., 2005; Elo 2009; Van Kipperrsluis et al., 2009). In this study, three main models, social selection, life course perspective and social causation models were adapted from the Black Report and the work of Bambra (2010) and Mackenbach (2012), to explain how socio-economic conditions generate health inequalities.

The social selection model suggests that SEP is determined by health outcomes rather than the fact that SEP determines health outcomes (Black 1980; Canning and Bowser 2010). Hence, indicating that individuals with good health will move towards high SEP while those with poor health outcomes will move to low SEP, leading to health inequalities (Blane et al., 1993; Canning and Bowser 2010). The social causation model proposes that health inequalities in health outcomes are generated by the unequal

distribution of material resources, behavioral and psychosocial factors (Brunner and Marmot 2006; Brunner 2007).

The life course perspective suggests that the trend and manifestation of disease and poor health outcomes are determined by the exposure to many different factors such as social, psychosocial and biological factors across the lifespan (Krieger 2001; Steindbach 2009). While the life course approach would be preferable because the trend of disease outcomes accumulates through exposure to many different social and economic risk factors over the life course, the life course approach was not used to inform the current study because the datasets are the results of a cross-sectional study. Although there are available longitudinal datasets such as the 1970 UK birth cohort study on the early life course and health outcomes and Whitehall ll study that have longitudinal data on respiratory disease and environmental conditions. These datasets were not used to examine the study questions because there was limited information on all the indoor environmental factors that were required to answer the research questions of the current study. As a result, the social causation of health inequality framework was used to guide the current study.

The social causation of health inequality framework, drawn from the work of Dahlgren and Whitehead (1991), Bartley (2004) and Mackenbach et al. (2007), will be utilized to examine three different years of secondary cross-sectional data. The aim is to explore if the relationships between socio-demographic factors and the reporting of CLRD among adult ACBS respondents are mediated by one or more indoor environmental factors and access to healthcare. Also, the study aims to investigate if the relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. depends on indoor environmental factors and access to healthcare. The social causation of health inequality framework was selected to guide

the current study because it is based on the social determinants of health inequalities. The model posits that health inequality is generated by economic, social and material conditions in which people live and work (Dahlgren and Whitehead 1991; Bartley 2004).

1.3 Aim of the Study

To explore if indoor environmental factors and healthcare access (medical cost) mediates the relationship between socio-demographic factors and CLRD among adult ACBS survey respondents in the U.S. and to determine if the effects of the relationship between indoor environmental factors, access to healthcare and CLRD vary by different social, economic and demographic groups.

1.4 Objectives

The objectives of this study are to:

1. Explore the reporting of CLRD among adult ACBS respondents in different social, economic and demographic groups in the U.S.

2. Explore if indoor environmental factors and access to healthcare impact the relationships between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S.

3. Explore if the relationships between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. depends on indoor environmental factors and access to healthcare.

1.5 Research Questions

The following research questions were explored in the current study:

1). What is the relationship between socio-demographic, indoor environmental factors, access to healthcare and the reporting of current asthma, COPD, chronic bronchitis and emphysema among adult ACBS respondents in the U.S?

2). What indoor environmental factors and access to healthcare mediates the relationships between socio-demographic factors and CLRD among adult ACBS respondents in the U.S?

3). What relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. depends on indoor environmental factors and access to healthcare?

1.6 Study Hypotheses

The following hypotheses were examined in the current study:

1. There is a relationship between socio-demographic, indoor environmental factors, medical cost and the reporting of current asthma, COPD, chronic bronchitis and emphysema among ACBS respondents in the U.S.

2. One or more indoor environmental factors (mold, pest infestation, smoking indoors, smoking status, occupational exposure and access to healthcare (medical cost) might mediate the effects of socio-demographic factors (gender, age, ethnicity, educational level, employment status and income) on the reporting of CLRD among ACBS respondents in the U.S.

3. The relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. might depend on one or more indoor environmental factors and access to healthcare.

CHAPTER 2

This chapter examines the models that have been proposed to explain how health inequalities are generated. It begins with an overview of health inequalities followed by the limitations of the biomedical model. It looks at the social determinants of health and disease. It then explores the different models and theories that have been employed by researchers to understand health inequalities. In the last section of this chapter, the conceptual framework for the current study is outlined.

2.0 CONCEPTUAL FRAMEWORK

Health inequality is the systematic difference in health among individuals in different SEP (Graham 2009). Health inequalities occur across multiple social dimensions, education, employment, income, social class, deprivation, ethnicity and geography (McCartney et al., 2013). The implications of health inequalities are that individuals with less education, inadequate employment and less income tend to have poorer health outcomes (Kroger et al., 2015). These inequalities have been found to persist in many different countries in the world (Singh and Siahpush 2006; WHO 2015; Mackenbach et al., 2015). Consequently, questions on how health inequalities are generated among individuals in different SEP becomes more important. Given this, to conceptualize the disparities of the risk of CLRD among individuals in different SEP, living conditions and various levels of access to healthcare, a framework of health inequalities have been constructed. The framework aims to help understand the risk factors that are associated with poor health and how health inequality is generated. The framework is grounded in the theorization of the social determinants of health inequalities, rather than the biomedical model (Solar and Irwin 2010). This is because there is a large body of compelling evidence demonstrating that socio-economic factors influence health and disease outcomes (Adler et al., 1999; Braveman et al., 2011; Marmot and Bell 2012).

2.1 Limitation of Biomedical Model

This evidence does not refute the fact that biomedical factors such as high blood pressure, high cholesterol and body mass index influences health and disease outcomes; instead, it emphasizes that biomedical factors are not the only influence on health outcomes. The evidence demonstrates that the effects of the biomedical model may be more limited than frequently assumed, particularly in determining which individual becomes sick (Adler et al., 1999; Adler and Stewart 2010; Braveman et al., 2011). The biomedical model focuses on the physical processes that affect health, such as the biochemistry, physiology, and pathology of a condition (Wade and Halligan 2004; Cockerham 2007). The model has been effective in treating health problems and returning people to a healthy state, thus improving the quality of life for individuals with chronic diseases (White 2002; Cockerham 2007). However, the model does not take into consideration that social and psychosocial factors could play a role in poor health outcomes (Nettleton 2006; Abelson et al., 2008). For example, although in the United Kingdom (UK) (with universal healthcare coverage) overall health was better compared to the U.S. (with no universal healthcare coverage), health disparities by income level was similar in the two countries (Martinson 2012). This is supported by the huge differences in health inequalities according to SEP that have been previously documented across different European countries, despite universal access to healthcare (Mackenbach et al., 1997; Mackenbach et al., 2000; Mackenbach et al., 2008). Also, although healthcare spending in the U.S. is higher than any other developed nation, a recent report revealed that poor health in both morbidity and mortality in the U.S. applies across most indicators of health and all age groups except those older than 75 years of age, which also applies to Americans in high and low SEP (Woolf and Aron 2013). This is supported by an earlier review by McGnnis et al. (2002) they estimated

that only 10-15% of preventable mortality in the U.S. could be avoided by adequate medical care. However, previous studies have disputed these estimates and assert the importance of social factors (Mackenbach et al., 1989; Mackenbach 1996). In her review of the book "Social Causes of Health and Disease" Blaxter (2007) eloquently stated that in medical sociology, a paradigm shift is emerging which acknowledges the limitation of biomedical model and looks beyond the individual causes of poor health to emphasize social causes. These social causes have been identified to have an impact on the level of biological risk (Dalton et al., 2003). Evidence has shown that the relationship between education, employment status, income level and mortality is strongly influenced by health-related behaviors (Stringhini et al., 2010; Braveman et al., 2011). For example, a Canadian census mortality follow-up study found that males with very low income can expect to live on average to age 73 while those with very high income can expect to live to age 80, a difference of 7 years, among women the gap was 4 years (Wilkins et al., 2008). Findings from a U.S. study concluded that almost half of all deaths among working-age adults in the U.S. is as a result of avoidable factors associated with lower educational status (Jemal et al., 2008). Similarly, a previous study of mortality change in Britain found that an increased capability to purchase material resources through high wages, along with improved work conditions had a substantial effect on reducing mortality (Blane 1990).

There is significant evidence to support the fact that socio-economic factors generate health inequalities through complex interactions with other factors such as living conditions, type of neighborhood and healthcare access (Braveman and Gottlieb 2014). Socio-economic factors are connected to poor health through relatively direct exposures to other factors (Braveman and Gottlieb 2014). For instance, exposures to mold, dust, pest allergens and pollution are more common in deprived neighborhoods,

and these exposures have been linked to increased asthma prevalence (Lanphear et al., 2001). Due to the complex relationships between social factors and health, the main problem with the argument that social factors generate health inequalities is identifying specifically how these social factors generate health inequalities (Shaw et al., 1999). Moreover, not only is the empirical evidence to support the direction of the effects of social factors on health inequalities limited, but there is also an ongoing debate on the strength of the evidence supporting a causal role of socio-economic factors. As a result, the plausibility of this causal relationship has been challenged and remains an area of contention (Hedstrom and Swedberg 1998; Braveman et al., 2011; Phelan and link 2013). Although evidence on the relationship between low SEP and poor health outcomes is convincing, there are differences among researchers about the effects of income and education on health and disease outcomes (Braveman and Gottlieb 2014). Some studies have argued that reverse causation is reflected in the relationships between education and health, or income and health, for example, poor health can lead to lower educational achievement which leads to inadequate employment resulting in low income or income loss (Braveman et al., 2011; Braveman and Gottlieb 2014). According to Kawachi et al. (2010), poor health frequently results in income loss or low income and educational achievement could be limited by poor health in childhood. However, evidence from cross-sectional and longitudinal studies concluded that these do not explain the significant and persistent relationships observed between these factors and poor health outcomes (Case et al., 2005; Link et al., 2008; Kawachi et al., 2010). Also, reverse causation cannot explain the relationship between educational attainment and health outcomes because once education has been achieved, it cannot be reduced (Braveman and Gottlieb 2014). Another area of contention is that despite substantial evidence demonstrating the important effects of social factors on health, not

every individual in low SEP develops a disease or become sick (Braveman and Gottlieb 2014). This is because protective factors such as self-efficacy and social support may alleviate the adverse effects of poor socio-economic conditions (Mathews et al., 2010; Seeman et al., 2010). For example, among Latino immigrants in the U.S. income and education have not predicted health outcomes as consistently as among other groups (Gallo et al., 2009). One of the main justifications for these inconsistencies has included the effect of protective factors such as attitudes, social and community support (Franzini et al., 2001; Gallo et al., 2009).

Despite these arguments, there is evidence that asserts that SEP is a "fundamental cause" of disparities in disease and mortality outcomes (Link and Phelan 1995; Phelan and Link 2013). The concept of fundamental causes summarizes why the relationship between low SEP and health inequalities persist over time. It is hypothesized that SEP and living conditions influence disease outcomes through multiple risk factors and lack of adequate resources that can protect health (Phelan et al., 2010; Braveman et al., 2011; Flaskerud and Delilly 2012). For example, in a U.S. study, patients from higher SEP had significantly better blood glucose management, health and survivability thus maintaining stable employment and good income compared to patients from lower SEP, hence confirming that there is a relationship between SEP and variation in health outcomes and mortality (Lutfey and Freese 2005). Supporting this view is evidence that health inequalities have reduced when inequalities in material resources have reduced while health inequalities have increased when inequalities in the distribution of material resources have increased (Krieger et al., 2008; Thomas et al., 2010).

At the community level, Castello et al. (2003) reported that the health outcomes of communities have improved when the communities have more material resources. For example, the availability of quality neighborhood services such as housing,

employment resources, schools, transportation and adequate social support has been linked with improved physical and psycho-social health (Williams and Collins 2001; Diez Roux and Mair 2010; Braveman et al., 2011). A U.S. study concluded that there was an increased risk of developing coronary heart disease among individuals living in the most disadvantaged communities even after controlling for personal socio-economic factors (Diez Roux et al., 2001). Disparities in mortality among different socio-economic groups have been found to persist within different countries regardless of wealth. For example, poor health outcomes and high mortality rates have been reported among males, blacks, less educated, unemployed and those with low income in the UK, U.S., Ghana, Namibia and Korea (Brockerhoff and Hewett 2000; Mackenbach et al., 2003; Khang et al 2004; Lutfey and Freese 2005).

The framework of the current study is based on the theorization of the social determinants of health and disease and involves the synthesis of components from previous theories and models. The social determinants of health inequalities will be discussed in this framework to highlight the fact that health inequalities are socially produced and to emphasize that exposure to health-damaging factors plays an important role in determining poor health outcomes among individuals in lower SEP (Jarvis and Wardle 1999; Graham 2004). The primary purpose of the framework is to explore the link between socio-economic, environmental factors and healthcare access that influence individual health and to clarify their relationships with disease and health outcomes within the context of the present study.

2.2 Social Determinants of Health Inequalities

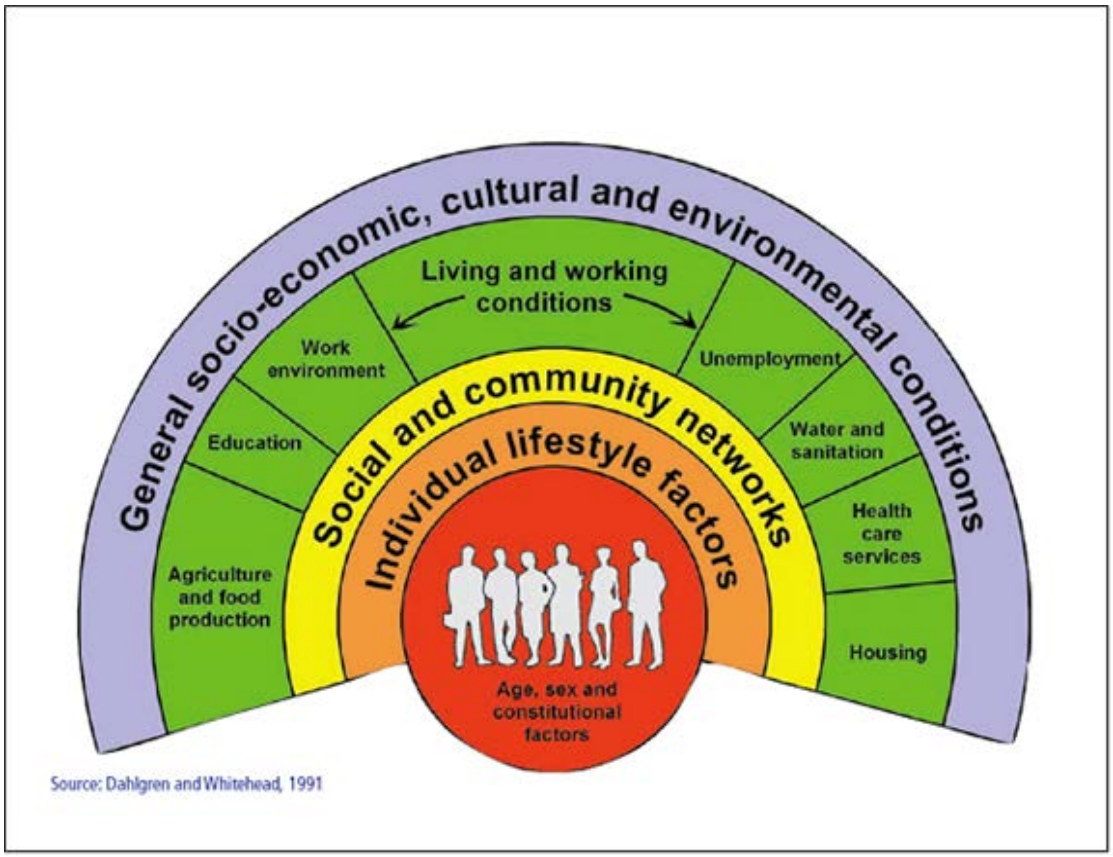

Figure 1. Dahlgren and Whitehead's Model of Social Determinants of Health.

The material and social conditions in which people live and work influence their health (Dahlgren and Whitehead 1991; WHO 2007; Graham 2007). As indicated in Figure 1, these conditions are shaped by social, economic and demographic factors such as age, gender, race/ethnicity, education, employment and income, which are important determinants of health and disease outcomes (Dahlgren and Whitehead 1991; WHO 2007; Satcher 2010). Socio-economic factors influence environmental conditions such as housing conditions, mold growth, pest infestation, second-hand smoke, occupational exposure and access to adequate healthcare. For example, less educated individuals tend to have inadequate employment with low wages which results in insufficient financial resources to support the purchase of suitable living conditions (intermediary factors) such as good quality housing, adequate healthcare and access to basic facilities,

which have direct impact on health and disease outcomes (Golabardes et al., 2006**;** Cockerham 2007; Prus 2007). The basic concept is that health inequalities are as a result of the unequal distribution of adequate material resources among individuals in different socio-demographic groups (Davey Smith 1996; Lynch et al., 2000; Solar and Irwin 2010).

2.3 Theoretical Explanations of Health Inequalities

Evidence from multiple sources has established that health is stratified at every level of SEP by social and economic resources (Marmot 2004; Cockerham 2007; Solar and Irwin 2010; Satcher 2010). Although the relationship between health disparities and SEP has been well established, knowledge in the direction through which SEP generates health inequalities is still limited. As a result, some theories have been advanced in an attempt to provide a consistent explanation of how health inequality is created. The categorization of these theories in the Black Report and the work of Bambra (2010) and Mackenbach (2012) was adapted to review some of the theories of health inequalities. In this section of the framework, relevant theories will be discussed with examples from previous studies that have used diverse datasets, methods and designs to explain how and why health inequalities arise. Also, to unpack the concept of the social determinants of health and disease, the influence of the relationship between structural determinants (socio-demographic factors) and intermediary determinants (indoor environmental factors) on individual health outcomes such CLRD will be discussed in detail under the social causation model. Although social selection, behavioral, psychosocial and life course approaches were not used to inform the current study, to get a general understanding of how health inequalities are generated these approaches will also be discussed briefly.

2.3.1 Social Selection Theory

Social selection emphasizes reverse causation, stating that SEP is determined by health outcomes (Blane et al., 1993; Canning and Bowser 2010). This theoretical perspective suggests that individuals suffer ill health first before drifting down in the social hierarchy, and that poor health is as a result of disability, unemployment and inadequate resources which may cause the decline in social position (McCartney et al., 2013). A meta-analysis by Van Rijn et al., (2014) and a recent study in 11 countries in Europe by Reeuwijk et al., (2017) revealed that poor health increases the risk of exit from paid employment through disability pensions which has an impact on individual and household income and their health outcomes. Also, Yelin et al. (2006), compared income level between disabled individuals and those without a disability, they demonstrated that disability and the inability to work has an impact on available income and the ability to maintain needed health support. While a previous study has supported the explanation that poor health can cause social slide for some individuals, the effect size of this study was too small to account for much of the overall difference in health (Wilkinson 1997). However, evidence from several longitudinal studies has failed to demonstrate that social selection accounts for health inequalities (Power and Mathew 1997; Smith et al., 1998; Brimblecombe et al., 2000). The Black Report examined and rejected the notion that social selection might explain health inequalities (McCartney et al., 2013). Also, previous data analysis observed that only very few sick skilled professionals experience downward occupational changes (Townsend and Davidson 1990). Given that the current study will seek to explore health outcomes among individuals in different SEP, the framework of the present study will focus on the social determinants of health and social causation of health inequalities.

2.3.2 Psychosocial Approach

The current study will explore the impact of social, economic, demographic and indoor environmental factors on the reporting of CLRD among adult ACBS respondents. Given this, the psychosocial approach was not used to inform this framework because it was not the focus of the present study. However, previous studies have established that, individuals in low SEP experience poor health outcomes (Marmot et al 2010) because of their exposure to inadequate life conditions (White 2002), lack of adequate social support (Elstad 1998) and less job security and self-sufficiency (Marmot et al 1997; Marmot and Wilkinson 1999). Although these different relationships have been reported, the core argument is that individual perceptions and experience of personal position in unequal societies lead to stress, which negatively affects health outcomes by increasing susceptibility to illness (Kelly et al., 1997; Raphael 2006). A different concept of psycho-social factors was put forward by Siegrist (1998, 2000, and 2004) and echoed by Bartley (2004) who argued that stress is generated by a perceived lack of mutual exchange in the work environment, which cause individuals to become more vulnerable to addiction and other high-risk behaviors.

2.3.3 Behavioral Approach

Individual behaviors such as physical activity, smoking, heavy drinking, diet and illicit drug use are important determinants of health outcomes (Health Canada 2008; Solar and Irwin 2010). According to Dahlgren and Whitehead (2006) and WHO (2007), these behaviors are influenced by the individual's SEP. In a more direct explanation, the difference in health-related behaviors among different socio-economic groups is as a result of personal health-damaging behaviors such as consumption of alcohol, drugs, tobacco and psychological characteristics (Skalicka´ et al., 2009). The uneven distribution of these behaviors between different socio-economic groups indicates that

behavioral factors are important as determinants of health inequalities (Solar and Irwin 2010). However, according to a previous long-term study of British civil servants by Marmot et al. (1991), only one-third of social class differences in mortality was explained by health behaviors of the study participants. Also, no apparent improvements in health that would be predicted by the behavioral approach were identified in an evaluation of interventions that sought to change health behaviors (Steinbach 2009). Moreover, this approach is limited as it focuses on individual behaviors and does not take into consideration that, unhealthy behaviors and poor lifestyle choices may result from living in poorer material circumstances (Laaksonen et al., 2005). Although the behavioral concept was not used to inform the framework of the current study, smoking will be included in this study. This is because previous studies have suggested an association between lower SEP and increased risk of smoking and that smoking is an important risk factor for the development of respiratory illness such as COPD (Sherman 1992; Finkelstein et al., 2006). The effects of smoking on CLRD will be discussed in detail in the literature review.

2.3.4 Life Course Perspective Approach

Individual health outcomes reflect the patterns of exposure to favorable and unfavorable social, psychosocial and biological conditions over time (Steinbach 2009). The life course approach is an essential mechanism through which social determinants impact individual health outcomes (solar and Irwin 2010). This approach adds a dimension to the difference in health outcomes and explains inequalities in health and disease outcomes as the result of different socio-economic factors, which influences health at different times in life (Davey Smith et al., 2002; Galobardes et al., 2004), operating at different levels such as individual, household and neighborhood (Diez Roux et al., 2001; Pickett and Pear 2001; Sampson et al 2002), through different

pathways or causal mechanisms (Wilkinson 1997; Marmot 2001; Pickett and Pear 2001). Poulton and colleagues (2002) stated that, low socio-economic conditions in childhood could have negative influences on health later in life, regardless of the health status at the beginning of life or where the individual ends up as an adult in the socio-economic hierarchy. Similarly, a systematic review revealed that those from low socio-economic backgrounds were more likely to be exposed to inadequate conditions that might have a long-lasting negative influence on health and disease outcomes later in life (Garlobardes et al., 2006). In the same light, a body of evidence demonstrated that adult health is influenced by a variety of exposure to different conditions in childhood (Kuh and Hardy 2002; Kuh and Ben-Sholomo 2003; Davey Smith 2003; Irwin et al., 2007). Therefore, individuals in high and low SEP, experience different health and disease outcomes because of the cumulative effects of exposure to the material environment (Davey Smith 1996; Lynch et al., 2000; Solar and Irwin 2010), psychosocial factors (Marmot and Davey Smith 1997; Marmot et al., 1998; Seigrist and Marmot 2004; Pearlin et al., 2005) and early life behaviors (Brunner 1999; Holland et al., 2000; Berney et al., 2000) on their health. As a result, Solar and Irwin (2010) noted that adopting a life course approach directs attention to how social determinants of health function at every level of development from early childhood to adulthood, both how these determinants impact health and how they provide the basis of health and disease outcomes later in life. Also, the life course perspective is important because it allows different causal processes and mechanism to explain the health difference among different socio-economic groups (Skalicka et al., 2009). As Krieger indicated, the health of individuals is no longer only as a result of existing conditions and the lifestyle choices of the individual but is also determined by past events and living conditions (Krieger 2001). This concept revealed that life course is an essential

dimension in determining the difference in health outcomes among individual in different social, economic and demographic groups from early childhood to adulthood (Ben-Sholomo and Kuh 2002). Despite the significance of the life course perspective, this approach was not used to inform the current study because the datasets are a result of a cross-sectional study. Although longitudinal datasets that were identified, such as the 1970 British Cohort study and the UK Whitehall ll study contain early socio-economic status and health outcomes these studies did not have enough information on indoor environmental factors required to answer the study questions. As a result, these datasets were not considered.

2.3.5 Social Causation of Health Inequalities

Socio-economic disparities have usually been defined by education, income and occupation, and are the leading cause of health inequalities (Link and Phelan 1995). Inequalities in education, income, and occupation increases the gaps between health outcomes of individuals in high and low SEP (Link and Phelan 1995). To clarify this concept of socio-economic status and health inequalities Diderichsen (2004) social position model of "the mechanisms of health inequality" and Cockerham (2007) theoretical perspective on "the social causation of health and disease" were incorporated into the framework. These models posit that individuals are assigned to different social positions due to social stratification generated by structural determinants such as gender, ethnicity, education, employment and income (Diderichsen 2004; WHO 2007; Cockerham 2007). Social stratification further determines the differential consequences and pattern of health and disease outcomes of individuals in high and low SEP, and it also defines how people in different SEP experience illness (Hallqvist et al., 1998; Diderichsen 2004; WHO 2007; Cockerham 2007). These differential consequences of poor health and disease outcomes are due to

the direct and indirect effects of the relationship between structural determinants such as socio-economic factors and intermediary determinants such as environmental conditions (Whitehead 1990; Solar and Irwin (2010). Whitehead (1990) cited factors such as smoking, overcrowding, poor living conditions and inadequate indoor environmental conditions as the leading cause of the differences in health outcomes. For example, individuals with low income are unable to afford proper living conditions (intermediary factors) such as good quality housing, adequate healthcare and access to basic facilities, which have a direct impact on health and disease outcomes (Cockerham 2007). Health inequalities are generated when there is an uneven distribution of material resources and the difference in exposure to these material resources among individuals in different social, economic and demographic groups (Solar and Irwin 2010). For example, low income can impact living conditions and reduce access to medical services, which can lead to poor health outcomes. This concept is in agreement with Graham's (2004) view of the social processes influencing the unequal distribution of material factors such as intermediate determinants of health.

While the general relationship between socio-economic status and health outcomes has been well established (Marmot & Wilkinson, 1999; Cockerham 2007; Solar & Irwin, 2010), this relationship does not prove causality (Thisted 2003). Also, because of the difficulties in linking social and biological factors (Thisted 2003; Cockerham 2007), the specific mechanism through which social and environmental factors determine health is not yet fully understood (Shaw et al., 1999). In this regard, Thisted (2003) suggested that since the concept of social determinants of health requires a mechanism of action to confirm that social factors determine disease outcomes, it is important to identify social mechanisms at the population level that affect health and diseases at the individual level. Moreover, to develop effective ways to improve public health, it is

essential to identify determinants of biological and environmental markers of health outcomes by first understanding the social determinants of the risk factors that are responsible for the unequal distribution of disease and poor health in different population groups (Marmot and Wilkinson 2006). Therefore, the fundamental empirical question for this study is "What indoor environmental factors and access to healthcare mediate the relationships between socio-demographic factors and CLRD and does the relationships between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. depend on indoor environmental factors and access to healthcare?"

2.3.6 Healthcare Approach

The healthcare system contributes in determining health outcomes through access to adequate care (WHO 2010; Nagata 2011). Evidence indicates that SEP such as education, employment and income influences access to adequate healthcare services, which has an impact on health and disease outcomes (Link et al., 1998; Phelan et al., 2010). Although the disparity in healthcare access is not the primary influence of the onset of poor individual health conditions (Evans and Studdart 1990, Oliver and Mossialos 2004), evidence indicates that inequitable access to adequate care is an important contributor to the differences in health and disease outcomes (Lurie and Dubowitz 2007). Also, access to healthcare influences health and disease outcomes of individuals in different SEP (McGibbon et al., 2008; Cameron et al., 2014), through availability, quality, information and cost of care (Goddard and Smith 2001). However, Aldler et al. (1993) argued that health differences among individuals in different SEP could not be explained by healthcare access alone because it is not the main influence on health and disease outcomes. Cockerham (2007) echoed this view; he indicated that SEP is an important indicator for the access, and use of adequate healthcare services

(Cockerham (2007). For example, a recent study in Canada concluded that people of high socio-economic status had better health outcomes than those of low socio-economic status because they were more likely to access primary care services (Olah et al., 2013). In the U.S. healthcare is provided through private and public insurance as a result large percentage of the population is uninsured or under-insured (Pylypchuk and Sarpong 2013). Chu and Rhaodes (2011) reported that in 2009, 43 million adult Americans were uninsured, while Schoen et al. (2011) reported that in 2010, 29 million were under-insured. Problems accessing adequate care were identified to be significantly higher among the uninsured (Karen et al., 2006). A number of studies in the U.S. have determined that low SEP measured by education attainment, employment characteristics/occupational status and income are significant barriers to adequate access to healthcare of all types including health insurance coverage (Pappas et al., 1997; van Doorslaer et al., 2000; Monheit and Vistries 2000; Fiscella et al., 2003). These findings were supported by Blackwell et al. (2009), they found that low-income individuals in the U.S. were less likely to access adequate healthcare due to medical cost. These findings revealed that SEP is linked to disparities in access to suitable healthcare, which may have a significant impact on health and disease outcomes (Gelberg et al., 2000; Mendis et al., 2007; Cruz et al., 2010; Olah et al., 2013). Therefore, as highlighted by WHO (2007) and Nagata et al. (2011), the role of the healthcare system in health inequality becomes particularly relevant through access to adequate healthcare, which determines who will be able to get adequate health intervention as a result, the healthcare system should be viewed as an intermediary determinant. Given this, the concept of equitable access to healthcare has been incorporated into the theoretical framework for this study to unpack the influence of

indoor environmental factors and healthcare access on the relationship between socio-demographic factors and CLRD.

2.4 Conceptual Framework Examining Socio-demographic, Indoor Environmental Factors and Health Inequalities

In this section, a framework that will be adopted by the current study is outlined. Schulz and Northridge (2004) proposed a framework to understand the dynamic mechanism through which social, economic and demographic factors influence aspects of the indoor environment thereby impacting individuals and population health. They posit that social inequalities are produced by, but not limited to inequalities based on structural determinants such as age, gender, race/ethnicity, education, employment and income (Schulz et al., 2002; Northridge and Sclar 2003; Schulz and Northridge 2004). These inequalities result in the unequal distribution of material resources (House et al 1994; Link and Phelan 1995), which influence the indoor environment or intermediary factors such as occupational exposure, mold, pest infestation, second-hand smoke and access to healthcare (Northridge et al., 2003; Schulz and Northridge 2004), which in turn impact individual and population health outcomes such as chronic respiratory diseases (Schulz and Northridge 2004), through greater exposures to these inadequate conditions (Cockerham 2007). This is a focused conceptual framework for the current study that will be used to guide the study analyses, discussion of results and conclusion. This conceptual framework is summarized below in Figure 2 to delineate the relationship between SEP, indoor environment, access to healthcare and respiratory health outcomes (CLRD).

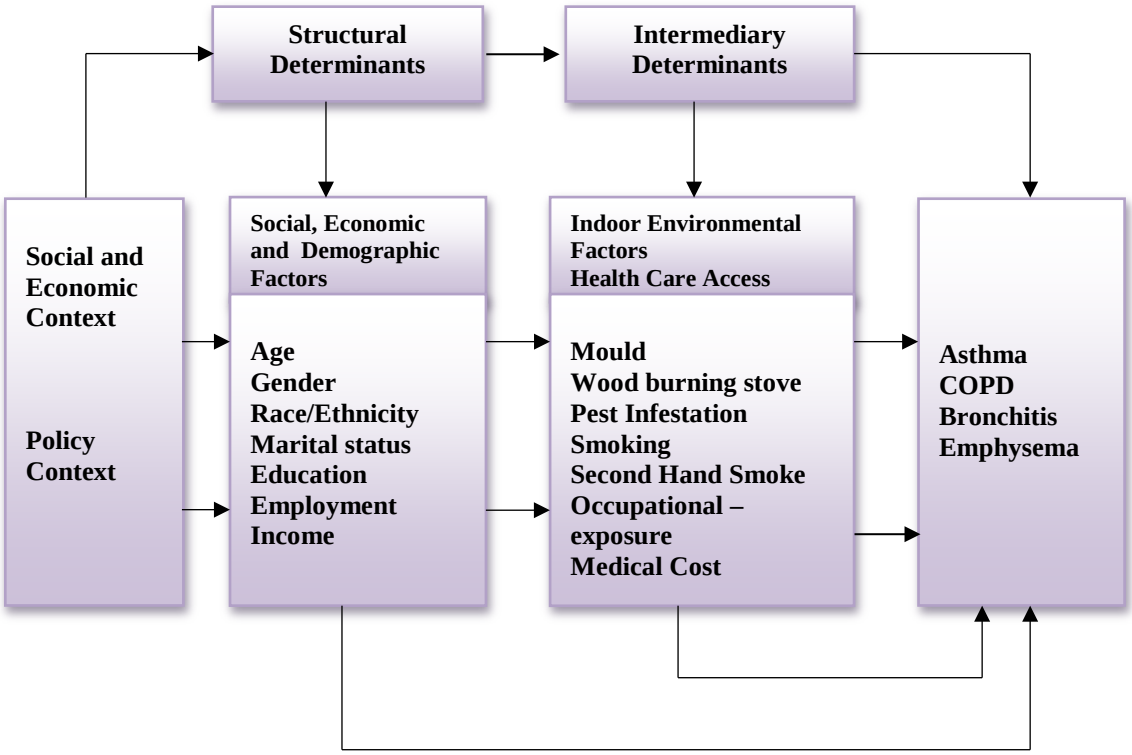

Figure 2. Outline of the Relationship between Socio-demographic, Indoor Environmental Factors, Healthcare Access and CLRD Outcomes.

The diagram shows the summary of the process through which social, economic and demographic status impact CLRD outcomes through intermediate determinants such as indoor environmental factors and access to healthcare. The diagram was adapted from Marmot and Wilkinson (1999), Diderichsen et al. (2001), Schulz and Northridge (2004), Graham (2004) and Mackenback (2006).

2.5 Conclusion

The proposed conceptual framework for this study has been developed to investigate if indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. Although different theories including social selection, biomedical model, psychosocial approach, behavioral approach, life course perspective were discussed in this framework, the social causation of health inequality model was

the appropriate model that was used to inform the current study. This model was used to guide the current study because it explains how health inequalities are generated and to build on the suggestion of Marmot and Wilkinson (2006) that it is important to identify empirically the factors that generate health inequalities. Also, to determine how these factors impact the health and disease outcomes of individuals in different social, economic and demographic groups. In light of this framework, three important areas were explored. First, the difference in the reporting of CLRD among adult ACBS respondents in different socio-demographic groups. Second, the mediating effects of indoor environmental factors and access to health on the relationship between socio-demographic factors and CLRD. Third, if the relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the US depends on indoor environmental factors and access to healthcare.

In this chapter, I have outlined the conceptual framework for the current study that examined how social and economic factors generate health inequalities through other closely related factors such as living conditions and healthcare access. In the next chapter, the empirical evidence on the relationships between socio-demographic, indoor environmental factors and healthcare access and CLRD will be discussed.

CHAPTER 3

3.0 LITERATURE REVIEW

3.1 Structure of the Literature Review

The search of the literature identified a limited, but relevant studies that looked at the relationship between CLRD, socio-demographic, indoor environmental factors and healthcare access. 7,644 studies related to the current study were identified. Narrowing the search with more specific search terms, 173 relevant studies were identified. A preliminary assessment of this revealed its heterogeneity, demonstrating that many different socio-demographic and indoor environmental factors may be associated with CLRD. Hence, this literature review is a comprehensive and focused methodological assessment of studies investigating three important areas of the study. Firstly, the individual association of socio-demographic and indoor environmental factors and CLRD; secondly, the effect of access to healthcare on CLRD; and thirdly, the impact of the relationship between socio-demographic and indoor environmental factors on CLRD**.** The search strategy for the literature review is presented in appendix 1.

The literature review presented here is divided into four main sections:

- Studies examining the relationship between socio-demographic factors and CLRD.
- Studies examining the relationship between indoor environmental factors and CLRD.
- Studies examining the relationship between access to healthcare and CLRD.
- Studies examining the effect of the relationship between socio-demographic and indoor environmental factors on CLRD.

3.2 Socio-Demographic Factors and Chronic Lower Respiratory Disease

This section will review studies on the relationships between age, gender, ethnicity, marital status, education, employment, income and CLRD.

3.2.1 Age

Evidence from some studies in the U. S. and several countries in Europe indicates that age is a risk factor for CLRD (Hamzacebi et al., 2006; Leone et al., 2012), although the evidence is contradictory (Moorman et al., 2007; Wilner et al., 2012). In the U.S. higher asthma incidence was observed in children than adults especially younger children (Moorman et al., 2007; Wilner et al., 2012). However, evidence from epidemiological studies has highlighted the frequency of lower respiratory diseases among older adults, with the prevalence ranging from 4.5% to 12.7% (Kotaniemi et al., 2001; Hamzacebi et al., 2006; Moorman et al., 2007). Age was identified as a strong predictor of acute asthma, COPD and chronic bronchitis (Tsai et al., 2009; Ferre et al., 2012). An increased rate of asthma was identified among those 65 years or older in France (Leone et al., 2012), while this increase was less pronounced among those under 40 years old in Sweden (Brogger et al., 2003). In the UK, COPD was reported to vary with age and mortality and three times higher among those aged ≥85 years (Connolly et al., 2006). A recent study reported that COPD has a significant personal, economic and societal burden on the working age population (Fletcher et al., 2011). However, evidence from several studies has suggested that the burden of these diseases in relation to hospitalization, mortality and medical cost was significantly higher among those 65 years or older (Plaza et al., 2000; Moorman et al., 2001; Bellia et al., 2007; Hanania et al., 1997). Interactions of various factors such as environmental exposures, social, economic, comorbidities and epigenetic factors have been reported to increase the inequalities of these diseases in adults and older adults (Yanez et al., 2014). Given this,

there is a need to focus on specific adult age groups and to perform age-adjusted analysis (Stone et al., 2012). As a result, in the current study age-adjusted analysis was explored to determine the specific age groups that are most at risk of CLRD in relation to other factors such as gender and ethnicity.

3.2.2 Gender

A review of prospective evidence indicated that there is significant variability of incidence and risk of respiratory symptoms between gender and age (King et al., 2004). Reflecting the overall trends in asthma incidence, a study of young children found high asthma incidence in boys (Gilliland et al., 2003), while studies of adults found high asthma incidence in females (Camargo et al., 1999; Chen et al., 2002; Romieu et al., 2003). Chronic bronchitis was observed to be more common among men in a general population study in France (Ferre et al., 2012). However, the increase in hospitalization for acute and severe asthma was reported to be common among females than males (Wood et al., 2003; Dolan et al., 2004; Lougheed et al., 2006; Almarri 2006; Lin and Lee 2008; Smith et al., 2009; Rowe et al., 2009). Although more hospitalization for COPD and high proportions of death in hospitals was reported among men than women in Canada, the relative risk for women versus men increased gradually with increased age (Chen et al., 2005). Given these contrasting results, it is important to include gender in the analysis of the current study to determine if there is a gender difference in the reporting of CLRD after controlling for other factors.

3.2.3 Ethnicity

The less healthy profiles of racial minorities in countries like the United States and Great Britain indicates that ethnicity might be an especially significant factor influencing health and disease outcomes (Cockerhams, 2007). However, Thisted (2003) argues that because ethnicity lacks independent explanatory power, it is not a

social determinant of health. The rationale for Thisted's (2003) argument is that ethnic difference in health is closely related to other factors such as socio-economic status and living conditions, and there is a lack of adequate evidence to show that ethnicity by itself influences health and disease outcomes. However, the highest variation of COPD prevalence was observed among blacks in the UK (Nacul et al., 2007), while high susceptibility and greater COPD severity was found to be more strongly associated with African Americans as opposed to whites in the U.S. (Chatila et al., 2004; Eisner et al., 2011). Although increased prevalence and attributable mortality rate of COPD was reported among whites compared to African Americans, the high prevalence among whites could not be attributed to risk factors such as smoking and low socio-economic status as these factors are more prevalent among African Americans (Mannino et al., 2000; Hardie et al., 2000; American Lung Association 2001; NCHS 2002). Kaufman et al. (1997) had previously, suggested that even after adjusting for socio-economic status, a residual ethnicity difference may remain. However, in the U.S., non-Hispanic blacks and Hispanics had greater frequencies of emergency department visits for current asthma compared to non-Hispanic whites and non-Hispanic Asians (Rhode et al., 2004). To add to this discussion, the current study will not only investigate the impact of ethnicity on CLRD but will also control for socio-economic factors in an attempt to clarify the strength of the relationship between ethnicity and CLRD.

3.2.4 Marital Status

No studies were identified that specifically examined the relationship between marital status and asthma, COPD, bronchitis and emphysema in adults. However, many studies have examined the relationship between marital status and various health outcomes (Koskinen and Martelin 1994; Mackenbach et al., 1999; Kiecolt-glaser et al., 2001; Maselko et al., 2009). Marriage has been shown to have a positive impact on the health

outcomes of both men and women with men experiencing a greater positive effect than women (Kiecolt-glaser et al., 2001). Meanwhile, Gordon and Rosenthal (1995) and Johnson et al. (2000), reported that unmarried patients had a poorer prognosis in some diseases. Married patients with acute exacerbation of COPD were found to live longer than unmarried patients, and being unmarried was an independent predictor of mortality (Amagro et al., 2002). Furthermore, patients suffering from acute exacerbation of asthma that depend primarily on crisis-oriented care were more likely to live alone (Hanania 1999). In contrast, Almagro et al. (2002) found no difference in patients with acute exacerbation of COPD living alone in relation to socio-economic status. Given the public health burden of CLRD and the increasing interest to identify all relevant factors that are associated with CLRD, it is essential to consider the potential role of marital status on the reporting of CLRD in the current study.

3.2.5 Education

The relationship between education, health outcomes and health disparities among the more and less educated has been well established (Elo and Preston 1996; Deaton and Paxson 2001; Cutler and Lleras-Muney 2006). This association has been found in many countries and time periods (Christenson and Johnson 1995; Elo and Preston 1996; Deaton and Paxson 2001; Cutler and Lieras-Muney 2006). Increased risk of asthma and chronic bronchitis was reported among adults of lower social class and less education in Europe, Australia, New Zealand and the United States (Basagana et al., 2004; Ellison-Loschmann et al., 2007). Low educational level was identified to be a risk factor for asthma morbidity among adults in Canada (Bacon et al., 2009) and Norway even after adjusting for age, sex, smoking, occupational exposure and hay fever (Bakke 1995; Engan et al., 2004). Low educational level was found to be associated with increased risk of COPD in Finland (kanervisto et al., 2011) and poor prognosis of

already established COPD in Denmark (Lange et al., 2014). This evidence indicates that there is a relationship between educational level and respiratory diseases. However, Prescott et al. (1999) and Engana et al. (2004) recommended further studies to identify factors that are responsible for the impact of educational level on respiratory symptoms. Based on these recommendations, educational level will be included in the study analyses to determine the impact of educational status on CLRD after adjusting for other factors.

3.2.6 Employment Status

Several studies have identified a link between unemployment and poor health outcomes (Brenner and Mooney 1983; Bartley 1994; Jin et al., 1995; Mathers and Schofield 1998; Benavides et al., 2000; Fryers et al., 2003; Waddell and Burton 2006). While other studies have indicated reverse causation that poor health outcomes increase the risk of exiting from paid employment resulting in income loss or inadequate household income (Van Rijn et al., 2014; Reeuwijk et al., 2017). A consistent relationship was observed between unemployment and poor health outcomes across 23 European countries (Bambra and Eikemo 2009). Adults in lower SEP based on their employment status were more likely to have severe recurring asthma (Littlejohns and McDonald 1993). Similarly, occupational status was associated with greater asthma severity (Blanc et al., 2006). This was further confirmed by studies in Germany, which concluded that unemployed individuals were more likely to have asthma (Hoffmann 2007) and that perceived job insecurity might be related to an increased risk of new asthma onset in adults (Jian 2014). In Spain, a higher risk of bronchitis-type symptoms was identified among unemployed adults compared to employed subjects (Kogevinas et al., 1998). In the current study, the impact of employment on CLRD was assessed in relation to other predictors.

3.2.7 Income Level

Income is an important indicator of socio-economic status and a significant predictor of health and disease outcomes (Galobares et al., 2006). On the other hand, poor health and the inability, to work due to disability has an impact on individual and household income which has a further impact on health and disease outcomes (Yelin et al., 2006). A population-based cross-sectional survey in Brazil found that low family income was significantly associated with chronic bronchitis (Menezes et al., 1994). Similarly, a study of adults with asthma in the U.S. concluded that low income was associated with greater risk of hospitalization for asthma; they also mention that the process of asthma care among low-income patients may be less adequate (Eisner et al., 2001). A similar finding was reported by Haas et al. (1994) they discovered that, after admission to the hospital for asthma, low-income patients received lower intensity asthma management than those patients with higher income. Low income was strongly associated with COPD, with a much stronger association observed among men than women in a Canadian study (Chen et al., 2000). Active asthma was observed to be associated with low income among randomly selected adults in California (Von Behren et al., 2002). However, a previous study in Canada concluded that the prevalence of asthma over the years was not related to income level, although they also mention that low-income individuals had more asthma-related hospitalizations than high-income individuals (Erzen et al., 1997). As a result, it is important to examine if the impact of income on the reporting of CLRD is influenced by other factors.

3.3 Indoor Environmental Factors

The indoor and household environments are important components of the physical environment and have been recognized as a major source of exposure to allergens, irritants and toxic chemicals (Richardson et al., 2000). For many years, the indoor environment has been recognized as an indicator of social and health inequalities and an important factor that can influence population health and disease outcomes (Richardson et al., 2000; Bonnefoy 2007; Braubach and Savelsberg 2009; Braubach and Fairburn 2010). This is because the indoor environment contains significant exposures that can affect the health of its occupants (Mitchell et al., 2007), and as people spend more time indoors, exposure to these contaminants increases the opportunity for significant health effects (Harrison and Holmes 2000; Mitchell 2007; Bernstein et al., 2008). Exposure to indoor environmental factors such as allergens and toxins are thought to exacerbate respiratory conditions such as asthma. Also, these factors can act independently or in combination with other factors to influence the respiratory health outcomes of individuals in low SEP (Blanc et al., 2005). In light of this, this section of the review will critically examine some important indoor environmental factors such as mold, pest infestation, smoking indoors, smoking and occupational exposure and their relationships with CLRD.

3.3.1 Mold

Exposure to indoor mold has been linked by several studies to adverse adult respiratory conditions, particularly with symptoms in sensitized individuals such as cough, wheezing and asthma symptoms (Dales et al., 1991; Brunekreef 1992; Pirhonen et al., 1996; Williamson et al., 1997; Evans et al., 2000; Kilpelainen et al., 2001; Bornehag et al., 2004; Institute of Medicine 2004). Indoor mold growth was identified to have an adverse effect on adult asthma in a study of 38 centers in Europe Zock et al. (2002).

Three meta-analyses reported a statistically significant relationship between indoor dampness and mold and increased risk of current asthma among adults (Fisk et al., 2007; Fisk et al., 2010; Quansah et al., 2012). Although dampness was identified as a risk factor for lung function decline in women, no association was found between indoor mold growth and lung function decline in young adults (Norbäck et al., 2011). However, indoor dampness and mold growth were identified to be associated with increased incidence of asthma among adults in Europe, Australia and United States (Norbäck et al., 2013). There is compelling evidence that indoor dampness and mold are determinants of respiratory symptoms such as asthma-related symptoms. As a result, the current study examined the influence of mold presence on the reporting of CLRD in relation to other factors.

3.3.2 Pest Infestation

High incidence of pest infestation such as cockroach and mice has been reported in some U.S. public housing (Litonjua et al., 1999; Leaderer et al., 2002; Wang et al., 2008). This high incidence of pest infestation has been linked to low socio-economic status and inadequate housing maintenance (Wang et al., 2008). A significant poor respiratory health outcome associated with pest infestations is asthma (Wang et al., 2008). Also, mouse and cockroach allergens have been identified as strong risk factors for allergic sensitization and asthma morbidity (Cohn et al., 2004; Cohn et al., 2006). These associations have been confirmed by several studies (Rosentreich et al., 1997; Phipantankul et al., 2000; Eggleston et al., 2001; Huss et al., 2001; Arruda et al., 2001; Crain et al., 2002; Rogers et al., 2002). Furthermore, a study in the U.S. found elevated levels of mouse and cockroach allergens in households with lower income, concluding that high levels of mouse and cockroach allergens in the household could contribute to asthma morbidity (Cohn et al., 2004). Although there is a link between pest infestation

and some respiratory symptoms, only a few studies have investigated these relationships. As a result, pest infestation was included in the analyses to determine its influence on the reporting of CLRD.

3.3.3 Smoking

Smoking has a harmful effect on the structure and function of the lung, and it is an important risk factor for the development of COPD (Sherman 1992). The evidence consistently indicates that increased risk of smoking is associated with lower socio-economic status (Finkelstein et al., 2006). Carlos et al. (2001) reported that smokers with COPD had higher tobacco consumption, which was found to be more prevalent in men and individuals with lower educational level. Some studies have suggested an association between active cigarette smoking and the development of asthma (Plaschke et al., 2000; Rasmussen et al., 2000; Kim et al., 2002). While other studies found no independent association between smoking and asthma development but concluded that active smoking might exacerbate asthma symptoms and increase morbidity in susceptible individuals (Vesterinen et al., 1988; Troisi et al., 1995; Lemiere and Boulet 2005). Also, Eisner and Iribarren (2007) concluded that smoking is a modifiable risk factor for adverse asthma health outcomes. Given this evidence, smoking was included in the analyses to determine its influence on the reporting of CLRD.

3.3.4 Second Hand Smoke (SHS)

It has been recently concluded that exposure to second-hand smoke (SHS) causes disease and premature death in children and adults who are non-smokers (USDHHS 2006). Several studies have documented the respiratory effects of children and infant's exposure to SHS with the strongest effects identified among the younger ages (Li et al., 1999; Cook and Strachan 1999; Difranza et al., 2004). However, studies that examined the respiratory effect of adults exposed to second-hand smoke are limited, and as a

result, less is known about the health effects of SHS on adults and young adults (USDHHS 2006). In the U.S. never smoked adults exposed to environmental tobacco smoke reported more acute respiratory health effects than unexposed never smoked adults (Mannino et al., 1997). This was confirmed by a review that identified a causal relationship between chronic respiratory symptoms and environmental tobacco smoke (ETS) (Jaakkola and Jaakkola 2002). Although evidence on the relationship between SHS and COPD is also limited, previous studies have suggested that SHS may be a cause of new onset of COPD and that exposure in childhood was associated with increased risk of COPD in men and women (Upton et al., 2004; Svanes et al., 2004; de Marco et al., 2004; Eisner et al., 2005; Johannessen et al., 2012). Similarly, SHS was identified as an important factor influencing disease severity and health status of adults with COPD (Eisner et al., 2006). Despite evidence linking SHS exposure with respiratory symptoms, reports indicate that evidence-linking SHS to respiratory health outcomes in adults is only suggestive and not enough to conclude that there is a causal relationship (USDHHS 2006). To add to this discussion, the current study investigated the effects of smoking indoors on the reporting of CLRD.

3.3.5 Occupational Exposure

Occupational exposures (chemicals, smoke, fumes and dust) play a role in the onset of several CLRD (Zock et al., 2001). Estimates indicate that 15-17% of adults with asthma are attributable to occupational factors (Balmes et al., 2003: Toren and Blanc 2009). The impact of occupational exposure on the prevalence of respiratory diseases has been estimated at 4-5% for females and 11-19% for males (Bakke et al., 1991; Heederik and Pal 1993; Kogevinas et al., 1996; Kogevinas et al., 1999; Vermeulen et al., 2002). Occupational asthma has been identified as the most common occupational respiratory disease in industrialized countries (Tarlo et al., 1998). Occupational exposure was

identified as a risk factor for current asthma, COPD and chronic bronchitis (Zock et al., 2001; Trupin et al., 2003; Mazurek et al., 2013). A study in the United States and Canada reveal that ongoing exposure to occupational fumes had an adverse effect on the rate of decline in lung function in men with early COPD (Harber et al., 2007). In Germany, among individuals with COPD, occupational exposure was independently associated with respiratory symptom severity and work inactivity (Rodriguez et al., 2008). Similarly, in the U.S., individuals diagnosed with work related-asthma had a negative employment outcome such as being unable to work (White et al., 2013). However, in a previous study in Italy, no definite association was observed between occupational exposure and lung function (Viegi et al., 1991). The current study included participants whose asthma were caused by chemicals, smoke, fumes or dust in any previous job to determine its influence on the reporting of CLRD.

3.4 Healthcare

There is no evidence in the literature that inadequate access to healthcare is responsible for the onset of CLRD or that access to adequate healthcare can prevent the development of CLRD among people that are at increased risk of respiratory diseases. Given this, the literature will focus on access to health care post diagnosis of CLRD. Previous studies have shown that individuals in low SEP cannot afford the cost of regular treatment of chronic diseases such as asthma, COPD, bronchitis and emphysema (Mendis et al., 2007; Cruz et al., 2009). Also, in communities in the U.S. where individuals perceive poor access or barriers to adequate medical care, there are high rates of hospitalization for these chronic diseases (Bindman et al., 1995). As a result, there are high proportions of people with uncontrolled asthma, COPD and bronchitis that can have a significant economic burden on individuals, families and the healthcare system, and can also lead to the deterioration of the quality of life (Mendis

et al., 2007; Cruz et al., 2009; Franco et al., 2009). This was demonstrated in a longitudinal study which concluded that the lack of a regular asthma care provider is a significant predictor of increased acute resource utilization and worse asthma quality of life among inner-city minority adults with asthma (Wisnivesky et al., 2005). Worse healthcare access and less optimal care were reported among young adults with asthma compared to adolescents with asthma, losing insurance coverage and other social factors were identified to be contributors to the difference (Chua et al., 2013). A similar finding was reported by a previous study, which indicated that uninsured young adults are less likely to have a usual source of care than insured individuals (Callahan and Cooper 2005). Zoratti et al., (1998) mention that there is a race/ethnic difference in patterns of asthma-related healthcare access within a managed care setting, which is partially due to financial barriers. Also, a report on asthma prevalence and healthcare use in the United States revealed that non-Hispanic black persons had relatively low rates of ambulatory visits compared with their use of urgent healthcare services (Akinbami et al., 2011). Given this, the current study examined access to healthcare by looking at the reporting of all CLRD among respondents who were unable to see a doctor because of cost.

3.5 Socio-demographic and Indoor Environmental Factors

Evidence from the literature suggests that many socio-demographic and environmental factors contribute to the development or exacerbation of chronic lower respiratory diseases (WHO 2002) and that the burden of these diseases is unevenly distributed in the population due to different SEP, environmental exposures, health status, healthcare access and deprivation (Cruz et al., 2009; Schraufnagel 2010). Many of these studies have used questionnaires to investigate the association of these specific risk factors and chronic lower respiratory diseases such as asthma, COPD, bronchitis and emphysema

(Montnémery et al., 2001; Zock et al., 2002; Kanervisto et al., 2011). Some of these studies have reported no association between these risk factors with some respiratory symptoms (Montnemery et al., 2001; Huovinen et al., 2003), while other studies have reported an association between these risk factors and respiratory symptoms (Zock et al., 2002; Basagana et al., 2004; Eagana et al., 2004; Kanervisto et al., 2011). The inconsistent findings of some of these studies may be due to the lack of standardization between studies, specifically with regards to the definition and measurement of respiratory diseases, socio-demographic and indoor environmental factors (Eliison-Loschmann et al., 2006). This section of the review will look at the relationship between socio-demographic, indoor environmental factors and CLRD. Studies by Litonjua et al (1998), Kuschnir and Alves de Cunha (2007), Montnemery et al (2001), Basagana et al (2004), Szynkiewicz et al (2013) and a review by Gershon et al (2012), were identified in the literature that examined the relationships between socio-demographic, some indoor environmental factors and CLRD, none of these studies examined access to healthcare. Two studies were identified that used the BRFSS and ACBS datasets, Zahran et al. (2014) and Zahran et al. (2015) both studies examined medical cost in their studies. Some of these studies only controlled for specific risk factors such as gender, age, educational level and income while other studies generally controlled for SEP, living conditions and environmental exposure. However, no study was identified in the literature that specifically looked at how indoor environmental factors and medical cost mediates the relationships between socio-demographic factors and CLRD with predictor-mediator interaction effects. Indicating that, questions remain on which indoor environmental risk factors and access to healthcare influence the relationships between socio-demographic factors and increased risk of CLRD among adult ACBS respondents in the U.S.

A cross-sectional study of environmental and socio-demographic factors in Brazil found that environmental factors such as second-hand smoke, cat presence and socio-demographic factors such as age, gender and income were identified to be associated with asthma in adults (Kuschnir and Alves de Cunha 2007). Although a study in Sweden concluded that living condition was not a risk factor for chronic bronchitis and emphysema, increased risk of bronchitis and not asthma was found to be associated with low SEP compared with middle or high SEP (Montnemery et al., 2001). A similar association was observed between low SES and increased risk of asthma, regardless of the SES measure used, although exposure to environmental factors was identified to be partly responsible for the association (Basagana et al., 2004). In the U.S., it was concluded that SEP and environmental exposure were responsible for increased risk of asthma among the elderly (Litonjua et al., 1998). However, no association was reported between sex, place of residence and quality of life of asthma patients in Poland (Szynkiewicz et al., 2013). Two distinctive results were observed in a study on socio-economic status and COPD in Finland after adjusting for gender, age, smoking history and body mass index (BMI), low household income was associated with the increased risk of asthma in women, while the basic education level was associated with increased risk of COPD in both genders (Kanervisto et al., 2011). Two studies that used the BRFSS and ACBS data were identified, Zahran et al. (2014) assessed asthma prevalence and observed variation in risk of asthma among the racial/ethnic groups while Zahran et al. (2015) assessed asthma control among adults and observed that uncontrolled asthma is influenced by social, economic and demographic factors. The current study differs from the study of Zahran et al. (2014) and Zahran et al. (2015) in that, it examined whether indoor environmental factors (mold, pest infestation, smoking status, smoking indoors and occupational exposure) and access to healthcare (medical

cost) mediates the relationship between socio-demographic factors and CLRD; and whether the effects of the relationship between indoor environmental factors, access to healthcare and the reporting of CLRD among adult ACBS respondents varies by different socio-demographic groups. A review by Gershon et al. (2012), indicated that COPD disparity is as a result of many different factors and that the relationship observed between low SEP and increased risk of COPD outcomes, is influenced by factors such as housing conditions, smoking, occupation, environmental exposure and air pollution. The review also recommended further studies to determine factors that are responsible for the difference in excess risk of COPD among individuals in low SEP (Gershon et al., 2012).

3.6 Conclusion and Research Gap

The review indicates that evidence on the relationship between, socio-demographic and indoor environmental factors and the risk of CLRD is contradictory. Some studies did not identify any association between certain risk factors and increased risk of CLRD (Montnemery et al., 2001; Szynkiewicz et al., 2013). While other studies did not only reveal an association between SEP and respiratory health outcomes, they concluded that respiratory health outcomes might differ by certain socio-demographic factors, indoor environmental conditions and healthcare access (Chen et al., 2002; Blanc et al., 2005; Mendis et al., 2007; Ellison-Loschmann et al., 2007; Bonnefoy 2007; Eisner et al., 2011; Ferre et al., 2011; Chua et al., 2013). The inconsistencies observed in some of the study findings are because, some of these studies vary in their definition of CLRD, socio-demographic and indoor environmental factors used in their studies (Basagaña et al., 2004). As Wright and Fisher (2004) explained, there is a strong geographical and temporal variation in the distribution of respiratory diseases that remain unexplained by the known risk factors such as social, economic, demographic

and environmental factors. As a result, Basagana et al. (2004) indicated that the relationship between these socio-demographic indicators and respiratory diseases among adults is less well understood. Their views were echoed by Ellison-Loschmann et al. (2006), who explained that little is known about the relationships and mechanisms by which socio-demographic factors affect respiratory diseases in adults. Eisner et al., (2011) further confirmed the need for additional studies to clarify the relationship between socio-demographic factors and CLRD. Although a recent study revealed that the increased risk of uncontrolled asthma was related to multiple factors, the study recommended more comprehensive research to determine all modifiable risk factors responsible for the increased risk of CLRD among adults in different socio-demographic groups (Zahran et al. 2014). This suggestion was in accordance with the recommendations of previous studies (Wright and Fisher 2003; Eisner et al., 2011; Gershon et al., 2012). As emphasized by Wright and Fisher (2003) comprehensive research may provide an excellent view to understanding the role of these background factors on the risk of respiratory diseases.

No study was identified in the literature that examined how indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and the reporting of CLRD among adults. Although the public health burden of CLRD has advanced increasing interest among researchers to identify all relevant risk factors of CLRD, most studies identified in the literature did not only controlled for specific or general risk factors, the evidence identified from some of these studies was contradictory. Given these gaps, there is limited theoretical and empirical knowledge on the disparities of CLRD among adults in different socio-demographic groups. These gaps and the recommendations from previous studies confirmed the importance of my research questions and supported the need for a more in-depth study. To fill some of

these gaps a detailed mediation test with interaction effects will be explored to determine which indoor environmental factors and access to healthcare influence the relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents. The study will also explore if the relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. depends on indoor environmental factors and access to healthcare. The current study will be more in-depth in that it will use three different years of cross-sectional data within the social causation of health inequality framework to establish more consistent and rigorous relationships between multiple socio-demographic, indoor environmental factors, access to healthcare and the reporting of CLRD among adult ACBS respondents. Most importantly the current study will explore disparity in the reporting of CLRD among adult ACBS respondents in different social, economic and demographic groups based on their living conditions and access to adequate healthcare. Social causation of health inequality framework will be used to inform the current study analysis because it is based on the premise that CLRD outcomes are impacted by multiple and inter-related socio-demographic, indoor environmental factors and access to adequate healthcare. The framework explains the assumption that some of the effects of socio-demographic factors on CLRD are mediated through inadequate indoor environmental conditions and access to healthcare which will contribute to existing evidence on this topic.

CHAPTER 4

4.0 METHODOLOGY

The current study will explore mediating effects of environmental factors and access to healthcare on the relationship between socio-demographic factors and CLRD among adult ACBS respondents in the U.S. The social causation of health inequality framework used to guide the current study revealed that the increased risk of CLRD is influenced by multiple, socio-demographic, indoor environmental factors and inadequate access to healthcare. As a result, to answer all the research questions and to fill some of the gaps identified in the literature, this study will employ a series of quantitative methods including logistic regression analyses to explore mediating effects of environmental factors and access to healthcare on the relationship between socio-demographic factors and CLRD among adult ACBS respondents in the U.S. with interaction effects. The study will use existing rich secondary data collected by the Behavioral Risk Factor Surveillance Survey group (BRFSS). This secondary data was selected because it is comprehensive, contain large sample size and includes the whole sets of relevant factors suggested by the conceptual framework. As emphasized by Hox and Boeije (2005), Magee et al. (2006) and Dunn et al. (2015) considering all these components in the methodology improved the reliability, validity and generalizability of the study findings. Reliability refers to the repeatability of study findings. That is the extent to which the findings are consistent over time, and the same findings can be reproduced using similar methodology (Joppe 2000). Validity is the degree to which evidence supports that the interpretation of the study data is correct that is, how successful have the results achieved what it set out to achieve and can the findings be transferred to similar situations (Joppe 2000; Moskal et al., 2002). Generalizability of the study findings describes the extent to which the findings can be applied to other

research settings or larger population other than that in which they were initially tested that is, applying the results in a broader context to make the findings relevant (Baumgarten, 2012).

4.1 Study Design and Procedure

The study design is a cross-sectional study. The datasets for the proposed study were a combined cross-sectional secondary data from the Behavioral Risk Factor Surveillance Survey (BRFSS) and Asthma Call-Back Survey (ACBS). The data was collected through landline telephone interviews by the Communicable Disease Control surveillance groups using standardized questionnaires from 2009 to 2011 (CDC 2011).

4.1.1 Rationale for Study Design

As noted in Chapter 1, three different years of secondary cross-sectional data were used to test the study hypotheses that:

1. There is a relationship between socio-demographic, indoor environmental factors, medical cost and the reporting of CLRD among ACBS respondents in the U.S.

2. One or more indoor environmental factors might mediate the effects of socio-demographic factors on the reporting of CLRD among ACBS respondents in the U.S.

3. The relationship between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S. might depend on one or more indoor environmental factors and access to healthcare.

Rothman (1986) and Levin (2006), argue that a cross-sectional design is useful for assessing the relationships between an outcome of interest and exposure variables in a population at a specific point in time (Rothman, 1986; Levin, 2006). Cross-sectional designs can be the first step in identifying potential risk factors for disease outcomes (Hennekens 1987). For example, additional risk factors of CLRD could be identified by using a cross-sectional design to explore the relationship between socio-

demographic, indoor environmental factors and healthcare access and the reporting of CLRD. Also, a cross-sectional design is important in finding the risk of chronic diseases within a population or subgroup in a population of interest (Hennekens and Buring 1987; Bland 2001; Levin 2006). Using a cross-sectional design to identify the association between CLRD and exposures of interest could lead to the formulation of hypotheses that could be tested with more rigorous designs such as case-control and cohort studies (Blind 2001; Levin 2006). The main limitation of a cross-sectional study is that it is difficult to examine the cause and effect relationships (Levin 2006) because the cause must precede the effect (Vartanian 2011). However, the datasets of the current study contain three different years of cross-sectional data which will be analyzed independently. As a result, the consistency of the findings will be explored hence adding plausibility to the findings. As recommended by CDC (2011) combined analysis of all three years of data could not be explored in this study because the weighting procedure for 2011 data was different from 2009 and 2010.

Although cohort and case-control study designs are alternative and more rigorous methods that could be useful in identifying factors associated with the increased risk of CLRD, these designs were not selected to answer the present study questions for several reasons (Blind 2001; Levin 2006). In the current study population, as there was no registry of individuals with current asthma, COPD, chronic bronchitis and emphysema, it would have been difficult to verify all cases of CLRD and to match all cases of interest with control subjects. On the other hand, for cohort study design the lack of current information of potential etiologic factors would make it difficult and expensive to identify an appropriate cohort for a prospective study (Hennekens 1987). Therefore, given the limited amount of studies that have assessed the effect of these risk factors on CLRD and the need to identify additional risk factors that could influence the risk of

CLRD among adults who reported CLRD, cross-sectional study design was considered to be the most appropriate study design to explore the current study hypotheses. Findings from a population-based cross-sectional survey of current asthma, COPD, chronic bronchitis and emphysema could provide important information that can influence the design of future analytical studies using cohort and case-control methods.

4.1.2 Study Participants

The study participants were both males and females aged 18 years or older who lived in households (CDC 2011). All BRFSS respondents who reported being diagnosed with asthma were eligible to participate in the ACBS. Only one adult per household could participate in the ACBS (CDC 2011). An eligible household is defined as housing premises with a separate entrance, occupied by its members as their primary or secondary place of residence, where the occupants eat separately from other persons on the property (CDC 2011). Only adult ACBS respondents were included in the current study analyses for all three years.

4.1.3 Data Collection Procedure

The BRFSS is a cross-sectional survey that collects uniform state-specific data on healthcare access, health risk behaviors and preventive health practices related to chronic and preventable infectious diseases that affect the non-institutionalized adult population in the U.S (CDC 2011). The ACBS is a telephone survey conducted two weeks after the BRFSS telephone survey, and it is designed in a way that respondents of the BRFSS telephone interview who reported ever being told by a physician that they have asthma were eligible for an in-depth asthma call-back. The ACBS collects information on the prevalence of asthma, several indirect pointers of asthma-related illness (morbidity), such as doctor's visits and hospitalization. The survey also collects information on indoor environmental indicators and comorbid conditions such as

COPD, chronic bronchitis and emphysema (CDC 2011). The advantage of using these secondary datasets was because the sample size was large enough to allow for greater precision of statistical estimates (Vartanian 2011; Dunn et al., 2015).

4.2 Sampling Design

The combined BRFSS and ACBS data used to answer all the research questions of the current study were collected using simple random sampling and disproportionate stratified sampling. Selecting an appropriate sampling design is important in data collection for evidence-based decision-making (Ross, 2005). A well-developed sampling design plays a critical role in ensuring that there are sufficient data to draw the required conclusion (Murphy and Schulz, 2006). There are two main types of sampling methods, probability sampling and non-probability sampling (Trochim, 2002).

Probability sampling refers to when the chance of any given study participant being selected is known, and these participants are sampled independently of each other (Trochim 2002; Ross 2005). This includes simple random sampling, where a random number generator is used to choose study participants, the advantage of this type of sampling is that it ensures a high degree of representativeness (Trochim 2002; Ross 2005). Systematic sampling is a sampling strategy where the first sampling group is chosen at random, while the remainder is selected at a regular interval (Trochim 2002; Ross 2005). Stratified random sampling involves dividing the target population into strata and then sampling each stratum separately to get enough study participants from each stratum to be able to draw appropriate conclusions (Trochim 2002; Ross 2005). The strength of this type of sampling is that it allows for a high degree of representativeness of all strata or layers of the study population (Trochim 2002).

Non-probability sampling is a sampling method that does not give all the individuals in the study population equal chances of being selected (Ross 2005). In contrast with probability sampling, the stability of sample estimates based on non-probability sampling cannot be identified from the internal evidence of a single sample (Trochim 2002). Consequently, these types of samples are not appropriate for testing the study hypotheses (Trochim 2002; Ross 2005).

4.2.1 Sampling Description

The Behavioral Risk Factor Surveillance branch provided all 54 states and territories with landline telephone samples obtained from a market research firm (CDC 2009 2010, 2011). A computer system randomly generates and selects phone numbers that are called for the survey to avoid any selection bias (CDC 2009, 2010, 2011). In the current study, all participating states and territories were provided with landline telephone samples by BRFSS, and all phone numbers that were called for the survey were randomly generated by a computer system to avoid any selection bias (CDC 2009, 2010, 2011). A disproportionate stratified sampling (DSS) design was used by 51 states while a simple random design was used by Guam and Puerto Rico. DSS design is a type of sampling design that is most commonly used in landline telephone surveys where telephone numbers to be sampled for the survey are drawn into two strata, a high density and low-density strata which are then sampled separately (CDC 2009, 2010, 2011). The telephone numbers were classified into two strata to generate telephone samples that are expected to belong mostly to households rather than the general population (CDC 2009, 2010, 2011).

4.2.2 Sampling Process

In the current study, telephone samples in the high-density stratum were sampled at the highest rate to ensure that the data collected was representative of the participating

state's population (Vartanian 2011). The sampling ratio from high to medium strata was 1.5:1. The BRFSS response rate for adults ranged from 66.7% to 68.8%, while the ACBS response rate for adults ranged from 47.5% to 49.7% during 2009 to 2011. A representative sample is important because it ensures that all relevant participants of interest in the study population are included in the sample (Vartanian 2011). On the other hand, if the sample is not representative, it will be subjected to bias resulting in the under or over representation of certain study subjects which can skew the study findings (Vartanian 2011). According to CDC the sample size of respondents in the combined BRFSS and ACBS for 2009, 2010 and 2011 were large enough for statistical inference (CDC 2009, 2010, 2011). In 2009, records were collected from 15, 403 individuals from 34 states, in 2010 records were collected from 17, 753 individuals from 37 states and in 2011 records were collected from 16, 693 individuals from 40 states including the District of Columbia and Puerto Rico (CDC 2009, 2010, 2011). The BRFSS is designed to obtain sample information from adult U.S. population residing in different states (CDC 2009, 2010, 2011). The BRFSS weighting methodology comprises of design weights, and demographic adjustment of the sample population and the data weights incorporated the design of BRFSS survey and the characteristics of the population (CDC 2009, 2010, 2011). The final weights of the data included adjustments for gender, age, race/ethnicity, educational level and marital status such that the sample data was more representative of the general population (CDC 2009, 2010, 2011). The data included sample weights to adjust for the unequal probability of selection, the unequal selection of population subgroups, disproportionate non-response and non-coverage errors (CDC 2009, 2010, 2011).

4.2.3 Sample Size

Identifying appropriate sample size is a fundamental characteristic of sound research design (Bernstein 2008). This is particularly critical in the pre-study design stage and important during interpretation of the research findings (Patel et al., 2003; Bernstein 2008). Also, this is important to avoid bias in interpreting the study findings (McCrum-Gardener 2010; Kadam and Bhalerao 2010). In the current study, the response rate for BRFSS ranged 66.7% to 68.8% since ACBS samples were drawn from the BRFSS samples, potential bias is limited because non-response is not systematic even though the response rate for ACBS ranged from 47.5% to 49.7%. Evaluating the implication of sample size or identifying the appropriate number of participants to be included in the study involves consideration of statistical power, which is the probability of correctly rejecting the null hypothesis in favor of the alternative hypothesis (Bernstein 2008). As indicated by Kirby et al. (2002), the sample size of any study would have an impact on the acceptable level of significance, the power of the study and the effect size. Power analysis guides selection of a sample size that is large enough to identify important effects or relationships **(**Bernstein 2008 Kadam and Bhalero 2010). However, if the sample size is too small, it might be difficult to generalize the results to the general population (Kadam and Bhalero 2010). Furthermore, a sample size that is too small might increase the risk of a Type II error which consists of falsely concluding that there was no association between an indicator variable and an outcome of interest when indeed there was one (Streiner 1990; Bernstein 2010). On the other hand, if the sample size is too large, it might put more study participants at risk, making the study unethical and might lead to the unnecessary expenditure of resources, time and efforts by the researcher (Streiner 1991; Kadam and Bhalero 2010). In light of this, the calculation of an appropriate sample size is not only a key aspect of the recruitment process, but it

is required to be able to arrive at ethical and scientifically valid results (Larsen 1985; Streiner 1991; Kadam and Bhalero 2010).

4.2.4 Sampling Challenges

In public health research, because it is sometimes challenging to study the entire population, a subset of the target population must be selected which can generate several errors (Pelham and Blanton 2006). Different samples can produce different results because of chance, and this difference is referred to as sampling error (Kirkwood, 2003). Its variability is measured by the standard error (Pelham and Blanton 2006), which cannot be eliminated but can be reduced to an acceptable level by increasing the sample size of the study (Kirkwood, 2003). The sampling error decreases as the sample size increases, as a result, the use of adequate sample size will reduce the degree to which chance variability may account for the results observed in a study (Friis and Seller 2013). The sampling error of the datasets used in the current study could be minimized because of the large sample size (CDC 2009, 2010, 2011).

4.3 Measures and Study Variables

The BRFSS questionnaire was used to collect data on health risk behaviors and chronic diseases that affect the health of adults. The ACBS questionnaire was used to collect in-depth asthma data from BRFSS respondents who reported asthma diagnosis (CDC 2013). Only adult ACBS respondents were included in the study analyses. Information for all variables included in the current study was extracted from the CDC database. All predictor and outcome variables in this study are categorical variables.

4.4 Dependent Variables

4.4.1 Chronic Lower Respiratory Diseases (CLRD)

Asthma was assessed by asking participants to answer “yes or no” to “Have you ever been told by a doctor, nurse or other health professionals that you had asthma?” and

"Do you still have asthma?" (CDC 2011, 2012; Zahran and Bailey 2013; Zahran et al., 2014). To be consistent with the methodology used by Zahran et al., (2014) and Zahran et al., (2015) and previous CDC publications, study subjects were considered to have current asthma if they answered yes to both questions. Both definitions of ever had asthma and currently have asthma were considered because misclassification of the status of childhood asthma due to poor recall by adults has been demonstrated to be very common among survey respondents especially women (Burgess at al., 2006). Current asthma, a subcategory of ever had asthma was used to minimize the likelihood of such misclassification and to increase the possibility that current exposures such as mold presence, pest infestation, indoor pollutants and other indoor environmental factors temporally precedes the development or exacerbation of asthma (Brunekreef 1992; Bornehag et al., 2004; Institute of Medicine 2004). Self-reported doctor-diagnosed asthma has been widely used to define asthma in other epidemiological studies including one study that used the combined BRFSS and ACBS data (Brunekreef 1992; Wang et al., 2001; Manfreda et al., 2001; Liss et al., 2003; Willemsen et al., 2008; Zahran et al., 2015). Self-reported asthma in the BRFSS and ACBS survey has been shown to have a high level of validity when compared with variables of pulmonary test collected from objective measures of the forced expiratory flow and forced vital capacity (Senthilselvan et al., 1993). Comorbid conditions were assessed by asking respondents to answer "yes or no." "Have you ever been told by a doctor or health professional that you had?" "Chronic Obstructive Pulmonary Disease (COPD)," "chronic bronchitis" or "emphysema."

4.5 Independent Variables

Variables related to social, economic, demographic, indoor environmental factors and access to healthcare are described in table 1.1. The conceptual framework was used to

identify independent variables and all the variables were self-reported. This is a strength for the secondary datasets selected for this study because it contained all the independent variables required to answer the research questions. However, the limitation of the datasets was that the sample size for some specific subgroups was smaller while some other groups were larger, which makes it difficult to compare with other population groups (Salkind, 2007; Varnatian, 2011). To minimize these difficulties and because the effect of different socio-demographic and indoor environmental factors on health outcomes are almost certainly interdependent, some of the subgroups with small sample size were re-categorized to provide reliable estimates and structure for the analyses, comparisons and discussion of results.

4.5.1 Socio-Demographic Factors

Socio-demographic characteristics that were assessed by BRFSS questionnaire consisted of gender, age, race/ethnicity, marital status, educational level, employment status and income level. Although there are several indicators of socio-economic status, Kunst and Mackenbach (2000) noted that the most important indicators are educational level, employment status and level of income. They recommended the use of all three indicators in the analyses instead of one as each indicator covers different aspects of social stratification (Kunst and Mackenbach 2000).

4.5.1.1 Educational Level

The computed educational level was re-categorized into four groups 1) “Did not graduate high school” 2) “Graduated high school,” 3) “Attended College or technical school,” 4) “Graduated College or technical school.” Education is a strong determinant of future employment and income (Smith et al., 1998; Lynch and Kaplan 2000; Golabardes et al., 2006). It reflects material resources and captures the influence of adult resources on health and disease outcomes (Smith et al., 1998; White et al., 1999).

Education shapes employment opportunities, which are major determinants of the economic resources responsible for the purchase of adequate housing and access to healthcare which can directly influence respiratory health outcomes such as CLRD as represented in the conceptual framework (Golabardes et al., 2006).

4.5.1.2 Employment Status

Employment status was re-categorized into five groups, which included: 1) Employed 2) Unemployed 3) Homemaker 4) Retired 5) Unable to work. Employment is strongly related to income, and as a result, the impact on health outcomes may be as a result of the relationship between income and the standard of material resources (Golabardes et al., 2006). Employment also reflects SEP and may be related to health outcomes through easier access to better healthcare and adequate housing (Golabardes et al., 2006). Employment status has a significant impact on the level of income (Golabardes et al., 2006). As represented in the conceptual framework, employment status determines the availability of adequate economic resources responsible for the purchase of good living conditions such as good housing and adequate access to healthcare which might have a direct impact on respiratory health outcomes such CLRD.

4.5.1.3 Income

To be consistent with previous studies that have examined the BRFSS and ACBS datasets (Zahran and Bailey 2013; Zahran et al., 2014; Zahran et al., 2015), annual household income from all sources was re-categorized into five groups, "<$15000", "$15000-$24999", "$25000-$49999", "$50000-$74999" and "≥$75000". Household income is a useful indicator especially for women who may not be the main earners of the household, and it is the best single indicator of material resources such as housing (Lynch and Kaplan 2000; Golabardes et al., 2006). In the social causation of health inequalities that was used to guide the current study, income is an important social

determinant of respiratory health outcomes because it shapes the overall living conditions (Cockerham 2007). Inadequate income can impact the affordability of good living conditions (intermediary factors) such as good quality housing, adequate healthcare and access to basic facilities, which might have a direct impact on respiratory health outcomes such as CLRD (Cockerham 2007).

4.5.2 Indoor Environmental Factors

Indoor environmental indicators were assessed using the ACBS questionnaire. The respondents were asked to answer "yes or no" to questions about the presence of mold, smoking status, smoking indoors, cockroach infestation, mice/rat infestation, occupational exposure which included ("Was your asthma CAUSED by chemicals, smoke, fumes or dust in any PREVIOUS job you ever had"). Asthma caused by exposure to a current job was not considered in this study because of missing data. The characteristics of the indoor environment measures material aspects of SEP, and it provides some indications of specific mechanisms linking SEP to health outcomes (Golabardes et al., 2006). Housing conditions such as mold growth and pest infestation are housing-related indicators of material resources (Golabardes et al., 2006).

4.6 Access to Healthcare

Access to healthcare was assessed by asking survey participants to answer "Yes" or "No" to "Was there a time in the past 12 months when you needed to see a doctor but could not because of cost?" The role of the healthcare system in health and disease outcomes is particularly relevant through access to adequate healthcare, which determines who will be able to get adequate health intervention (WHO 2007). As a result, access to adequate care is an important determinant of the health outcomes of individuals in different SEP (WHO 2007; Nagata et al., 2011).

Table 1.1: Summary of Independent Variables Examined in the Analyses

Category	Factors	Definition
Socio-demographic factors	• Age	• Self-reported (years) 5 groups 18-34" (R), "35-44", "45-54", "55-64" and "65+".
	• Gender	• Self-reported (Male / female)
	• Race/ethnicity	• Race/ethnicity was re-classified into four groups. 1) Whites(R), 2) Blacks 3) Hispanic 4) Other race
	• Marital Status	• Marital status was categorized into 3 groups "Married(R)," "Single" and "Separated or widowed."
	• Education	• The re-categorized educational level had four groups 1) "Did not graduate high school" 2) "Graduated high school" 3). "Attended college or technical school." 4) "Graduated from college or technical school" (R).
	• Employment	• Employment status was merged into five groups 1) "Employed" (R) 2) "Unemployed" 3) "Homemaker" 4) "Retired" 5) "Unable to work"
	• Income	• Annual household income from all sources was re-categorized into five groups, "<$15000", "$15000-$24999", "$25000-$49999", "$50000-$74999" "≥$75000" (R).

(R), is the reference category

Category	Factors	Definition
Indoor Environmental Factors	• Mold	• "Ever seen or smell mold in the past 30 days?" (Yes/No).
	• Smoking	• Categorized into three groups 1) "Current smoker" 2) "Former smoker" 3) "Never smoked."
	• Smoking indoors	• "Anyone smoked inside your home?" (Yes/No).
	• Cockroaches	• "Saw cockroach inside your home in the past 30 days?" (Yes/No).
	• Mice / Rat	• "Saw mice or rats inside your home in the past 30 days?" (Yes/No).
	• Occupational exposure	• "Was your asthma CAUSED by chemicals, smoke, fumes or dust in any PREVIOUS job you ever had? (Yes/No).
Access to Health Care	• Medical Cost	"Was there a time in the past 12 months when you needed to see a doctor but could not because of cost?" (Yes/No)

4.7 Ethical Approval

The University of Lancaster Faculty of Health and Medicine Research Ethics Committee (FHMREC) approved this study. The study will analyze secondary data, as a result, this does not involve contact or interaction with the original survey participants. According to Salkind (2007), ethical issues could become important when using secondary data if the survey participants are to be contacted. However, the advantage of using these secondary datasets is that there is low risk to individuals who participated in the survey because it did not involve any contact or interaction with the original survey participants (Doolan and Froelicher 2009). All information of survey respondents was stored in accordance with the Public Health Service Act and the Privacy Act of 1974 (NCHS 1997). Data confidentiality was maintained by lock storage and computer password protection.

4.8 Statistical Analysis Plan

To account for the complex sampling design of the combined BRFSS and ACBS data, IBM SPSS version 22 for Mac was used for data processing and analyses. The advantages of using these secondary datasets included the fact that the data was easy to access, cleaned, weighted and stored in an SPSS format that was ready to be used.

4.8.1 Relationship between Socio-demographic, Indoor environmental factors and Healthcare access

4.8.1.1 Descriptive and Bivariate Analysis

Descriptive statistics (frequency distributions with percentages for categorical variables) were performed for all variables included in the study. Descriptive statistics are important because it can describe, present and summarize various aspects of the datasets, and it gives details about the samples and provides information about the population from which study samples were drawn and also provides an understanding of the distribution of data for each variable (Larson 2006).

Cross-tabulation was used to determine the individual relationships between socio-demographic, indoor environmental factors, healthcare access and all CLRD. The standard principle according to Yates, Moore and McCabe, (1999) is that Chi-square test is valid if 80% of the cells have expected frequencies greater than 5 and all the expected frequencies exceeded 1. The Chi-Square test is important because it allows for evaluation of whether the association observed between socio-demographic, indoor environmental factors, healthcare access and CLRD in the study sample is likely to represent an actual relationship between these variables in the population (Campbell 2007). In the initial bivariate analysis, the p-value was set to <0.25 for testing significance. Variables with significant p-value <0.25 were kept for testing mediation. In the final mediation test, the p-value was set at <0.05 for testing significance.

4.8.2 Mediation

A mediator is an intermediate variable that accounts for the relationship between an independent variable and a dependent variable (Mackinnon et al., 2007; Iacobucci 2012). Mediators attempt to describe 'how' and 'why' effects occur (Mackinnon et al., 2007). Mediation analysis examines the mechanism that triggers an observed association between an independent variable and an outcome variable and explores how they relate to a third intermediate variable, the mediator (Valeri and Vanderweele 2013). Rather than hypothesizing only a direct relationship between an independent variable and a dependent variable, a mediation model hypothesizes that an independent variable, X_1 might influence a dependent variable, Y, indirectly through a mediating variable X_2 as represented in figure (3) (Barron and Kenny 1986; Mackinnon et al., 2007; Iacobucci 2008; Hayes and Preacher 2014). Understanding the mediating mechanism is important as it provides evidence that is required in the designing of policies and interventions that could impact the outcomes of interest by targeting potential predictors and mediating factors that are related to the outcomes of interest (Iacobucci 2012: Valeri and Vanderweele 2013). In this mediation analysis, dependent variables and potential mediators were selected based on the conceptual framework used to guide the study analysis. The framework posits that the indirect relationship between socio-demographic factors and CLRD might be influenced by intermediate factors such as indoor environmental factors and access to healthcare (Solar and Irwin 2010). As a result, socio-demographic factors were selected as independent variables while indoor environmental factors and access to healthcare were selected as potential mediators.

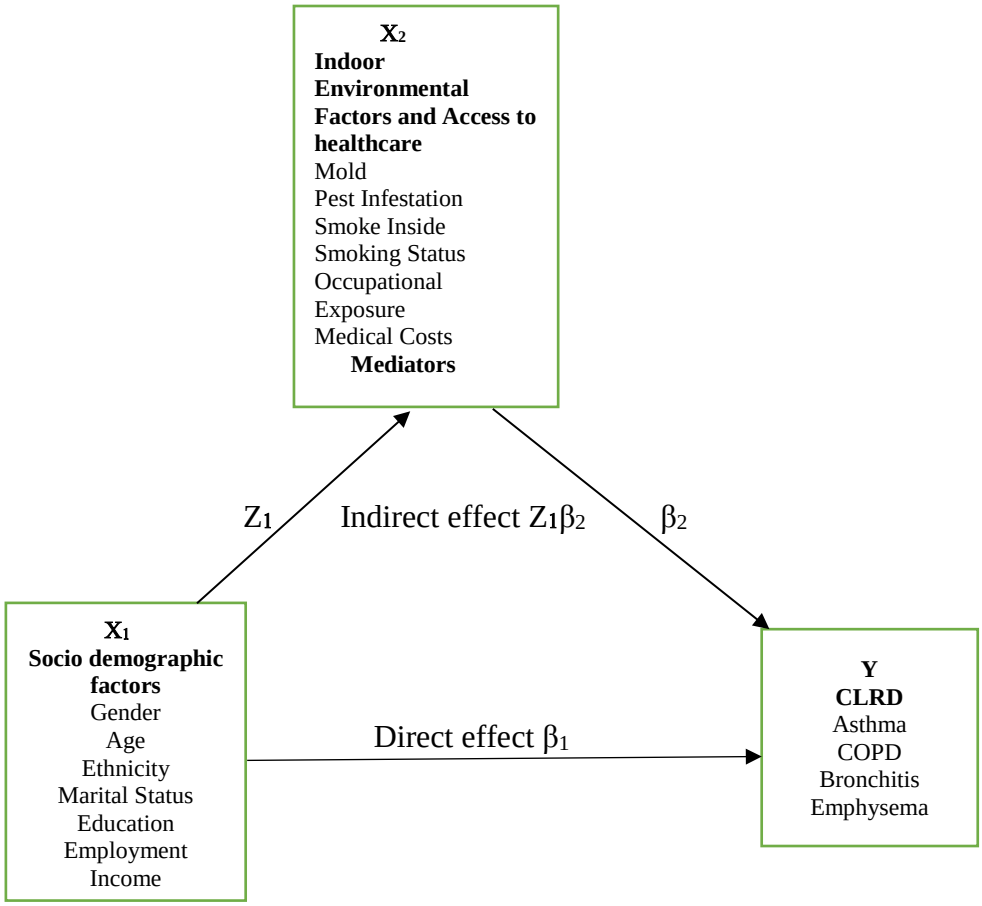

Figure 3. Diagram of Mediating Model

In the above diagram X_1 (Socio-demographic factors) is modelled to influence outcome variables Y (CLRD) directly and as well as indirectly through intermediary or potential mediator variables X_2 (Indoor environmental factors and access to healthcare) which is located between X_1 (socio-demographic factors) and Y (CLRD).

In a statistical model, if the independent variable is categorical and the dependent variable is binary, the equation could be rewritten for logistic regression (Iacobucci 2012; Mascha et al., 2013). The outcome variables Y (CLRD) are binary as a result, Y is modelled via a logistic regression as recommended by Baron and Kenny (1986), Iacobucci (2012) and Mascha et al. (2013). Given this recommendation, to estimate the direct effect of X_1 (sociodemographic factors) on Y (CLRD) the odd of Y was modelled in equation 1 as follows:

$$\text{Log}\,[p/\,1\text{-}p] = \beta_{01} + \beta_1 X_1 + \varepsilon_1 \qquad (1)$$

Where Log [p/ 1-p] = Log (probability of reporting Y (CLRD) / probability of not reporting Y (CLRD) = β_{01}+ β_1 socio-demographic factors + ε_1

β_{01} is the intercept, β_1 is the coefficient estimate, and ε_1 is the residual error. The direct effect of X_1 (socio-demographic factors) on Y (CLRD) is estimated with β_1 in equation 1.

The indirect effects of X_1 are derived from two models.

First, estimating X_2 (indoor environmental factors and Healthcare) from X_1 (Sociodemographic factors), the odd of X_2 (indoor environmental factors and access to healthcare) was modelled in equation 2 as follows;

$$\text{Log}\,[q\,/1\text{-}q] = Z_{01} + Z_1 X_1 + \varepsilon_2 \qquad (2)$$

Where Log [q/1-q] = Log (Probability of reporting poor indoor environmental conditions and inadequate access to healthcare/Probability of not reporting poor indoor environmental conditions and inadequate access to healthcare) = Z_{01} + Z_1 sociodemographic factors + ε_2

Z_{01} is the intercept, Z_1 is the coefficient estimate, and ε_2 is the residual error. The relationship between X_1 and X_2 is estimated with Z_1 in equation 2.

Second, estimating the indirect effect of X_1 (socio-demographic factors) on Y (CLRD) through X_2 (indoor environmental factors and access to healthcare) is estimated as Z_1 β_2, meaning the product of the effect of X_1 on X_2 (Z_1 in equation 2) and the effect of X_2 on Y controlling for X_1 (β_2 in equation 3).

The odds of Y (CLRD) is modeled in equation 3 to estimate the direct and indirect effect of X_1 on Y to yield the total effect of X_1 on Y. The equation is as follows:

$$\text{Log}\,[p'\,/\,[1\text{-}p'] = \beta_{02} + \beta'_1 X_1 + \beta_2 X_2 + \varepsilon_3 \quad (3)$$

Where Log [p'/ 1-p'] = Log (probability of reporting Y (CLRD) / probability of not reporting Y (CLRD) = β_{02} + β'_1 socio-demographic factors + β_2 indoor environmental factors and access to healthcare + ε_3

β_{02} is the intercept, β'_1 and β_2 are the coefficient estimates and ε_3 is the residual error

4.8.2.1 Predictor-Mediator interaction

The predictors (sociodemographic factors) and mediators (indoor environmental factors and access to healthcare) interaction means that the effect of the predictor on the outcome variables depends on the observed level of the proposed mediator. Similarly, the effect of the mediator on the outcome varies by the level of the exposure to the extent that there is a predictor-mediator interaction (Mascha et al., 2013).

As recommended by Mackinnon et al. (2007) the interaction terms between X_1X_2 are added to the mediation equation to form a general model that includes all effects. In a situation where the effect of the mediator X_2 is not equal across the value of the predictor X_1, an interaction between the predictor and mediator, known as X_1X_2 interaction is present (Mackinnon et al., 2007). A significant X_1X_2 interaction indicates that the effect of X_2 on Y is a function of X_1 and changes as the value of X_1 changes. The equation for the interaction is as follows:

Log [p'' / [1-p''] = β_{03} + β''_1X_1 + β''_2X_2 + $\beta_3X_1X_2$ + ε_4 (4)

Where Log [p''/1-p''] = Log (probability of reporting Y (CLRD) / probability of not reporting Y (CLRD) = β_{03} + β''_1 socio-demographic factors + β''_2 indoor environmental factors and access to healthcare + β_3 socio-demographic*indoor environmental factors and access to healthcare) + ε_4

β_{03} = Intercept (constant)

β''_1 = Coefficient for independent variables (socio-demographic factors).

β''_2 = Coefficient for mediators (indoor environmental factors and access to health care).

β_3 = Coefficient for interaction terms for sociodemographic*indoor environmental factors and access to healthcare

Y= CLRD

X_1= Sociodemographic factors

X_2 = Indoor environmental factors and access to healthcare

X_1X_2 = Interaction terms for sociodemographic*indoor environmental factors and access to healthcare.

ε_4 = Residual error

To assess mediation, many researchers have used many different methods ranging from the simple regression analysis to the more sophisticated structural equation modelling. In the case of the present study as recommended by Iacobucci (2012) and Hayes and Preacher (2014), I used logistic regression models to test mediation because the outcomes, predictors and potential mediators were all categorical variables. The study considered multiple dependent, independent and mediator variables as emphasized by Mackinnon et al. (2007) the multiple-mediator model which is a straightforward extension of a single mediator is more likely to provide a more accurate assessment of the mediating effects. Also, according to the literature increased risk of CLRD is as a result of multiple predictors and mediating factors. As a result, the multiple-mediator model is the correct method to access if indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and CLRD (Mackinnon et al., 2002).

4.8.3 Mediation Analysis

Mediation analysis as emphasized by Judd and Kenny (1981), James and Brett (1984), Baron and Kenny (1986) and Iacobucci (2012) involves four steps. In the first step, a

logistic regression analysis was performed for each dependent variable (i.e., current asthma, COPD, chronic bronchitis and emphysema) with each socio-demographic factor. This step shows whether the odds of reporting CLRD differed by different socio-demographic groups. In the second step, bivariate analyses were used to test the relationships between the predictors and potential mediators. In this step, the potential mediators were treated as dependent variables to examine the relationships between the mediators (indoor environmental factors and medical cost) and the predictors (socio-demographic factors). In the third step, logistic regression models were created to test whether potential mediators (indoor environmental factors and access to healthcare) have significant effects on the odds of reporting CLRD after controlling for socio-demographic factors. In the fourth step, to establish mediation, the strength of the relationship between socio-demographic factors and CLRD must be completely or substantially reduced by controlling for the mediators. Perfect mediation holds if socio-demographic factors have no effects after controlling for the mediators, partial mediation holds if a significant but reduced (odds ratio) magnitude of the effect is observed (Iacobucci 2012; Valeri and Vanderweele 2013; Hayes and Preacher 2014). That is if socio-demographic factors are no longer statistically significant predictors of CLRD when the mediating variables indoor environmental factors and medical costs are controlled for, then the findings would support full mediating effect. If the socio-demographic factors are still significantly predicting the dependent variables (current asthma, COPD, bronchitis and emphysema) but the strength of the effect (odds ratio) is reduced, then the findings would support partial mediating effect. The size of the magnitudes of the effects (odds ratios) in model 1 (that is model adjusted for only socio-demographic factors) will be compared to the size of the magnitude of the effects (odds

ratios) in model 2 (fully adjusted model, model including all socio-demographic factors and potential mediators).

The next step is to include predictor-mediator interaction terms; this is in accordance with the suggestion of Vanderweele and Vansteelandt (2010) that in accessing mediation, it is important to examine the interaction between the effects of the predictor and the mediator on the outcome of interest. Rather than including extensive interaction terms, I developed a rationale for including interaction terms based on the direction of the relationship between socio-demographic factors, indoor environmental factors, access to healthcare and the reporting of CLRD. Evidence indicates that socio-demographic factors such as education level, employment status and income level influences indoor environmental conditions such as mold, pest infestation, second-hand smoke, smoking status and access to occupational exposure and access to healthcare (House et al 1994; Link and Phelan 1995; Northridge et al., 2003; Schulz and Northridge 2004). Also, prospective evidence indicated that there is significant variability of incidence and risk for respiratory symptoms between gender and age (King et al., 2004). Given this, interaction terms will be created between gender, age, education, employment and income and all relevant mediators to determine if the effect of the relationship between socio-demographic factors and CLRD depends on indoor environmental factors and access to healthcare (Mackinnon et al., 2007).

4.8.4 Assessing Mediation

To assess mediation and interaction effects, I estimated three different logistic regression models. The first model was adjusted only for socio-demographic factors (gender, age, marital status, race/ethnicity, education, employment and income) and CLRD. In model 2, the fully adjusted model, I introduced all socio-demographic factors, potential mediators (mold, pest infestation, smoke indoors, smoking status,

occupational exposure and medical cost), that showed significant associations with both the predictor variables and CLRD to assess the degree to which the magnitude and effect size of the relationships between socio-demographic factors and CLRD changed. Model 3 included relevant predictor-mediator interaction terms to determine if the effects of gender, age, education, employment status and income level on CLRD depend on the mediators and if the effects of the mediators on CLRD varies by the difference in gender, age, education, employment and income level in incremental models. These models were constructed based on the methodology of previous studies that examined mediation (Park et al., 2008; Mascha et al., 2013; Hystad et al., 2013; Hsu and Cossman 2013; Russell et al., 2015; Washington et al., 2017).

The likelihood ratio test (LRT) was used to assess nested models and to determine whether a model with additional variables was a significantly better fit than the previous model. A defined and consistent strategy was used based on a combination of different methods recommended by Victoria et al. (1997), Hosmer and Lemeshow (2005) and Massons and Pastor (2006). Multicollinearity between covariates was tested before using pairwise correlation among them ($r<0.40$; where r is the correlation coefficient). The Hosmer-Lemeshow test was used to assess the goodness of fit of the models. This involves evaluating how well the observed data correspond to the fitted model by comparing the observed value with the fitted value (Hosmer and Lemeshow 2000). The statistical significance level was established at 5% significance. Whitley and Ball (2002) defined the statistical significance as p-value <0.05 or the observed significance. The strength and significance of the statistical association between categorical predictors and CLRD were determined by calculating the socio-demographic factors adjusted odds ratios and the fully adjusted odds ratios (OR). The precision of the

measurements and stability of the statistical estimates was determined by calculating the 95% confidence interval (CI) (Davies and Crombie 2009).

Testing mediation implies causation; consequently, because the current study analyses were derived from cross-sectional datasets, it is not possible to make any causal interpretation of the relationships identified. This is explained further in the limitation section.

CHAPTER 5

This chapter begins with a description of socio-demographic characteristics of the study participants. This is followed by descriptions of the results and a summary of all the findings.

5.0 RESULTS

5.1 Socio-demographic Characteristics of Study Participants

Table 2.1, 2.3 and 2.5 summarizes the characteristics of study participants for 2009, 2010 and 2011 respectively. Only adults 18 years or older who responded to the ACBS were included in the analyses. The total number of subjects included in the analyses for 2009 was 15,403, 17,753 for 2010 and 16,693 for 2011. There were more female than male participants and more whites than blacks, Hispanics and other race participants. Most participants were 55 years or older, married, have attended college or graduated from college or technical school, employed or retired with an annual household income of over $50000.

5.2 Individual Association between Socio-demographic, Indoor Environmental factors, Access to Healthcare and CLRD

The results of the bivariate analyses between dependent variables (CLRD) and independent variables socio-demographic, indoor environmental factors and access to healthcare for 2009, 2010 and 2011 are summarized in tables 2.1 to 2.6. Since most of the findings were consistent for all three years, full descriptions of the most important findings were reported for 2009, while a summary was presented for 2010 and 2011. However, the descriptions of the complete findings for 2010 and 2011 are presented in appendix 4.

Table 2.1: Distribution and Bivariate Relationship of Socio-demographic Factors and CLRD for 2009

Factors	Sample Size N [a]=15403 n(%)[b]	Current Asthma χ^2 [c] P-value [c] n(%)	COPD χ^2 P-value n(%)	Bronchitis χ^2 P-value n(%)	Emphysema χ^2 [c] P-value [c] n(%)
Sex		χ^2 (1)= 190.4 <0.001[c]	χ^2 (1)= 24.43 <0.001	χ^2 (1)= 192.8 <0.001	χ^2 (1)= 9.65 0.002
Male	4653 (30.2)	2938 (64.7)	653 (14.3)	981 (21.4)	521 (9.6)
Female	10750 (69.8)	7974 (75.6)	1852 (17.5)	3450 (32.5)	1028 (11.3)
Age, year range		χ^2 (4)=105.9, <0.001	χ^2 (4)= 652.1 <0.001	χ^2 (4)= 256.4 <0.001	χ^2 (4)= 474.2 <0.001
18-34	1222 (7.9)	724 (60.3)	13 (1.1)	195 (16.1)	8 (0.7)
35-44	1291 (8.4)	881 (69.8)	67 (5.2)	240 (18.8)	28 (2.2)
45-54	2304 (15)	1652 (73.0)	315 (13.9)	680 (29.8)	178 (7.8)
55-64	2865 (18.6)	2094 (74.7)	576 (20.4)	982 (34.8)	330 (11.6)
65+	3102 (20.1)	2267 (74.5)	858 (28.4)	1063 (35.0)	581 (18.9)
Race/Ethnicity [d]		χ^2 (3)=89.9, <0.001	χ^2 (3)= 24.5 <0.001	χ^2 (3)= 16.6 0.001	χ^2 (3)= 16.1 <0.001
Whites	12284 (79.8)	8801 (73.2)	2070 (17.1)	3472 (28.6)	1288 (10.5)
Blacks	888 (5.8)	644 (74.4)	118 (13.1)	284 (32.5)	62 (7.0)
Hispanic	1090 (7.1)	647 (59.9)	126 (12.0)	300 (28.1)	89 (8.3)
Other race	1016 (6.6)	731 (73.4)	172 (17.3)	338 (33.6)	95 (9.4)
Marital Status		χ^2 (2)=60.38 <0.001	χ^2 (2)= 326.7 <0.001	χ^2 (2)= 257.9 <0.001	χ^2 (2)= 253.6 <0.001
Married	7920 (51.4)	5425 (69.8)	986 (12.6)	1886 (24.1)	587 (7.4)
Single	4973 (32.3)	3581 (73.8)	833 (17.0)	1554 (31.7)	503 (10.2)
Widowed/Separated	2466 (16.0)	1874 (77.4)	677 (28.2)	975 (40.3)	452 (18.6)
Education		χ^2 (3)=109.9 <0.001	χ^2 (3)= 512 <0.001	χ^2 (3)= 536.6 <0.001	χ^2 (3)= 529.5 <0.001
Did not Graduate High School	1389 (9.0)	1068 (78.8)	402 (29.8)	600 (44.3)	296 (21.8)
Graduated High School	3964 (25.7)	2957 (76.0)	855 (22.0)	1409 (36.1)	602 (15.3)
Attended College /Tech School	4475 (29.1)	3188 (72.7)	771 (17.5)	1378 (31.2)	408 (9.2)
Graduated College /Tech School	5559 (36.1)	3686 (67.8)	473 (8.6)	1037 (18.8)	239 (4.3)
Employment		χ^2 (3)=132.8, <0.001	χ^2 (3)= 919.4 <0.001	χ^2 (3)= 644.8 <0.001	χ^2 (3)= 654 <0.001
Employed	6994 (45.4)	4686 (68.4)	490 (7.1)	1391 (20.1)	258 (3.7)
Unemployed	1042 (6.8)	733 (71.8)	140 (13.6)	297 (28.8)	80 (7.7))
Homemaker	1132 (7.3)	783 (70.5)	166 (14.9)	302 (27.1)	96 (8.5)
Retired	3763 (24.4)	2721 (74.0)	948 (37.8)	1250 (33.7)	628 (16.9)
Unable to work	2742 (16.0)	1986 (81.8)	761 (31.6)	1191 (49.1)	487 (19.9)
Income		χ^2 (4)=148.9, <0.001	χ^2 (4)= 758.7 <0.001	χ^2 (4)= 844 <0.001	χ^2 (4)= 552.0 <0.001
<$15000	2206 (14.3)	1726 (79.8)	665 (30.9)	1052 (48.6)	435 (20.0)
$15000-$24999	2532 (16.4)	1897 (76.5)	581 (23.4)	928 (37.3)	373 (14.8)
$25000-$49999	3513 (22.8)	2455 (71.2)	555 (16.0)	968 (27.9)	350 (10.0)
$50000-$74999	2112 (13.7)	1431 (69.3)	208 (10.0)	475 (22.7)	104 (4.9)
≥$75000	3470 (22.5)	2272 (66.6)	208 (6.0)	529 (15.3)	108 (3.1)

[a]Total sample size (weighted) for the study population for 2009.
[b]Sub-sample (n) is the number of observation for each category of the study variable followed by the proportion in percentages (%).
[c]Chi-square value, (degree of freedom) and *p*-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.2.1 Relationship between Socio-demographic Factors and CLRD for 2009

The reporting of current asthma (75.6%), COPD (17.5%) and chronic bronchitis (32.5%) were significantly higher for females, while more males (11.3%) reported emphysema compared to females (9.6%). The reporting of all four CLRD increased progressively with age, except for current asthma and chronic bronchitis where no difference was observed between age groups 55-64 and over 65 years. More blacks (32.5%) and other race (33.6%) compared to whites (28.6%) and Hispanics (28.1%) reported chronic bronchitis while emphysema was reported by more whites. The reporting of all CLRD was significantly higher for singles and widowed/separated participants. The lower the educational level, the higher the proportion of those who reported CLRD with a significantly higher proportion observed among non-high school graduates compared with college or technical school graduates. The reporting of all CLRD was also significantly higher for retired and unable to work participants and participants with annual household income <$15000. These findings imply that socio-demographic factors gender, age, marital status, educational level, employment status, and income level are potential predictive factors of the reporting CLRD among ACBS respondents.

Table 2.2: Distribution and Bivariate Relationship of Indoor Environmental Factors, Access to Healthcare and CLRD for 2009

Factors	Sample Size N [a]=15403 n(%)[b]	Current Asthma χ^2 [c] P-value [c] n(%)	COPD χ^2 P-value n(%)	Bronchitis χ^2 [c] P-value [c] n(%)[d]	Emphysema χ^2 [c] P-value [c] n(%)
Mold		χ^2 (1) = 20.6 <0.001[c]	χ^2 (1)= 3.7 0.056	χ^2 (1)= 31.9 <0.001	χ^2 (1)= 1.82 0.177
No	13708 (89.4)	9685 (71.8)	2195 (16.3)	3840 (28.4)	1359 (10.0)
Yes	1626 (10.6)	1228 (77.1)	290 (18.1)	565 (35.2)	178 (11.0)
Smoking		χ^2 (2)=49.98 <0.001	χ^2 (2)= 942 <0.001	χ^2 (1)= 536.8 <0.001	χ^2 (1)= 920.2 <0.001
Current smoker	2547 (16.5)	1898 (76.7)	747 (29.9)	1122 (44.8)	522 (20.8)
Former smoker	5101 (33.1)	3680 (73.8)	1177 (23.3)	1649 (32.8)	797 (15.7)
Never smoked	7710 (50.1)	5302 (69.9)	573 (7.5)	1649 (21.6)	227 (3.0)
Smoking Indoors		χ^2 (1)=47.7 <0.001	χ^2 (1)= 316.1 <0.001	χ^2 (1)= 351.2 <0.001	χ^2 (1)= 346.5 <0.001
No	13079 (84.9)	9138 (71.3)	1838 (14.3)	3391 (26.3)	1069 (8.2)
Yes	2314 (15.0)	1767 (78.3)	664 (29.3)	1037 (45.6)	479 (21.0)
Saw Cockroach Past 30 Days		χ^2 (1)=4.25, 0.039	χ^2 (1)= 1.15 0.283	χ^2 (1)= 5.63 0.018	χ^2 (1)= .008 0.927
No	13997 (90.9)	13710 (72.6)	2264 (16.4)	3993 (28.9)	1408 (10.1)
Yes	1384 (9.0)	1355 (70.0)	237 (17.6)	433 (32.0)	137 (10.0)
Saw Mice Past 30 Days		χ^2 (1)=0.035, 0.556	χ^2 (1)= .032 0.857	χ^2 (1)= 3.92 0.048	χ^2 (1)= .567 0.452
No	14340 (93.1)	10147 (72.3)	2334 (16.5)	4097 (28.9)	1433 (10.1)
Yes	1049 (6.8)	753 (73.1)	167 (16.3)	328 (31.8)	112 (10.8)
Asthma Caused by Previous Job		χ^2 (1)=227.7 <0.001	χ^2 (1)= 242.7 <0.001	χ^2 (1)= 351.3 <0.001	χ^2 (1)= 193.0 <0.001
No	10508 (68.2)	6958 (67.7)	1350 (13.0)	2494 (24.0)	787 (7.5)
Yes	2550 (16.6)	2081 (82.9)	637 (25.5)	1071 (42.6)	416 (16.5)
Medical Cost		χ^2 (1)=20.5 <0.001	χ^2 (1)= 9.4 0.002	χ^2 (1)= 155.5 <0.001	χ^2 (1)= 9.07 0.003
No	12959 (84.1)	9102 (71.6)	2056 (16.1)	3475 (27.2)	1263 (9.8)
Yes	2419 (15.7)	1794 (76.2)	444 (18.7)	947 (39.8)	284 (11.8)

[a]Total sample size (weighted) for the study population for 2009.
[b]Sub-sample (n) is the number of observation for each category of the study variable followed by the proportion in percentages (%).
[c]Chi-square value, (degree of freedom) and *p*-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.

5.2.2 Relationship between Indoor Environmental Factors, Access to Healthcare CLRD for 2009

The reporting of current asthma (77.1%) and chronic bronchitis (35.2%) was higher for those who saw mold in the past 30 days. While those who saw cockroach (32.0%) and mice (31.8%) in the past 30 days reported more chronic bronchitis. The reporting of all CLRD was significantly higher for former smokers and current smokers, those who smoked indoors, exposed to chemicals, fumes and dust in a previous job and participants who could not see a doctor because of cost (medical cost). These findings suggest that indoor environmental factors mold, smoking, exposure to second-hand smoke, pest infestation, occupational exposure and medical cost are statistically significant predictors of CLRD among ACBS respondents.

Table 2.3: Distribution and Bivariate Relationship of Socio-demographic Factors and CLRD for 2010

Factors	Sample Size N [a]=15403 n(%)[b]	Current Asthma χ^2 [c] P-value [c] n(%)	COPD χ^2 [c] P-value [c] n(%)[d]	Bronchitis χ^2 [c] P-value [c] n(%)[d]	Emphysema χ^2 [c] P-value [c] n(%)
Sex		χ^2 (1)=293.4 <0.001[c]	χ^2 (1)=12.03 0.001	χ^2 (1)= 165.2 <0.001	χ^2 (1)=32.04 <0.001
Male	5296 (29.8)	3326 (64.2)	854 (16.4)	1194 (23.0)	644 (12.3)
Female	12457 (70.2)	9379 (76.8)	2281 (18.6)	4007 (32.7)	1169 (9.5)
Age, year range		χ^2 (4)=109.3 <0.001	χ^2 (4)=968.4 <0.001	χ^2 (4)=402.7 <0.001	χ^2 (4)=618.5 <0.001
18-34	1594 (9.0)	973 (62.9)	25 (1.6)	205 (13.0)	20 (1.3)
35-44	1729 (9.7)	1192 (70.1)	69 (4.0)	348 (20.3)	33 (1.9)
45-54	3170 (17.9)	2269 (73.0)	474 (15.2)	937 (30.0)	232 (7.4)
55-64	4249 (23.9)	3143 (75.4)	846 (20.2)	1396 (33.5)	461 (11.0)
65+	4817 (27.1)	3531 (75.1)	1393 (29.8)	1704 (36.2)	868 (18.3)
Race/Ethnicity [d]		χ^2 (3)=28.34 <0.001	χ^2 (3)=65.51 <0.001	χ^2 (3)=14.26 0.003	χ^2 (3)=16.13 0.001
Whites	13985 (78.8)	9997 (73.0)	2574 (18.7)	4061 (29.5)	1465 (10.6)
Blacks	1369 (7.7)	1046 (77.8)	212 (15.8)	454 (33.7)	129 (9.5)
Hispanic	1061 (6.0)	708 (68.1)	98 (9.4)	283 (27.2)	71 (6.8)
Other race	1181 (6.7)	845 (72.8)	217 (18.8)	355 (30.6)	126 (10.8)
Marital Status		χ^2 (2)=89.39 <0.001	χ^2 (2)=566.4 <0.001	χ^2 (2)=360.5 <0.001	χ^2 (2)=300.4 <0.001
Married	8961 (50.5)	6200 (70.5)	1139 (12.9)	2137 (24.2)	644 (7.2)
Single	5798 (32.7)	4185 (73.8)	1052 (18.5)	1827 (32.0)	628 (11.0)
Widowed/Separated	2953 (16.6)	2287 (79.4)	934 (32.5)	1222 (42.3)	536 (18.4)
Education		χ^2 (3)=149.3 <0.001	χ^2 (3)=516.3 <0.001	χ^2 (3)=549.5 <0.001	χ^2 (3)=612.9 <0.001
Did not Graduate High School	1732 (9.8)	1353 (79.6)	492 (29.3)	763 (45.1)	388 (22.8)
Graduated High School	4594 (25.9)	3471 (77.1)	1062 (23.7)	1590 (35.3)	640 (14.1)
Attended College /Tech School	5096 (28.7)	3654 (73.3)	950 (18.9)	1594 (31.8)	520 (10.3)
Graduated College /Tech School	6308 (35.5)	4208 (68.2)	625 (10.0)	1246 (20.0)	262 (4.2)
Employment		χ^2 (3)=201.5 <0.001	χ^2 (3)=1330 <0.001	χ^2 (3)=842.5 <0.001	χ^2 (3)=797.1 <0.001
Employed	7448 (42.0)	4944 (67.7)	490 (6.6)	1426 (19.3)	249 (8.8)
Unemployed	1257 (7.1)	866 (70.5)	180 (14.6)	391 (31.6)	109 (16.5)
Homemaker	1229 (6.9)	876 (72.6)	135 (11.3)	307 (25.7)	75 (6.2)
Retired	4776 (26.9)	3530 (75.7)	1321 (28.4)	1628 (34.9)	790 (16.8)
Unable to work	3043 (17.1)	2489 (83.2)	1009 (34.0)	1449 (48.6)	590 (19.6)
Income		χ^2 (4)=227.3 <0.001	χ^2 (4)=1014 <0.001	χ^2 (4)=983.1 <0.001	χ^2 (4)=695.9 <0.001
<$15000	2701 (15.20	2160 (81.4)	852 (32.2)	1229 (46.3)	532 (20.0)
$15000-$24999	2998 (16.9)	2265 (77.0)	793 (27.1)	1166 (39.8)	478 (16.1)
$25000-$49999	4114 (23.2)	2914 (72.3)	680 (16.8)	1207 (29.8)	376 (9.2)
$50000-$74999	2430 (13.7)	1643 (68.9)	252 (10.5)	493 (20.5)	114 (4.7)
≥$75000	3683 (20.7)	2386 (66.1)	204 (5.6)	538 (14.8)	103 (2.8)

[a]Total sample size (weighted) for the study population for 2010.
[b]Sub-sample (n) is the number of observation for each category of the study variable followed by the proportion in percentages (%).
[c]Chi-square value, (degree of freedom) and *p*-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race

5.2.3 Relationship between Socio-demographic Factors and CLRD for 2010

The results of all socio-demographic factors and all CLRD for 2010 were similar to the findings for 2009. These findings suggest that socio-demographic factors, gender, age, ethnicity, marital status, educational level, employment status and income level are significant predictors of the reporting of CLRD among adult ACBS respondents. Descriptions of the full results for 2010 are presented in appendix 4.

Table 2.4: Distribution and Bivariate Relationship of Indoor Environmental Factors, Access to Healthcare and CLRD for 2010

Factors	Sample Size N [a]=15403 n(%)[b]	Current Asthma χ^2 [c] P-value [c] n(%)	COPD χ^2 [c] P-value [c] n(%)[d]	Bronchitis χ^2 [c] P-value [c] n(%)[d]	Emphysema χ^2 [c] P-value [c] n(%)
Mold		χ^2 (1)=26.5 <0.001[c]	χ^2 (1)=10.90 < 0.001	χ^2 (1)=62.23 <0.001	χ^2 (4)=9.256 0.002
No	15819 (89.1)	11243 (72.5)	2735 (17.6)	4482 (28.8)	1567 (10.0)
Yes	1821 (10.3)	1387 (78.2)	367 (20.7)	674 (37.8)	221 (12.3)
Smoking		χ^2 (2)=18.5 <0.001	χ^2 (2)=1241 <0.001	χ^2 (2)=564.5 <0.001	χ^2 (2)=1079 <0.001
Current smoker	2951 (16.6)	2196 (75.9)	949 (32.7)	1300 (44.8)	597 (20.5)
Former smoker	6067 (34.2)	4357 (73.4)	1508 (25.4)	1963 (33.0)	969 (16.2)
Never smoked	8676 (48.9)	6105 (71.8)	670 (7.8)	1914 (22.4)	240 (2.8)
Smoking Indoors		χ^2 (1)=56.2 <0.001	χ^2 (1)=526.9 <0.001	χ^2 (1)=380.5 <0.001	χ^2 (1)=395.0 <0.001
No	15153 (85.4)	10687 (72.0)	2268 (15.2)	4026 (27.0)	1268 (8.4)
Yes	2588 (14.6)	2011 (79.2)	865 (34.2)	1173 (46.2)	544 (21.4)
Saw Cockroach past 30 days		χ^2 (1)=1.08 0.299	χ^2 (1)=3.83 0.050	χ^2 (1)=18.33 <0.001	χ^2 (1)=8.603 0.003
No	16125 (90.8)	11555 (73.2)	2821 (17.8)	4652 (29.3)	1613 (10.1)
Yes	1591 (9.0)	1127 (72.0)	306 (19.8)	536 (34.5)	194 (12.5)
Saw Mice past 30 days		χ^2 (1)=10.8 0.001	χ^2 (1)=.3410 0.559	χ^2 (1)=4.94 0.026	χ^2 (1)=1.584 0.208
No	16504 (93.0)	11768 (72.8)	2907 (17.9)	4802 (29.6)	1673 (10.2)
Yes	1230 (6.9)	924 (77.1)	224 (18.6)	392 (32.6)	138 (11.4)
Asthma cause by Previous Job		χ^2 (1)=313.0 <0.001	χ^2 (1)=305.4 <0.001	χ^2 (1)=440.5 <0.001	χ^2 (1)=226.7 <0.001
No	11758 (66.2)	7849 (68.1)	1668 (14.3)	2865 (24.6)	916 (7.8)
Yes	3120 (17.6)	2591 (84.3)	847 (27.7)	1353 (43.9)	520 (16.9)
Medical Cost		χ^2 (4)=30.27 <0.001	χ^2 (1)=9.223 0.002	χ^2 (1)=178.1 <0.001	χ^2 (1)=5.085 0.024
No	14802 (83.4)	10471 (72.2)	2559 (17.6)	4039 (27.7)	1476 (10.1)
Yes	2914 (16.4)	2209 (77.2)	568 (20.0)	1150 (40.2)	329 (11.5)

[a]Total sample size (weighted) for the study population for 2010.
[b]Sub-sample (n) is the number of observation for each category of the study variable followed by the proportion in percentages (%).
[d]Chi-square value, (degree of freedom) and *p*-value with significance at alpha =0.05 for the Chi-square test to determine whether there is a significant relationship between two categorical variables.

5.2.4 Relationship between Indoor Environmental Factors, Access to Healthcare and CLRD for 2010.

The findings for smoking status, smoking indoors, occupational exposure and could not see a doctor because of cost (medical cost) were consistent with the results of 2009. However, a different result was observed for mold, where the reporting of current asthma (78.2%), COPD (20.75%), chronic bronchitis (37.8%), and emphysema (12.3%) was significantly higher among those who saw mold in the past 30 days. High reporting of COPD (19.8%), chronic bronchitis (34.5%), and emphysema (12.3%) was identified among those who saw cockroach in the past 30 days while significantly higher reporting of current asthma (77.1%) and chronic bronchitis (32.6%) was observed among those who saw mice in the past 30 days. These results suggest that inadequate indoor environmental conditions and medical cost are significant predictors of the reporting of CLRD among adult ACBS respondents. Descriptions of the full results for 2010 are presented in appendix 4.

Table 2.5: Distributions and Bivariate relationships of Socio-demographic Factors and CLRD for 2011

Factors	Sample Size N [a]=15403 n(%)[b]	Current Asthma χ^2 [c] P-value [c] n(%)	COPD χ^2 [c] P-value [c] n(%)[d]	Bronchitis χ^2 [c] P-value [c] n(%)[d]	Emphysema χ^2 [c] P-value [c] n(%)
Sex		χ^2 (1)=160.1 <0.001[c]	χ^2 (1)=0.285 0.594	χ^2 (1)=126.0 <0.001	χ^2 (1)=37.17 <0.001
Male	4793 (28.7)	3221 (68.6)	931 (19.7)	1157 (24.6)	617 (13.0)
Female	11900 (71.1)	9118 (78.1)	2352 (20.1)	3931 (33.5)	1153 (9.8)
Age, year range		χ^2 (4)=65.25 0.004	χ^2 (4)=804.7 <0.001	χ^2 (4)=292.9 <0.001	χ^2 (4)=464.8 <0.001
18-34	1292 (7.7)	854 (67.2)	15 (1.2)	182 (14.3)	11 (0.9)
35-44	1517 (9.9)	1090 (73.2)	93 (6.2)	331 (22.0)	45 (3.0)
45-54	2583 (15.5)	1926 (76.0)	415 (16.4)	821 (32.3)	199 (7.8)
55-64	3984 (23.9)	2984 (76.3)	882 (22.4)	1365 (34.7)	446 (11.3)
65+	4796 (28.7)	3647 (77.6)	1425 (30.4)	1674 (35.5)	826 (17.4)
Race/Ethnicity[d]		χ^2 (3)=11.28 0.010	χ^2 (3)=64.36 <0.001	χ^2 (3)=16.81 0.001	χ^2 (3)=17.72 0.001
Whites	13002 (77.9)	9572 (75.1)	2686 (21.0)	3946 (30.8)	1423 (11.0)
Blacks	1316 (7.9)	1021 (78.8)	239 (18.5)	436 (33.9)	116 (8.9)
Hispanic	1133 (6.8)	822 (73.3)	122 (11.1)	300 (26.8)	88 (8.0)
Other race	1106 (6.6)	822 (76.0)	220 (20.2)	362 (33.2)	136 (12.4)
Marital Status		χ^2 (2)=57.20 <0.001	χ^2 (2)=417.4 <0.001	χ^2 (2)=332.1 <0.001	χ^2 (2)=277.7 <0.001
Married	8283 (49.6)	5941 (73.0)	1247 (15.3)	2051 (25.1)	546 (7.6)
Single	5410 (32.4)	4050 (76.5)	1079 (20.3)	1786 (33.6)	594 (11.1)
Widowed/Separated	2957 (17.7)	2316 (79.8)	952 (32.9)	1237 (42.6)	627 (18.7)
Education		χ^2 (3)=138.5 <0.001	χ^2 (3)=614.1 <0.001	χ^2 (3)=502.3 <0.001	χ^2 (3)=644.3 <0.001
Did not Graduate High School	1555 (9.3)	1246 (82.0)	508 (33.8)	689 (45.6)	352 (23.2)
Graduated High School	4308 (25.8)	3333 (79.1)	1118 (26.5)	1536 (36.3)	695 (16.3)
Attended College /Tech School	4887 (29.3)	3638 (75.6)	1027 (21.4)	1629 (33.8)	465 (9.6)
Graduated College /Tech School	5923 (35.5)	4105 (70.6)	625 (10.7)	1226 (20.9)	255 (4.3)
Employment		χ^2 (3)=157.5 <0.001	χ^2 (3)=1160 <0.001	χ^2 (3)=779.7 <0.001	χ^2 (3)=699.1 <0.001
Employed	6470 (38.8)	4500 (70.8)	497 (7.8)	1298 (20.3)	213 (3.3)
Unemployed	1065 (6.4)	770 (74.0)	164 (15.6)	350 (33.3)	85 (8.1)
Homemaker	1145 (6.9)	837 (74.3)	115 (13.8)	287 (25.4)	79 (7.0)
Retired	4951 (29.7)	3698 (76.4)	1364 (28.1)	1660 (34.2)	785 (16.0)
Unable to work	3062 (18.3)	2534 (84.2)	1103 (37.0)	1493 (49.8)	608 (20.1)
Income		χ^2 (4)=191.9 <0.001	χ^2 (4)=931.7 <0.001	χ^2 (4)=875.1 <0.001	χ^2 (4)=620.8 <0.001
<$15000	2653 (15.9)	2166 (83.1)	874 (34.1)	1200 (46.3)	525 (20.1)
$15000-$24999	2914 (17.5)	2249 (78.8)	837 (29.2)	1221 (42.6)	478 (16.6)
$25000-$49999	3730 (22.3)	2747 (75.0)	729 (19.8)	1083 (29.5)	357 (9.6)
$50000-$74999	2198 (13.2)	1562 (72.3)	248 (11.4)	476 (21.9)	115 (5.3)
≥$75000	3410 (20.4)	2307 (68.8)	237 (7.0)	567 (16.7)	107 (3.1)

[a]Total sample size (weighted) for the study population for 2011.
[b]Sub-sample (n) is the number of observation for each category of the study variable followed by the proportion in percentages (%).
[c]Chi-square value, (degree of freedom) and *p*-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.2.5 Relationship between Socio-demographic Factors and CLRD for 2011

The results for all socio-demographic factors for 2011 presented in Table 2.6 were consistent with the findings for 2009 and 2010. These findings imply that socio-demographic factors, gender, age, ethnicity, marital status, educational level, employment status and income level are potential predictive factors of the reporting of CLRD among adult ACBS respondents. Descriptions of the full results for 2011 are presented in appendix 4.

Table 2.6: Distribution and Bivariate Relationship of Indoor Environmental Factors, Access to Healthcare and CLRD for 2011

Factors	Sample Size N [a]=15403 n(%)[b]	Current Asthma χ^2 [c] P-value [c] n(%)	COPD χ^2 [c] P-value [c] n(%)[d]	Bronchitis χ^2 [c] P-value [c] n(%)[d]	Emphysema χ^2 [c] P-value [c] n(%)
Mold		χ^2 (1)=54.43 <0.001[c]	χ^2 (1)=6.16 0.013	χ^2 (1)=37.58 <0.001	χ^2 (1)=2.192 0.139
No	14813 (88.7)	10823 (74.4)	2867 (19.7)	4395 (30.1)	1549 (10.5)
Yes	1779 (10.7)	1435 (82.5)	385 (22.2)	653 (37.3)	205 (11.7)
Smoking		χ^2 (2)=34.63 <0.001	χ^2 (2)=1298 <0.001	χ^2 (1)=666.6 <0.001	χ^2 (2)=1077 <0.001
Current smoker	2655 (15.9)	2045 (79.0)	943 (36.2)	1252 (48.0)	586 (22.4)
Former smoker	5571 (33.4)	4176 (76.3)	1573 (28.7)	1942 (35.3)	918 (16.6)
Never smoked	8413 (50.4)	6082 (73.3)	759 (9.2)	1880 (22.7)	262 (3.1)
Smoking Indoors		χ^2 (1)=41.9 <0.001	χ^2 (1)=465.0 <0.001	χ^2 (1)=349.5 <0.001	χ^2 (1)=476.6 <0.001
No	14350 (86.0)	10491 (74.5)	2442 (17.3)	3994 (28.2)	1224 (8.6)
Yes	2327 (13.9)	1837 (80.8)	838 (36.8)	1088 (47.7)	545 (23.8)
Saw Cockroach past 30 days		χ^2 (1)=0.560 0.454	χ^2 (1)=4.984 0.026	χ^2 (1)=5.943 0.015	χ^2 (1)=15.36 <0.001
No	15046 (90.1)	11111 (75.3)	2922 (19.8)	4545 (30.7)	1548 (10.4)
Yes	1605 (9.6)	1200 (76.1)	349 (22.1)	530 (33.7)	215 (13.6)
Saw Mice past 30 days		χ^2 (1)=7.483 0.006	χ^2 (1)=3.66 0.056	χ^2 (1)=4.39 0.036	χ^2 (1)=1.352 0.245
No	15544 (93.1)	11450 (75.1)	3034 (19.9)	4712 (30.8)	1637 (10.6)
Yes	1128 (6.8)	872 (78.8)	247 (22.2)	372 (33.8)	131 (11.7)
Asthma cause by Previous Job		χ^2 (1)=215.4 <0.001	χ^2 (1)=391.9 <0.001	χ^2 (1)=466.8 <0.001	χ^2 (1)=207.2 <0.001
No	10888 (65.2)	7538 (70.6)	1687 (15.7)	2732 (25.4)	879 (8.1)
Yes	3131 (18.8)	2590 (83.8)	973 (31.7)	1407 (45.5)	526 (16.9)
Medical Cost		χ^2 (1)=36.73 <0.001	χ^2 (1)=13.77 <0.001	χ^2 (1)=219 <0.001	χ^2 (1)=18.30 <0.001
No	13939 (83.5)	10187 (74.4)	2674 (19.5)	3925 (28.6)	1414 (10.2)
Yes	2735 (16.4)	2136 (80.0)	604 (22.6)	1157 (43.0)	351 (13.0)

[a]Total sample size (weighted) for the study population for 2011.
[b]Sub-sample (n) is the number of observation for each category of the study variable followed by the proportion in percentages (%).
[c]Chi-square value, (degree of freedom) and *p*-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.

5.2.6 Relationship between Indoor Environmental Factors, Healthcare Access and CLRD for 2011

The findings for smoking status, smoking indoors, exposure to chemicals, smoke, fumes and dust in a previous job and could not see a doctor because of cost (medical cost) were consistent with the results of 2009 and 2010. However, a different result was observed for mold, where significantly higher reporting of current asthma (82.5%), COPD (20.5%) and chronic bronchitis (37.3%) was observed for those who saw mold in the past 30 days. Significantly higher reporting of COPD (22.1%), chronic bronchitis (33.7%), and emphysema (13.6%) was identified among those who saw cockroach in the past 30 days while the increased reporting of current asthma (78.8%), COPD (22.2%) and chronic bronchitis (33.8%) was observed among those who saw mice in the past 30 days. The results from 2009, 2010 and 2011 suggest that inadequate indoor environmental conditions such as mold, smoking, smoking indoors, pest infestation, and medical cost are significant predictors of the reporting of CLRD among adult ACBS respondents.

5.3 Mediation Analysis

To determine whether the relationship between socio-demographic factors, gender, age, ethnicity, marital status, educational level, employment status and income level may be mediated by intervening variables such as mold, pest infestation, smoke inside, being a current or former smoker, occupational exposure and medical cost, a mediation test was conducted. As a step towards establishing a mediated relationship, significant relationships between socio-demographic factors and selected mediators are required. These relationships are presented in appendix 4. Socio-demographic factors were found to be associated with selected mediators, mold, pest infestation, smoke indoors, smoking status, occupational exposure and medical cost. Socio-demographic factors, gender, age, ethnicity, marital status, education, employment, income and indoor environmental factors (potential mediators) mold, pest infestation, smoke inside, smoking status, occupational exposure and medical cost were found to be significantly associated with current asthma, COPD, chronic bronchitis and emphysema. These significant relationships were prerequisites for further tests to establish mediated relationships.

Logistic regression models were constructed to test mediation for current asthma, COPD, chronic bronchitis and emphysema, for 2009, 2010 and 2011. As previously described in the methodology chapter, the models were constructed according to the social causation of health inequality framework with variables that were statistically significant in the bivariate analyses and logistic regression based on the requirements for a mediation test. Model 1 was constructed by adjusting only for socio-demographic factors (gender, age, ethnicity, marital status, education, employment and income). Model 2 was constructed by fully adjusting for all socio-demographic factors entered in model 1 and all potential mediators, indoor environmental factors and access to

healthcare (mold, pest infestation, smoking inside, smoking status, occupational exposure and medical cost) to assess the degree to which the relationship between socio-demographic factors and CLRD change. Model 3 was constructed using all socio-demographic factors, potential mediator's indoor environmental factors and healthcare access (medical cost) entered in model 2 and all relevant predictor-mediator interaction terms. The sequential process was followed to explore the effect estimates due to the influence of mediating variables. Also, to include interaction effects to explore if the effects of indoor environmental factors and access to healthcare on the reporting of CLRD among adult ACBS respondents vary by different socio-demographic groups. The likelihood ratio test comparing each new model with the previous model revealed that each additional set of variables statistically improved the model ($P<0.001$). The results of the unadjusted model and model 1 for all three years are presented in appendix 4. Given the number of significant interaction effects that were identified in model 3, tables were not presented for the results of interaction effects. However, significant interaction effects were reported in details for all three years.

Comparing the unadjusted odds ratios and the socio-demographic adjusted odds ratios in model 1, the unadjusted odds ratios for gender, age, marital status, educational level, employment status, income were strongly reduced (attenuated[1]) after adjusting for all sociodemographic factors in model 1.

In the fully adjusted model, that is after adjusting for all seven potential mediators in the multivariable logistic regression model 2 for 2009, 2010 and 2011, mold, mice presence, smoking inside, being a current or former smoker, occupational exposure and medical cost remained significant for different CLRD for different years except for

[1]Attenuation is the reduction in the estimated effect size because of measurement errors (Crocker and Algina, 1986; Worthen, White, Fan, & Sudweeks, 1999)

occupational exposure that was consistent for all factors for all years. Comparing model 1 and 2, loss of significant effects was observed for some socio-demographic factors while significant but reduced magnitudes of the effects (OR) was observed for some socio-demographic factors. Significant but increased magnitudes of the effects were observed for gender and some age groups which did not support the mediation process. This indicates that mold, smoking inside, current or former smoker, mice presence, occupational exposure and medical cost completely or partially mediated the effects of age, marital status, education, employment and income on the reporting of CLRD although these results were not consistent for CLRD for all three years. Significant predictor-mediator interaction effects revealed that the effects of mold, mice presence, current or former smoker, smoking inside, occupational exposure and medical cost on the reporting of CLRD varies by the difference in gender, age, education, employment and income.

Table 2.7: Final results of factors mediating the relationship between socio-demographic factors and CLRD for 2009

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.76 (1.58-1.97) <0.001	1.26 (1.07-1.48) 0.005	1.71 (1.50-1.94) <0.001	.742 (.614-.897) 0.002
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.57 (1.30-1.90) <0.001	5.70 (2.64-12.3) <0.001	1.21 (.938-1.57) 0.142	3.90 (1.43-10.7) 0.008
45-54	1.53 (1.28-1.81) <0.001	13.4 (8.00-29.8) <0.001	2.06 (1.65-2.57) <0.001	10.9 (4.38-27.1) <0.001
55-64	1.64 (1.38-1.95) <0.001	21.9 (11.7-42.9) <0.001	2.28 (1.84-2.84) <0.001	19.9 (8.07-49.2) <0.001
65+	1.90 (1.54-2.34) <0.001	27.9 (14.3-54.3) <0.001	2.31 (1.80-2.95) <0.001	37.3 (14.9-93.1) <0.001
Race/Ethnicity[d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	.875 (.702-1.09) 0.237	.625 (.462-.846) 0.002	.901 (.720-1.13) 0.359	.533 (.360-.790) 0.002
Hispanic	.490 (.400- .600) <0.001	.727 (.531-.997) 0.048	.847 (.672-1.07) 0.159	.803 (.546-1.18) 0.263
Other race	.968 (.790-1.19) 0.747	.609 (.460-.807) 0.001	1.03 (.838-1.37) 0.769	.563 (.986-800) 0.001
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	1.08 (.948-1.22) 0.258	.971 (.811-1.16) 0.751	1.01 (.888-1.16) 0.834	1.12 (.890-1.40) 0.343
Widowed/Separated	.990 (.833-1.18) 0.908	1.21 (.996-1.48) 0.054	1.13 (.957-1.34) 0.147	1.28 (1.04-1.56) 0.026
Education				
Did not Graduate High School	1.27 (.997-1.61) 0.053	1.68 (1.29-2.20) <0.001	1.73 (1.38-2.16) <0.001	2.10 (1.52-2.91) <0.001
Graduated High School	1.12 (.966-1.30) 0.135	1.52 (1.24-1.85) <0.001	1.57 (1.35-1.83) <0.001	2.10 (1.63-2.72) <0.001
Attended College /Tech School	1.07 (.940-1.22) 0.312	1.35 (1.11-1.63) 0.003	1.36 (1.18-1.57) <0.001	1.39 (1.08-1.80) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	.981 (.795-1.21) 0.859	1.18 (.865-1.60) 0.303	.927(.744-1.16) 0.497	1.31 (.882-1.95) 0.181
Homemaker	.877 (.710-1.08) 0.227	1.53 (1.11-2.11) 0.100	1.05 (.830-1.33) 0.689	1.79 (1.67-2.76) 0.008
Retired	.889 (.751-1.05) 0.177	1.57 (1.27-1.93) <0.001	1.17 (.982-1.38) 0.080	1.80 (1.45-2.30) <0.001
Unable to Work	1.43 (1.19-1.72) <0.001	2.57 (2.07-3.20) <0.001	1.59 (1.34-1.88) <0.001	2.90 (2.19-3.83) <0.001
Income				
<$15000	1.33 (1.07-1.67) 0.012	2.23 (1.65-3.03) <0.001	2.16 (1.72-2.72) <0.001	1.98 (1.34-2.94) 0.001
$15000-$24999	1.29 (1.06-1.56) 0.010	1.81 (1.36-2.40) <0.001	1.68 (1.36-2.06) <0.001	1.60 (1.11-2.31) 0.012
$25000-$49999	1.01 (.863-1.17) 0.944	1.62 (1.27-2.09) <0.001	1.49 (1.24-1.78) <0.001	1.42 (1.01-1.99) 0.045
$50000-$74999	.995 (.851-1.16) 0.947	1.38 (1.04-1.83) 0.026	1.27 (1.04-1.54) 0.018	1.19 (.809-1.76) 0.373
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Factors	Current Asthma OR [a] (95% CI [b]) P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI [b]) P-Value [c]
Mold				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.30 (1.09-1.55) 0.003	1.10 (.874-1.37) 0.430	1.13 (.954-1.35) 0.153	1.14 (.869-1.50) 0.340
Smoking				
Current smoker	.970 (.812-1.16) 0.739	4.70 (3.70-5.97) <0.001	1.89 (1.58-2.26) <0.001	6.41 (4.72-8.71) <0.001
Former smoker	1.05 (.934-1.18) 0.415	2.87 (2.43-3.39) <0.001	1.48 (1.31-1.68) <0.001	3.90 (3.09-4.89) <0.001
Never smoked	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Smoking Indoors				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.10 (.914-1.31) 0.326	1.14 (.919-1.41) 0.234	1.27 (1.07-1.51) 0.007	1.27 (.981-1.63) 0.070
Saw Cockroach past 30 days				
No	1.0 (reference)	-	-	-
Yes	.872 (.731-1.04) 0.126			
Saw Mice past 30 days				
No	-	-	-	-
Yes				
Asthma cause by Previous Job				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.03 (1.75-2.34) <0.001	1.67 (1.43-1.96) <0.001	1.93 (1.70-2.19) <0.001	1.75 (1.45-2.10) <0.001
Medical Cost				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.02 (.870-1.19) 0.848	.938 (.773-1.14) 0.519	1.26 (1.09-1.46) <0.001	1.15 (.910-1.45) 0.244

[a]Adjusted odds ratio for multivariable logistic regression. Adjusted for all socio-demographic factors and seven potential mediators.
[b]95% Confidence interval from multivariable logistic regression model.
[c]P-value for multivariable logistic regression for all variables included in the model.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.3.1 Factors mediating the relationship between socio-demographic factors and CLRD for 2009

The results for 2009 are summarized in table 2.7. After adjusting for all socio-demographic factors and seven potential mediators in model 2, a significant effect was observed for mold, occupational exposure and current asthma. Comparing model 1 and 2, a significant but increased magnitude of the effect of gender predicting the reporting of current asthma was observed. Although this reveals that mold presence and occupational exposure have a significant effect on gender difference in the reporting of current asthma, this does not support the mediating process based on the mediation rule for the current study analyses. A loss of significance was observed for high school graduates supporting full mediation. While significant but reduced magnitudes of the effects were observed for all age groups, non-high school graduates, unable to work participants and those with income <$15000 and $15000-24999 supporting partial mediation. These findings indicate that disparities in the reporting of current asthma among adult ACBS survey respondents in different, age, education, employment and income groups can be fully or partially explained by mold presence and exposure to chemicals, fumes and dust in a previous job.

In the mediation test for COPD, significant effects were observed for current or former smokers and occupational exposure after controlling for all socio-demographic factors and potential mediators. Significant but increased magnitude of the effect was observed for gender predicting COPD indicating that being a current or former smoker and occupational exposure have a significant effect on gender difference in the reporting of COPD, but this does not support the mediation process. However, a loss of significance was observed for unemployed and homemaker supporting full mediation. While a significant but reduced magnitude of the effect remained for all age and education groups, retired and unable to work participants and all income groups supporting partial

mediation. Suggesting that being a former or current smoker and occupational exposure fully or partially explain age, education, employment and income difference in the reporting of COPD among adult ACBS respondents.

After controlling for all other factors in model 2, significant effects were observed for current and former smokers, smoking indoors, occupational exposure, medical cost and chronic bronchitis while a significant but increased magnitudes of the effects were observed for females and those over 65 years old, indicating that being a current or former smoker, smoking indoors, occupational exposure and medical cost have significant effects on gender and increased age difference in the reporting of chronic bronchitis, however, the mediation process was not supported. A loss of significance was observed for age group 35-44 years old and retired participants supporting full mediation. While significant but reduced magnitudes of the effects remained for age groups 45 to 64 years old, all educational groups, unable to work participants and income groups <$49999. Demonstrating that being a former or current smoker, occupational exposure and medical cost, fully or partially explain disparities in the reporting of chronic bronchitis among adults in different age, education, employment and income groups.

In the fully adjusted model for emphysema, significant effects remained for current and former smokers and occupational exposure. While a significant but increased effects were observed for widowed/separated participants, homemakers and all age groups. Revealing that being a current or former smoker and occupational exposure have significant effects on marital status, employment and age difference in the reporting of emphysema, however, the mediation test was not supported. A loss of significance was observed for singles and unemployed in predicting emphysema supporting full mediation. While significant but reduced magnitudes of the effects remained for all

educational groups, retired and unable to work participants and those who reported income <$50000 supporting partial mediation. Indicating that being a former or current smoker and occupational exposure fully or partially explains disparities in the reporting of emphysema among adults in different marital, educational, employment and income groups.

5.3.2 Interactions effects between selected socio-demographic factors, indoor environmental factors, access to health and CLRD for 2009

Seven significant predictor-mediator interaction effects were identified for current asthma for 2009. Gender by occupational exposure (AOR=.428 p=0.001), income <$15000 by mold (AOR=1.82 p=0.009), income <$15000 by current smokers (AOR=1.82 p=0.009) and former smokers (AOR=1.63 p=0.005), income $15000-$24999 by current (AOR=1.77 p=0.012) and former smokers (AOR=1.57 p=0.003). Age 35-44 by current smokers (AOR=1.79 p=0.025) and 55-64 years old by former smoker (AOR=2.58 p=0.024). These findings suggest that females with no occupational exposure were less likely to report current asthma. Those with income <$15000 who reported mold and were current or former smokers were more likely to report asthma. While age group 35-44 who were current smokers and age group 55-64 who were former smokers were more likely to report current asthma. These findings reveal that the effects of mold, smoking status and medical cost on the reporting of current asthma varies by the difference in gender, age, employment and income.

Seven significant predictor-mediator interaction effects were identified for COPD. Gender by smoke indoors (AOR=1.42 p=0.002), Age groups 45-54, 55-64 and 65+ by current smokers (AOR=4.05 p=0.001); (AOR=4.91 p=0.001); (AOR=3.32 p=0.001) and by former smokers (AOR=2.84 p=0.001); (AOR=2.63 p=0.001); (AOR=3.33 p=0.001), non-high school graduates by occupational exposure (AOR=1.79 p=0.010), unable to work by occupational exposure (AOR=.490 p=0.005). These findings indicate

that females who reported smoking indoors were more likely to report COPD compared to females who did not report smoking indoors. Current or former smokers who were 45 years or older were more likely to report COPD than non-smokers. Non-high school graduates who reported occupational exposure were more likely to report COPD while unable to work participants who did not report occupational exposure were less likely to report COPD. Thus, revealing that the differential gender, age, education and employment effects on the reporting of COPD depends on being a current or former smoker, smoking indoors and occupational exposure.

Four interaction effects that were significantly related to chronic bronchitis were identified, high school graduates by current (AOR=1.73 p=0.05) and former smokers (AOR=1.45 p=0.032). Income $25000-49999 by former smokers (AOR=1.62 p=0.009) and income $50000-$74999 by medical cost (AOR=.466 p=0.012). These findings indicate that high school graduates who were current or former smokers and those with household income $25000-$49999 who were former smokers were more likely to report chronic bronchitis while participants with income $50000-$74999 who did not report cost as a barrier to medical care were less likely to report chronic bronchitis. Demonstrating that the differential education and income effects on the reporting of bronchitis depends on being a current or former smoker and medical cost.

Seven interaction effects that were significantly related to emphysema were identified. Gender by mold (AOR 1.44 p=0.022), age group 45-54, 55-44 and 65+ by occupational exposure (AOR=1.70 p=0.001), (AOR 1.78 p=0.001) and (AOR=1.79 p=0.001). Unemployed by saw mice (AOR 4.94 p=0.001), unable to work by saw mice (AOR=3.20 p=0.027), Unable to work by smoke indoors (AOR=.438 p=0.006). These results suggest that female participants who reported mold were more likely to report emphysema. Those 45 years or older exposed to chemical fumes and dust in a previous

job were more likely to report emphysema. Unemployed and unable to work participants who reported mice were more likely to report emphysema. While unable to work participants who reported no smoking indoors were less likely to report emphysema. These findings imply that the differential gender, age and employment effects on the reporting of emphysema depends on mold presence, pest infestation and smoke indoors.

Table 2.8: Final results of factors mediating the relationship between socio-demographic factors and CLRD for 2010

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.96 (1.78-2.14) 0.047	1.18 (1.04-1.35) 0.013	1.59 (1.43-1.77) <0.001	.707 (.605-.825) <0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.42 (1.20-1.68) <0.001	2.63 (1.52-4.55) 0.001	1.84 (1.46-2.31) <0.001	1.15 (.572-2.30) 0.700
45-54	1.36 (1.16-1.58) <0.001	9.03 (5.58-14.6) <0.001	2.47 (2.01-3.03) <0.001	4.54 (2.62-7.86) <0.001
55-64	1.57 (1.35-1.93) <0.001	13.3 (8.41-21.8) <0.001	3.01 (2.47-3.68) <0.001	7.75 (4.52-13.3) <0.001
65+	1.39 (1.16.1.67) <0.001	21.3 (13.1-34.7) <0.001	3.28 (2.63-4.09) <0.001	15.5 (8.87-26.9) <0.001
Race/Ethnicity [d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	1.00 (.841-1.19) 0.989	.493 (.392-.619) <0.001	.805 (.680-.953) 0.012	.624 (.475-.828) 0.001
Hispanic	.738 (.616-.885) 0.001	.380 (.277-.521) <0.001	.689 (.568-.856) 0.689	.441 (.301-.647) <0.001
Other race	.853 (.723-101) 0.058	.860 (.689-1.07) 0.180	.815 (.683-.972) 0.023	.731 (.554-.963) 0.026
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	.942 (.848-1.065) 0.267	.956 (.825-1.11) 0.549	.974 (,870-1.09) 0.650	1.02 (.852-1.23) 0.800
Widowed/Separated	1.11 (.961-1.29) 0.152	1.33 (1.15-1.57) 0.001	1.13 (.989-130) 0.073	1.10 (.904-1.34) 0.340
Education				
Did not Graduate High School	1.22 (.998-1.50) 0.052	1.31 (1.05-1.64) 0.016	1.27 (1.06-1.53) 0.010	2.37 (1.81-3.09) <0.001
Graduated High School	1.22 (1.08-1.38) 0.002	1.41 (1.20-1.65) <0.001	1.24 (1.09-1.40) 0.001	1.97 (1.59-2.44) <0.001
Attended College/Tech School	1.07 (.955-1.19) 0.258	1.35 (1.15-1.57) <0.001	1.21 (1.08-1.36) 0.001	1.80 (1.46-2.22) <0.001
Graduated College/ Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	.961 (.809-1.14) 0.650	1.54 (1.20-1.98) 0.001	1.22 (1.02-1.47) 0.028	1.56 (1.13-2.15) 0.006
Homemaker	1.06 (.875-1.27) 0.575	1.38 (1.02-1.85) 0.034	1.05 (.854-1.29) 0.647	1.47 (.995-2.16) 0.053
Retired	1.28 (1.11-1.47) 0.001	2.05 (1.71-2.44) <0.001	1.40 (1.22-1.61) <0.001	1.78 (1.42-2.24) <0.001
Unable to work	1.71 (1.46-2.00) <0.001	3.48 (2.89-4.18) <0.001	2.12 (1.84-2.44) <0.001	2.53 (2.00-3.21) <0.001
Income				
<$15000	1.78 (.972-1.43) 0.094	2.20 (1.70-2.85) <0.001	1.93 (1.59-2.34) <0.001	2.14 (1.53-2.99) <0.001
$15000-$24999	1.04 (.886-1.22) 0.629	2.02 (1.60-2.56) <0.001	1.84 (1.55-2.18) <0.001	1.85 (1.36-2.51) <0.001
$25000-$49999	.998 (.877-1.14) 0.980	1.65 (1.33-2.04) <0.001	1.56 (1.34-1.81) <0.001	1.52 (1.14-2.02) 0.004
$50000-$74999	1.01 (.882-1.15) 0.905	1.30 (1.03-1.66) 0.030	1.20 (1.02-1.42) 0.031	1.11 (.794-1.55) 0.547
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Mold				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.17 (1.01-1.36) 0.043	1.06 (.882-1.28) 0.524	1.19 (1.03-1.38) 0.017	1.26 (1.01-1.57) 0.044
Smoking				
Current smoker	1.20 (1.02-1.40) 0.035	4.80 (3.94-5.85) <0.001	1.81 (1.56-2.10) <0.001	7.51 (5.77-9.79) <0.001
Former smoker	.947 (.859-1.04) 0.269	2.96 (2.59-3.39) <0.001	1.36 (1.23-1.50) <0.001	5.29 (1.44-1.95) <0.001
Never smoked	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Smoking Indoors				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.27 (1.08-1.48) 0.003	1.42 (1.19-1.70) <0.001	1.26 (1.09-1.46) 0.002	1.19 (.961-1.48) 0.111
Saw Cockroach past 30 days				
No	-	1.0(reference)	1.0 (reference)	1.0 (reference)
Yes		.944 (.778-1.15) 0.563	.973 (.834-1.14) 0.727	1.06 (.842-1.34) 0.616
Saw Mice past 30 days				
No	1.0 (reference)	-	1.0 (reference)	1.0 (reference)
Yes	1.22 (1.03-1.45) 0.024		1.02 (.863-1.22) 0.783	.962 (.735-1.26) 0.776
Asthma caused by previous Job				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.41 (2.12-2.73) <0.001	1.63 (1.43-1.85) <0.001	1.83 (1.65-2.03) <0.001	1.67 (1.44-1.95) <0.001
Medical Cost				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.05 (.921-1.19) 0.478	.981 (.837-1.15) 0.813	1.38 (1.22-1.56) <0.001	1.08 (.889-1.31) 0.464

[a]Adjusted odds ratio for multivariable logistic regression. Adjusted for all socio-demographic factors and seven potential mediators.

[b]95% confidence interval from multivariable logistic regression model.

[c]P-value for multivariable logistic regression for all variables included in the model.

[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.3.3 Factors mediating the relationship between socio-demographic factors and CLRD for 2010

Results for 2010 are summarized in Table 2.8. After adjusting for all socio-demographic factors and seven potential mediators in model 2, for current asthma, significant effects remained for mold, current smokers, smoke indoors, mice presence and occupational exposure and a loss of significance was observed for those who attended college and income groups <$15000 and $15000-$24999 supporting full mediation. While significant, but reduced magnitudes of the effects were observed for 35 years or older, non-high school graduates, high school graduates, retired and unable to work participants supporting partial mediation. A significant, but increased magnitude of the effect of gender predicting current asthma was observed, although this reveals that indoor environmental factors have a significant effect on gender difference in the reporting of current asthma this does not support the mediation process. The findings suggest that mold presence, being a current smoker, mice presence, smoking indoors and occupational exposure fully or partially explains the effect of age, education, employment and income difference in the reporting of current asthma.

Adjusting for all socio-demographic factors and seven potential mediators for COPD, a significant effect remained for smoking status, smoking inside and occupational exposure. Significant but increased magnitudes of the effects were observed for females and those 65 years or older demonstrating that smoking status, smoking inside and occupational exposure have a significant effect on gender and increased age difference on the reporting of COPD, however, this does not support the mediation process. While significant, but reduced magnitudes of the effects were observed for age group 35 to 65 years, all educational, employment and income groups suggesting partial mediation. Indicating that being a former or current smoker, smoking indoors and occupational

exposure partially explains the effects of age, marital status, education, employment and income on the reporting of COPD.

In the fully adjusted model for chronic bronchitis, significant effects were observed for mold presence, current and former smokers, smoking inside, occupational exposure and medical cost. While significant but increased magnitudes of the effects were observed for gender and those over 65 years old. This indicates that indoor environmental factors and medical cost have significant effects on gender and increased age difference in the reporting of chronic bronchitis, however, this does not support the mediation process. Conversely, a loss of significance was observed for widowed/separated participants in predicting chronic bronchitis supporting full mediation. While significant but reduced magnitudes of the effects were observed for 35 to 64 years old, all educational groups, unemployed, retired, unable to work participants and all income groups. These findings imply that mold presence, being a former or current smoker, exposure to second-hand smoke, occupational exposure and medical cost fully explains the effects of windowed/separated and partially explains the effects of age below 65 years old, education, employment, and income on the reporting of chronic bronchitis.

In the fully adjusted model for emphysema, significant effects remained for mold presence, current and former smokers and occupational exposure. A significant but increased effect was observed for those 65 years or older which indicates that indoor environmental factors have a significant effect on increased age difference in the reporting of emphysema, however, this does not support the mediation process. While a significant but reduced magnitude of the effect was observed for those above 35-64 years old, all educational, unemployed, retired, unable to work participants and those who reported income <$74999 supporting partial mediation. These findings suggest that

mold presence, being a former or current smoker and occupational exposure partially explains age, education, employment and income effect on the reporting of emphysema.

5.3.4 Interaction effects between selected Socio-demographic, Indoor Environmental factors, access to health and CLRD for 2010

Seven significant predictor-mediator interaction effects were identified for current asthma for 2010. Gender by rodents (AOR=1.33 p=0.012), gender by occupational exposure (AOR=.651 p=0.001), unable to work by mold (AOR=2.07 p=0.001), retired by current smokers (AOR 1.63 p=0.007) and former smokers (AOR=1.49 p=0.001), unable to work by current smokers (AOR=2.28 p=0.001) and former smokers (AOR=1.78 p=0.001). This indicates that females who reported mice presence were more likely to report current asthma, while females who reported no occupational exposure were less likely to report current asthma compared to males. When mold was present, unable to work participants were more likely to report current asthma. Retired and unable to work participants who were current or former smokers were more likely to report current asthma compared to never smoked participants. These findings reveal that the effects of gender and employment on the reporting of asthma depends on mold, pest infestation and smoke indoors. Also, the effects of mold, mice presence and smoking indoors on the reporting of asthma varies by gender and employment status.

Eight interaction effects that were significantly related to COPD were identified. Gender by occupational exposure (AOR =.633 p=0.001), non-high school graduates and high school graduates by former smokers (AOR=1.63 p=0.004) and (AOR=1.76 p=0.001), attended college by current and former smokers (AOR=1.53 p=0.002) and (AOR=1.49 p=0.001). Income <$15000 and $25000-$49999 by smoke indoors (AOR=1.66 p=0.001) and (AOR=1.61 p=0.030). These significant interaction effects suggest that females with no occupational exposure were less likely to report COPD than males. Non-high school graduates and high school graduates who were former

smokers were more likely to report COPD compared to those who never smoked. While current and former smokers who attended college were more likely to report COPD compared to those who never smoked. Those with income <$15000 and $25000-$49999 who smoked indoors were more likely to report COPD compared to those who did not smoke indoors. The findings indicate that the effects of gender, education and income level on the reporting of COPD depends on being a current or former smoker, smoke indoors and occupational exposure. Also, the effects of being a current or former smoker, smoking indoors and occupational exposure on the reporting of COPD varies by gender, education and income level.

Five significant interaction effects were identified for chronic bronchitis for 2010. Gender by smoking inside (AOR=1.31 p=0.001), age 55-64 by mice (AOR=1.47 p=0.015). Non-high school graduates by occupational exposure (AOR=.665 p=0.022). Income <$15000 and $25000-$49999 by medical cost (AOR=1.28 p=0.024) and (AOR=1.80 p=0.001). These significant interaction effects suggest that females who report smoking indoors were more likely to report chronic bronchitis. When mice were present, participants who were 55-64 years old were more likely to report chronic bronchitis, while non-high school graduates who had no occupational exposure were less likely to report chronic bronchitis. Also, increased odds of reporting chronic bronchitis were observed among participants with income <$15000 and $25000-$49999 who report cost as a barrier to medical care. Implying that the effects of gender, age, education and income on the reporting of chronic bronchitis depends on smoking indoors, mice presence, occupational exposure and medical cost. Also, the effects of smoking indoors, mice presence, occupational exposure and medical cost on the reporting of chronic bronchitis varies by gender, age, education and income level.

I identified nine significant interaction effects for emphysema for 2010. Gender by former smokers (AOR=1.69 p=0.017), age group 55-64 by smoke indoors (AOR=1.62 p=0.00), age group 35-44 by current smokers (AOR=8.52 p=0.004), age groups 45-54, 55-64 and 65+ by current smokers (AOR=6.78 p=0.001), (AOR=6.90 p=0.001), (AOR=5.39 p=0.001) and former smokers (AOR=2.39 p=0.036), (AOR=3.03 p=0.001) and (AOR=3.12 p=0.001). These findings suggest that former smokers who were females and former or current smokers who were 35 years or older had increased odds of reporting emphysema. While 55-64 years old who smoked indoors were more likely to report emphysema. Implying that the effects of gender and age on emphysema depends on being a current or former smoker and smoking indoors. Also, the effects of smoking status and smoking indoors on the reporting of emphysema varies by the difference in gender and age.

Table 2.9: Final results of factors mediating the relationship between socio-demographic factors and CLRD for 2011

Factors	Current Asthma OR [a] (95% CI)[b] P-Value[c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.77 (1.60-1.96) <0.001	1.00 (.880-1.14) 0.962	1.50 (1.45-1.74) <0.001	.637 (.544-.747) <0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.23 (1.02-1.48) 0.034	7.52 (3.36-15.9) <0.001	1.56 (1.22-2.00) <0.001	2.58 (1.25-5.35) 0.011
45-54	1.30 (1.10-1.56) 0.003	16.7 (8.14-34.1) <0.001	2.23 (1.80-2.78) <0.001	4.97 (2.56-9.65) <0.001
55-64	1.27 (1.07-1.50) 0.005	30.0 (14.7-51.1) <0.001	2.70 (2.17-3.34) <0.001	8.85 (4.61-17.0) <0.001
65+	1.58 (1.30-1.92) <0.001	48.1 (23.5-98.9) <0.001	3.17 (2.51-4.01) <0.001	16.1 (8.50-32.0) <0.001
Race/Ethnicity[d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	.965 (.811-1.15) .0688	.530 (.428-.657) <0.001	.770 (.650-.911) 0.002	.469 (.351-.626) <0.001
Hispanic	.795 (.663-.953) 0.013	.388 (.292-.516) <0.001	.738 (.607-.897) 0.002	.738 (.534-1.02) 0.660
Other race	1.04 (.863-1.24) 0.710	.792 (.635-.988) 0.038	.864 (.721-1.04) 0.115	.918 (.701-1.20) 0.918
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	.936 (836-1.05) 0.253	.869 (.751-1.01) 0.059	1.00 (.891-1.12) 0.990	1.08 (.896-1.30) 0.417
Widowed/Separated	.943 (.811-1.10) 0.441	1.11 (.944-1.30) 0.213	1.13 (.983-1.30) 0.085	1.33 (1.12-1.57) 0.002
Education				
Did not Graduate High School	1.31 (1.05-1.63) 0.018	1.44 (1.14-1.80) 0.002	1.41 (1.17-1.71) <0.001	2.42 (1.85-3.17) <0.001
Graduated High School	1.24 (1.09-1.42) 0.001	1.41 (1.20-1.66) <0.001	1.23 (1.08-1.40) 0.002	2.30 (1.86-2.85) <0.001
Attended College or Tech School	.998 (.890-1.12) 0.976	1.28 (1.10-1.50) 0.002	1.25 (1.11-1.41) <0.001	1.33 (1.07-1.66) 0.011
Graduated College or Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	.943 (.778-1.14) 0.546	1.25 (.962-1.63) 0.095	1.35 (1.11-1.63) 0.003	1.49 (1.06-2.11) 0.021
Homemaker	.920 (.751-1.23) 0.423	1.20 (.882-1.62) 0.249	1.11 (.900-1.38) 0.323	1.28 (.839-1.95) 0.254
Retired	.971 (.840-1.12) 0.695	1.49 (1.25-1.77) <0.001	1.15 (.999-1.33) 0.052	1.69 (1.33-2.14) <0.001
Unable to work	1.39 (1.19-1.63) <0.001	3.33 (2.78-4.00) <0.001	2.10 (1.82-2.43) <0.001	2.65 (2.07-3.37) <0.001
Income				
<$15000	1.40 (1.15-1.72) < 0.001	2.30 (1.79-3.00) <0.001	1.53 (1.26-1.87) <0.001	1.67 (1.20-2.32) 0.003
$15000-$24999	1.14 (.958-1.35) 0.141	2.31 (1.84-2.91) <0.001	1.76 (1.48-2.10) <0.001	1.68 (1.23-2.28) 0.001
$25000-$49999	1.09 (.951-1.26) 0.209	1.73 (1.41-2.14) <0.001	1.19 (1.02-1.40) 0.026	1.30 (.971-1.74) 0.078
$50000-$74999	1.04 (.898-1.20) 0.614	1.21 (.956-1.54) 0.112	1.02 (.858-1.21) 0.845	1.01 (.882-1.40) 0.974
≥$75000	1.0 (reference)	10 (reference)	1.0 (reference)	1.0 (reference)

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Mold				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.44 (1.22-1.70) <0.001	1.12 (.956-1.54) 0.229	1.18 (1.02-1.37) 0.023	1.11 (.882-1.40) 0.375
Smoking				
Current smoker	.922 (.778-1.09) 0.353	4.13 (3.38-5.06) <0.001	2.13 (1.81-2.50) <0.001	5.64 (4.33-7.33) <0.001
Former smoker	1.04 (.936-1.15) 0.474	2.90 (2.53-3.29) <0.001	1.51 (1.36-1.67) <0.001	4.48 (3.69-5.44) <0.001
Never smoked	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Smoking Indoors				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.18 (.989-1.41) 0.067	1.32 (1.10-1.59) 0.004	1.16 (.985-1.36) 0.076	1.68 (1.35-2.09) <0.001
Saw Cockroach past 30 days				
No	-	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes		1.06 (.874-1.27) 0.578	.960(.823-1.12) 0.604	1.06 (.846-1.34) 0.694
Saw Mice past 30 days				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0(reference)
Yes	1.08 (.896-1.31) 0.410	1.18 (.949-1.47) 0.135	1.04 (.871-1.25) 0.640	1.04 (.790-1.37) 0.781
Asthma cause by Previous Job				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	10 (reference)
Yes	1.96 (1.73-2.22) <0.001	1.86 (1.65-2.11) <0.001	1.95 (1.76-2.17) <0.001	1.56 (1.34-1.82) <0.001
Medical Cost				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.11 (.959-1.28) 0.164	1.03 (.878-1.2) 0.707	1.35 (1.19-1.53) <0.001	1.10 (.900-1.34) 0.361

[a]Adjusted odds ratio for multivariable logistic regression. Adjusted for all socio-demographic factors and seven potential mediators.
[b]95% confidence interval from multivariable logistic regression model.
[c]P-value for multivariable logistic regression for all variables included in the model.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.3.5 Factors mediating the relationship between socio-demographic factors and CLRD for 2011

Results for 2011 are summarized in Table 2.9. When socio-demographic factors and seven potential mediators were added in model 2, for current asthma, significant effects were observed for mold presence and occupational exposure while a significant but increased magnitude of the effect was observed for gender in predicting current asthma. However, this does not support the mediation process. Conversely, a loss of significance for income $15000-$24999 and $25000-$49999 in predicting asthma was observed supporting full mediation. While significant, but reduced magnitudes of the effects were observed for individuals 35 years or older, non-high school graduates, high school graduates, unable to work participants and those with income <$15000. These findings suggest that mold and exposure to chemical, fumes and dust in a previous job completely or partially explain disparities in the reporting of current asthma among adults in different age, education, employment and income groups.

For COPD, after controlling for socio-demographic factors and potential mediators, significant effects remained for smoking status, smoking indoors and occupational exposure. Significant but increased magnitude of the effect was observed for all age groups which does not support the mediation process for age. However, a loss of significance was observed for unemployment in predicting COPD supporting full mediation. While significant but reduced magnitudes of the effects were observed for all educational groups, retired, unable to work participants and those with income <$50000 supporting partial mediation. Indicating that being a former or current smoker, exposure to second-hand smoke and exposure to chemical fumes and dust in a previous job fully or partially explains education, employment and income effects on the reporting of COPD among adult ACBS respondents in the U.S.

Controlling for all socio-demographic factors and seven mediators in model 2 for chronic bronchitis resulted in a significant effect for mold presence, smoking status, occupational exposure and medical cost. Comparing model 1 and 2, significant but increased magnitudes of the effects were observed for females, those over 65 years old, indicating that indoor environmental factors and medical cost had significant effects on gender and increased age difference in the reporting of chronic bronchitis. However, the mediation process was not supported. Conversely, a loss of significance for widowed/separated and income $50000-$74999 in predicting chronic bronchitis was observed supporting full mediation. Significant but reduced magnitudes of the effects were observed for those below 65 years old, all educational groups, unemployed, retired, unable to work participants and those with income <$50000 supporting partial mediation. These findings suggest that mold presence, being a former or current smoker, exposure to chemicals, fumes and dust and medical cost, fully or partially explains the effects of gender, marital status, education, employment and income on the reporting of chronic bronchitis.

For emphysema, a statistically significant relationship remained for current and former smokers, smoke indoors and occupational exposure. While a significant but slightly increased magnitude was observed for those above 65 years old which does not support the mediation process. Loss of significance was observed for those with household income $25000-$49999 supporting full mediation. Significant but reduce magnitudes of the effects were observed for those below 65 years old, widowed/separated participants, all educational groups, unemployed, retired, unable to work participants and those who reported income of <$25000 supporting partial mediation. These findings suggest that being a former or current smoker, smoking indoors and occupational exposure fully explains income $25000-$49999 effects and partially

explains the effects of age below 65-year-old, widowed/separated, education, employment and income <$25000 on the reporting of emphysema among ACBS respondents.

5.3.6 Interaction effects between selected socio-demographic factors, indoor environmental factors, access to health and CLRD for 2011

Ten significant predictor-mediator interaction effects were identified for current asthma. Non-high school graduates by former smokers (AOR=2.08 p=0.001), high school graduates by current and former smokers (AOR=1.59 p=0.011) and (AOR=1.49 p=0.001). Unable to work by mold (AOR=.525 p=0.001), age groups 45-54, 55-64 and 65+ by current smokers (AOR=2.05 p=0.001), (AOR=2.17 p=0.001) and (AOR=2.94 p=0.001) and former smokers (AOR=1.49 p=0.048), (AOR=1.68 p=0.005) and (AOR=2.15 p=0.001). The findings suggest that when mold was not present participants who were unable to work were less likely to report current asthma. Non-high school graduates who were former smokers were more likely to report asthma. While the increased odds of reporting current asthma were observed among participants who were 45 years or older and high school graduates, who were current or former smokers. Indicating that the effects of age, education, and employment on the reporting of current asthma depends on mold and being a current or former smoker.

Seventeen significant predictors-mediator interaction effects were identified for COPD for 2011. Non-high school graduates by former smokers (AOR=1.89 p=0.001), high school graduates by current and former smokers (AOR 1.58 p=0.020) and (AOR=1.53 p=0.001). Age groups 35-44, 45-54, 55-64 and 65+ by smoke indoors (AOR=3.59 p=0.003), (AOR=2.57 p=0.030), (AOR=3.11 p=0.001) and (AOR=2.38 p=0.005). Age groups 45-54, 55-64 and 65+ by current smokers (AOR =4.15 p=0.001) (AOR=2.90 p=0.001) and (AOR=3.82 p=0.001) and former smokers (AOR=2.33 p=0.001), (AOR=2.01 p=0.001) and (AOR=2.50 p=0.001). Age group 35-44, 45-54, 55-64 and

65+ by occupational exposure (AOR=2.25 p=0.010), (AOR=3.73 p=0.001), (AOR=2.69 p=0.001) and (AOR=2.91 p=0.001). Increased odds of reporting COPD was observed for former smokers who were non-high school graduates. Increased odds of reporting COPD was observed for age group 35 years or older who reported smoking indoors. High odds of reporting COPD were identified among former and current smokers who were 45 years or older and high school graduates. While those 35 years or older who reported occupational exposure were more likely to report COPD. This suggests that the effect of gender, age and education on the reporting COPD among ACBS respondents depends on being a former or current smoker, smoking indoors and occupational exposure.

Six significant interaction effects were identified for chronic bronchitis. Gender by current smokers, (AOR=1.52 p=0.005) and income $25000-$49999 by mold (AOR=1.43 p=0.014). Age groups 35-44, 45-54, 55-64 and 65+ by occupational exposure (AOR=2.05, p=0.001), (AOR=2.18, p=0.001), (AOR=2.16 p=0.001) and (AOR=2.65 p=0.001). These findings revealed that females who were current smokers were more likely to report chronic bronchitis. While those with household income of $25000-$49999 who reported mold were more likely to report chronic bronchitis. Increased odds of reporting chronic bronchitis was observed for age groups 35 years or older who were exposed to chemical, fumes and dust in a previous job. Implying that the effects of gender, age, level of income on the reporting of bronchitis depends on mold, being a current smoker and occupational exposure.

Eight significant predictor-mediator interaction effects were identified for emphysema. Age groups 65+ by mold (AOR=5.27 p=0.002), 35-44 by smoke inside (AOR=5.27 p=0.002), age groups 35-44, 45-54 and 55-64 by former smokers (AOR =4.21 p=0.003), (AOR=8.48 p=0.001) and (AOR=11.3 p=0.001) and age groups 45-54, 55-64 and 65+

by current smokers (AOR=12.6 p=0.001), (AOR=8.54 p=0.001) and (AOR=6.43 p=0.001). These findings showed that when mold was present those above 65 years old were more likely to report emphysema. 35-44 years old who reported smoking indoors and were former smokers were more likely to report emphysema. Current or former smokers who were 45 years or older were more likely to report emphysema compared to never smoked participants. These findings suggest that the effect of age on the reporting of emphysema depends on mold presence, smoking status and smoking indoors.

5.4 Summary of Results

The results from the distribution and bivariate analyses revealed that the distribution of CLRD differs significantly by social, economic and demographic groups, indoor environmental factors and access to healthcare. Current asthma, COPD and chronic bronchitis were reported by more women compared to men, while emphysema was reported by more men compared to women. The reporting of COPD, chronic bronchitis and emphysema increased progressively with age. The reporting of all CLRD was high for singles and widowed/separated participants, non-high graduates and high school graduates, retired and unable to work participants and those with annual household income of <$15000 compared to other groups. For indoor environmental factors, the findings were not consistent for all three years. However, mold presence, being a current or former smoker, smoke indoors, pest infestation, exposed to chemicals, fumes and dust in a previous job and reporting cost as a barrier to medical care were associated with increased reporting of all CLRD among adult ACBS respondents.

After adjusting for all socio-demographic and all potential mediators in the logistic regression models, mold, mice presence, being a current smoker, smoking indoors and occupational exposure fully or partially mediated the relationship between age,

education, employment, income and the reporting of current asthma. Being a former or current smoker, smoking indoors, and occupational exposure fully or partially mediated the relationship between age, marital status, education, employment, income and the reporting of COPD among adult ACBS respondents. While mold presence, being a current or former smoker and smoking indoors fully or partially mediated the relationship between age, education, employment, income and the reporting of chronic bronchitis and emphysema. Medical cost was also identified as a mediator for the reporting of chronic bronchitis. Ninety-four (94) significant predictor-mediator interaction effects for 2009, 2010 and 2011 were identified. The significant predictor-mediator interaction effects revealed that the effects of gender, age, marital status, education, employment, income on the reporting of CLRD depends on mold, mice presence, being a current or former smoker, smoking indoors, occupational exposure and medical cost. Also, the effects of mold, mice presence, being a current or former smoker, smoking indoors, occupational exposure and medical cost on the reporting of CLRD varies by the difference in gender, age, education, employment and income.

CHAPTER 6

This chapter begins with the discussion of the main findings of the study. This is followed by an examination of the strengths and limitations of the study and concludes with a consideration of the unanswered questions and suggestions for future research.

6.0 DISCUSSION

The present study used structured social causation of health inequality framework to examine if indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and CLRD among adult ACBS respondents in the U.S from 2009 to 2011. The literature revealed that there is increased need to identify all relevant risk factors for CLRD. Also, there are inconsistencies in some of the findings of previous studies and questions remain on which risk factors influence the relationship between socio-demographic factors and respiratory health outcomes. The current study examined whether indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and CLRD among adult ACBS respondents in the US; and if the effect of the relationships between socio-demographic factors and CLRD depend on indoor environmental factors and access to healthcare. Only two studies by Zahran et al. (2014) and Zahran et al. (2015) were identified in the literature that examined the relationship between socio-demographic, indoor environmental factors, access to healthcare and asthma. Studies that examined socio-demographic and indoor environmental factors only controlled for specific or general risk factors while none of these studies specifically examined mediation with interaction effects. As a result, the findings of the current study that poor indoor environmental conditions and medical cost play a significant role in explaining the reporting of CLRD among adult ACBS respondents in different socio-demographic

groups contributes to existing knowledge on disparities in the reporting of CLRD among adults.

6.1 Current Asthma

Increased risk of asthma among individuals in lower SEP is mainly due to current, high and prolonged exposures to indoor environmental conditions such as mold, pest infestation, exposure to second-hand smoke, indoor air pollution and occupational exposures (Williams et al., 2009; Cruz et al., 2010). In the current study high proportions of blacks, Hispanics and other race groups, singles, non-high school graduates, unemployed, unable to work participants and those with annual household income <$15000 frequently reported inadequate housing conditions such as mold, cockroach, mice, smoking indoors, occupational exposure and medical cost. Consistent with the social causation of health inequality framework used to guide the current study. Previous evidence has hypothesized that the differences in the risk of asthma outcomes by SEP are due to socio-economic differences in exposure to indoor environmental pollutants (Peat et al., 1996; Chen et al., 2002; Rauh et al., 2002; Litt et al., 2010; Seo et al., 2014).

6.1.1 Socio-demographic Factors

In the bivariate analyses of the current study, a high percentage of current asthma was observed among females compared to males; this is supported by the findings observed among adults in previous studies (Toren et al., 2004; Knudsen et al., 2009; Leynaert et al., 2012). The reporting of current asthma was significantly higher among participants who were above 35 years old, as previously observed by Brogger et al., (2003) but was contrary to the findings of Leynaert et al. (2012). Age-specific rate of asthma was observed to decrease with age in a retrospective cohort study, although, these findings might be due to either increase in asthma incidence in the most recent generation or

recall bias (DeMarco et al., 2000). However, in the current study, current asthma a sub-category of ever asthma was used to minimize the likelihood of recall bias. Also, the increased reporting of current asthma with age was consistent for 2009, 2010 and 2011 results respectively, indicating that age is a risk factor for current asthma.

A high proportion of current asthma was observed by blacks compared to whites, Hispanics and other race groups with the lowest proportion observed among Hispanics. Conversely, earlier studies reported that Hispanics were more likely to be hospitalized for asthma (Carr et al., 1992; Gottlieb et al., 1995). However, previous studies in the U.S. by Arif et al. (2003) and Gorman and Chu (2009) reported a racial/ethnic difference in the risk of asthma. The inconsistencies identified among Hispanics may be due to the heterogeneity of persons of Hispanic race (Eisner et al., 2001).

As with the current study, the high proportion of asthma was identified among adults with less education in Europe, Australia, New Zealand and the U.S (Basagana et al., 2004; Ellison-Loschmann et al., 2007), this was also true for Canada (Bacon et al., 2009). Occupational status and unemployment were identified as risk factors for asthma by Blanc et al., (2006) and Hoffman (2007), in the current study the highest proportion of current asthma was observed among participants who were unable to work.

The lower the annual household income, the higher the proportion of current asthma, with the highest proportion observed among those with income <$15000, the percentage ranged from 79-83% from 2009-2011. This because people with low-income tend to live in poor quality or substandard housing, which has been linked with greater asthma morbidity and mortality due to greater exposure from substandard housing conditions such as mold, pest allergens and second-hand smoke (Bryant-Stephens 2009; Matsui 2014). A similar trend was observed in a Califonia study by Behren et al (2002) and supported by a review of the California health interview survey,

which revealed that individuals with income level below the Federal Poverty Level (FPL) were more likely to report current asthma and are more likely to experience asthma symptoms once a week compared to their high-income counterparts (Wolsteins et al., 2010). This is because, low income may be an indicator for exacerbating risk factors, such as cockroach allergen exposure (Gottlieb et al., 1995) cigarette smoking and exposure to second-hand smoke (Sippel et al., 1999).

These findings add to the current knowledge of socio-demographic factors and the risk of asthma. As it reveals that socio-demographic factors, gender, age, ethnicity, marital status, educational level, employment status and income level are significant predictive factors of the reporting of current asthma among adult ACBS respondents in the U.S.

6.1.2 Indoor Environmental Factors

The results of the individual relationships between indoor environmental factors and current asthma were not consistent for all factors for all three years. However, a significant relationship that was consistent for all three years was observed for mold presence and current asthma. This finding was supported by the recent findings of Quansah et al. (2012) and Norback et al. (2013). Significant associations were observed between current asthma and smoking indoors. According to Mannino et al. (1998), environmental tobacco smoke (ETS) is a principal indoor combustion source and a major source of indoor air pollution. The quality of indoor air may have an important influence on the respiratory health of adults, such as seniors and unemployed individuals because they spend almost 80% of their time indoors (Eisner et al., 2002; Breysse et al., 2004; Bernstein et al., 2008; WHO 2012). Continuous exposure to high levels of indoor air pollutants such as mold and tobacco smoke can exacerbate respiratory problems such as asthma (Noonan and Ward 2007; Noonan and Ward 2012). An independent relationship was observed between current and former smokers and

increased risk of current asthma. Mice and cockroach presence were observed to be related to the high proportion of current asthma. As highlighted by previous evidence, cockroach and mice infestation in a household are significant risk factors for asthma and asthma morbidity (Arruda et al., 2001; Crain et al., 2002; Cohn et al., 2004). A consistent relationship was observed between occupational exposure and current asthma in the present study. This might be because, for fear of income loss due to job loss some individuals may choose to remain exposed to agents at work (Ameille et al., 1997). This is supported by a recent conclusion that new asthma onset in one of six adult patients in the U.S. might be due to work-related exposures (Mazurek et al., 2013).

6.1.3 Healthcare Access

A significant relationship was observed between those who could not see a doctor because of cost and current asthma only in the bivariate analyses but not in the multivariable analyses. This is in accordance with the previous observation that the procedure and intensity of asthma management and care after hospitalization was significantly lower among low-income patients compared to high-income patients (Haas et al., 1994; Eisner et al., 2001). In the United States, Zoratti et al. (1998), observed that in a managed care setting where healthcare access is supposed to be ensured, low-income asthma patients were still less likely to visit an asthma specialist compared to their high-income counterparts.

6.1.4 Mediation Test for Current Asthma

The findings from the mediation analysis suggest that disparities in the reporting of current asthma among adults in different age, education, employment and income groups can be fully or partially explained by mold, mice presence, smoking indoors, smoking status and occupational exposure although the mediating effects were not consistent for all three years. Previous evidence has suggested that many risk factors

for asthma, such as smoking, occupational exposure and mold growth are related to socio-economic status (Basagana et al., 2003; Eagan et al., 2004). Conversely, a population-based study in Sweden by Montnemery et al., (2001) and a longitudinal cohort study in New Zealand by Hancox et al., (2004) found no socio-economic impact on the increased risk of asthma. However, none of these studies examined mediation. The significant predictor-mediator interaction effects that were identified for all three years revealed that the increased risk of reporting current asthma observed among females, 35 years or older, non-high school graduates, retired, unable to work and those with household income <$15000 depends on mold presence, pest infestation, smoking status and occupational exposure. The findings from the mediation test and interaction effects are significant because it supports the study hypotheses that the effects of socio-demographic factors and the reporting of current asthma among adult ACBS respondents may be completely or partially explained by one or more indoor environmental factors. Also, the social, economic and demographic difference in the reporting of current asthma depends on one or more indoor environmental factors.

Evidence indicates that less educated individuals tend to have inadequate employment, with low wages resulting in inadequate income to purchase good living conditions as a result are more exposed to poor indoor conditions such as mold, pest infestation, second -hand smoke and occupational exposure which have direct effects on asthma outcomes (Golabardes et al., 2006**;** Cockerham 2007; Prus 2007). The findings contribute to existing knowledge on asthma in that first, none of the studies identified in the literature specifically examined mediation with predictor-mediator interaction effects. Second, examining mediation highlights important factors that can significantly explain disparities in the reporting of current asthma among adults in different social, economic and demographic groups. Third, the predictor-mediator interaction effects that were

identified revealed that the effects of socio-demographic factors on the reporting of current asthma depends on indoor environmental factors and access to healthcare demonstrating that, targeting these specific risk factors in designing related policies can play a significant role in reducing the burden of current asthma among adults.

6.2 Chronic Obstructive Pulmonary Disease (COPD)

Increased risk of COPD exacerbation and mortality have been linked with SEP measured by age, ethnicity, education, employment and income (Eisner et al., 2005). This association may be explained in part by the greater proportion of smokers among people in lower SEP (Hollingsworth and Martin 2011), although, smoking may not explain all of the associations (Esiner et al., 2006; TorresDuque et al., 2008; Hollingsworth and Martin 2011).

6.2.1 Socio-demographic Factors

In the current study, high proportions of females, those above 35 years old, whites, other race groups, singles, widowed/separated, non-high school graduates, unable to work participants and those with income <$15000 reported COPD in the bivariate analyses. Earlier studies have revealed that individuals of lower SEP were at least twice more likely to experience poor COPD outcomes (Tao et al., 1992; Prescott and Vestbo 1999; Prescott et al., 1999; Gershon et al., 2012). Also, Eisner et al. (2010) identified a strong and consistent relationship between poorer COPD outcomes and low SEP in the US. Although a significant relationship was observed between ethnicity and COPD in the current study, the proportion of blacks that reported COPD was lower than whites and other race participants.

Age was observed as a significant predictor of COPD as the reporting of COPD was observed to increase progressively as age increases. This was supported by evidence from the findings of Cazzola et al. (2011) and Mannino and Buist (2007). However, it

was noted that because most studies of COPD consider populations over the age of 35 years old, it might have increased the effect size of their findings (Mannino and Buist 2007). In the current study participants aged 18 to over 65 years old were considered in the analyses.

6.2.2 Indoor Environmental Factors

The main findings for the bivariate associations between indoor environmental factors and COPD were the significant relationships observed between mold growth, smoking status, smoke indoors, saw mice in the past 30 days, occupational exposure and increased risk of COPD. While there is evidence that individuals with lower education, unemployed and inadequate income are at higher risk of developing COPD due to frequent exposures to poor indoor environmental conditions such as mold presence, mice and cockroach allergens, indoor air pollution and high smoking prevalence (Tao et al., 1992; Prescott and Vestbo 1999; Prescott et al., 1999). Questions remain on which of these environmental factors are the most important. In the current study, the most significant predictors of increased risk of reporting COPD in addition to socio-demographic factors are being a current or former smoker, smoking indoors and exposure to chemicals, fumes and dust in a previous job (occupational exposure). Although smoking has been identified as a dominant risk factor for the development of COPD (Eisner et al., 2006; Hollingsworth and Martin 2011), recent evidence supports the possibility that, the most important global risk factor for COPD is exposure to indoor air pollution (TorresDuque et al., 2008). According to Balmes et al. (2003), occupational exposure accounts for approximately 15% of non-tobacco related COPD in the U.S. The increased risk of COPD in the work environment is a result of exposure to high levels of fumes, chemicals and dust (Hollingsworth and Martin 2011).

6.2.3 Mediation Test for COPD

In the mediating analysis, I found that disparities in the reporting of COPD among adults in different age, marital, education, employment and income groups can be completely or partially explained by being a current or former smoker, smoking indoors and exposure to chemicals, fumes and dust in a previous job. Suggesting that the effects of age, marital status, education, employment, income on the reporting of COPD among ACBS respondents are influenced by being a current or former smoker, smoking indoors and occupational exposure. These findings suggest that disparities in the reporting of COPD are likely to be multi-factorial due to the difference in SEP (Gershon et al., 2012).

The significant predictor-mediator interaction effects revealed that there is a differential gender, age, education, employment and income effects of being a current or former smoker, smoking indoors, occupational exposure on the reporting of COPD among adults. More specifically the analysis revealed that females who reported smoking indoors were more likely to report COPD. While participants who were 35 years or older, non-high school graduates and those with income <$50000 who reported smoking inside and occupational exposure were more likely to report COPD. Unable to work participants who did not report occupational exposure were less likely to report COPD compared to participants who reported occupational exposure. Increased odds of reporting COPD were observed for current and former smokers who were 45 years or older, non-high school and high school graduates. Low SEP and poor housing conditions have been linked to increased risk of COPD (Prescott and Vestbo1999; Hegewald and Crapo 2007; Yin et al., 2011; Gershon et al., 2012). While Zhou et al. (2009) did not observe any relationship between females and increased risk of COPD, they observed that being male of advanced age with low education, having exposure to

environmental tobacco smoke, coal and/or biomass smoke and poor ventilation were all independently associated with a higher risk of having COPD among non-smokers. The increased risk of COPD with age could be attributed not only to the accumulative effect of different risk factors over time but also to the age-related weakening of respiratory muscles (Kojima et al., 2005; Zhou et al., 2009).

Although the magnitudes of the effects of the relationships varied widely across different factors and groups. The findings of this study supported the concept of the social causation of health inequality and the hypothesis that reporting of COPD among adults in different social, economic and demographic groups might be mediated by one or more indoor environmental factors. Also, the findings provide some answers to the question about which indoor environmental factors influence the relationship between socio-demographic factors and COPD. Given this, the findings of the current study contributes to existing knowledge on the risk of COPD among adults because it reveals that the effect of age, marital status, education, employment and income on the reporting of COPD is completely or partially explained by being a current or former smoker, smoking indoors and occupational exposure. These findings also contribute to knowledge in that the significant predictor-mediator interaction effects revealed that the impact of female gender, those 35 years or older, with low education, inadequate employment and low income on the reporting of COPD among adult ACBS respondents depends on smoking status, smoking indoors and occupational exposure. These findings are significant as it highlights specific factors that should be targeted by policymakers to reduce the burden of COPD among adults in the U.S.

6.3 Chronic Bronchitis

Chronic bronchitis has been found to be more consistently associated with low SEP, inadequate indoor environmental conditions and high medical resource consumption

(Cerveri et al., 2003; Ferre et al., 2012; Korad et al., 2013). Only a few studies have accessed the relationship between socio-demographic, indoor environmental factors, and chronic bronchitis in adults, but none of these studies examined mediation with predictor-mediator interaction effects.

6.3.1 Socio-demographic Factors

In the bivariate analysis, significant independent associations were observed between chronic bronchitis and female gender, increased age, blacks and other race groups, widowed/separated, non-high school graduates, retired, unable to work participants and those with annual income <$15000. The high proportion of chronic bronchitis observed among females compared to males in the current study is contrary to the findings of a general population study in France (Ferre et al., 2012). However, the high proportion of chronic bronchitis observed in females in the current study is not abnormal because a recent study by Konrad et al. (2013) identified a high probability of chronic bronchitis among females compared to males. As reported by Montnémery et al. (1998); Kongevinas et al. (1998) and Montnémery et al. (2001) individuals in low SEP measured by gender, age and employment status are at increased risk of bronchitis.

6.3.2 Indoor Environmental Factors

Previous studies have revealed that the increased risk of bronchitis is as a result inadequate indoor environmental conditions (Viegi et al., 1991; Bakke et al., 1991; Fishwick et al., 1997; Sunyer et al., 1998; Zock et al., 2001; Kurmi et al., 2010; Hu et al., 2010). More specifically, in the current study mold presence, smoking, second-hand smoke, mice, cockroach and occupational exposure were identified to be significantly related to the reporting of chronic bronchitis. Numerous studies have reported a link between occupational exposure, smoking status and increased risk of chronic bronchitis (Heederik et al., 1990; Sunyer et al., 1998; Montnemery et al., 1998;

Sethi and Rochester 2000; Zock et al., 2001; Rodriguez et al., 2014). Mold presence was consistently observed to be associated with chronic bronchitis for all three years. Although studies that access these relationships in adults are limited, a review by WHO (2009), concluded that there is sufficient evidence to document an association of dampness-related agents with respiratory infections, but evidence of an association with bronchitis was limited and only suggestive. However, a recent meta-analysis by Fisk et al. (2010) concluded that indoor dampness and mold are associated with substantial and statistically significant increases in both respiratory infections and bronchitis.

6.3.3 Healthcare Access

Medical cost was a significant predictor of increased risk of chronic bronchitis. Also, medical cost was identified as a mediator in the relationship between socio-demographic factors and chronic bronchitis which was consistent for all three years. In the U.S., medical cost is a significant barrier to adequate healthcare for individuals in low SEP measured by the level of education, employment characteristics and level of income (Monheit and Vistries 2000; Fiscella et al., 2003). Although studies that directly examined the effect of medical cost on the risk of respiratory diseases such as chronic bronchitis were lacking, Lurie and Dubowitz (2007) noted that disparities in health outcomes such as CLRD are directly related to healthcare access and that access to adequate healthcare is important because it leads to better health outcomes.

6.3.4 Mediation Test for Chronic Bronchitis

In the mediation analysis, mold presence, being a current or former smoker, smoking indoors, occupational exposure and medical cost completely or partially mediated the effects of age, marital status, education, employment and income on the reporting of chronic bronchitis. The findings revealed that gender, age, marital status, education, employment and income disparity in the reporting of chronic bronchitis is fully or

partially explained by, mold presence, being a current or former smoker, smoking indoors, occupational exposure and medical cost. Sunyer et al. (2006) and Ferre et al. (2012) identified lower social class, smoking, lower education, occupational exposure in men, home and outdoor No^2 levels in women as significant risk factors for lower respiratory infection. The significant predictor-mediator interaction effects revealed that there is differential gender, age, education, employment and income effects of mold presence, pest infestation smoking status, smoking indoors, occupational exposure and medical cost on the reporting of chronic bronchitis. Females who reported smoking indoors and were former smokers were more likely to report chronic bronchitis. While increased odds of reporting chronic bronchitis were observed among participants with income <$15000 and $25000-$49999 who report cost as a barrier to medical care. When mold was present those with a household income of $25000-$49999 were more likely to report chronic bronchitis. Increased odd of reporting chronic bronchitis was observed for age groups 35 years or older who reported occupational exposure. Current or former smokers who were high school graduates and those with household income $25000-$49999 who were former smokers were more likely to report chronic bronchitis. As reported by Ferre et al. (2012), the relationship between increased risk of chronic bronchitis and SEP could be related to differential exposures to environmental or occupational air pollutants or environmental tobacco smoke. Lange et al. (2003), identified male gender, advanced age, smoking and occupational exposure as predictors of chronic bronchitis. According to Steenland et al. (2002) and Prescott et al. (2003), the increased risk of chronic bronchitis observed in men than women might be because men are more likely to have occupations where they were more likely to be exposed to occupational pollutants. Although the mediating process was not supported for gender, a significant effect was observed for females and chronic bronchitis.

The current findings from the mediation test revealed that the impact of gender, age, marital status, educational level, employment status and income level on the reporting of chronic bronchitis among ACBS respondents in the U.S. is influenced by mold, pest infestation, smoking status, smoking indoors, occupational exposure and medical cost. More specifically from the interaction effects females, above 35 years or older, non-high school graduates, retired with income <$50000 who reported mold presence, pest infestation, occupational exposure, cost as a barrier to care, smoke indoors and were current or former smokers were at increased risk of reporting chronic bronchitis. These findings are novel and contribute to knowledge in that this is the first study to use three different years of cross-sectional data based on social causation of health inequality framework to identify mediating indoor environmental factors and access to healthcare on the relationship between socio-demographic factors and chronic bronchitis with specific predictor-mediator interaction effects. Thus, highlighting the important risk factors that can be targeted by policymakers to reduce the burden of chronic bronchitis and improve the health outcomes among adults in the U.S.

6.4 Emphysema

There was limited evidence on the relationship between socio-demographic, indoor environmental factors, healthcare access and the reporting of emphysema. Also, no study was identified that examined mediation with interaction effects.

6.4.1 Socio-demographic Factors

In the bivariate analysis, socio-demographic factors such as gender, age, race/ethnicity, marital status, educational level, employment status and income were significantly associated with emphysema. A high proportion of males reported emphysema compared to females for all three years. This was contrary to the findings of a recent study by Coxson et al., (2013) who observed that emphysema progression was more

severe among females. However, the findings of the current study are supported by previous findings by Martinez et al. (2007), Dransfield et al. (2007) and Grydeland et al. (2009) they identified more cases of emphysema among males than females. The increased risk of emphysema identified among males than females might be due to environmental factors because males are more exposed to occupational pollutants, which are potentially harmful to the lungs (Bakke et al., 2001). The plausibility of the notion of Bakke et al. (2001) is supported by the findings of the current study where a high proportion of male participants reported being exposed to chemicals, fumes and dust in a previous job. Increased risk of emphysema with ageing observed in the current study is supported by previous cross-sectional studies by Gevenois et al. (1996), Grydeland et al. (2009) and a longitudinal study by Soejima et al. (2000).

6.4.2 Indoor Environmental Factors

Indoor environmental factors, such as mold, smoking status, smoke indoors cockroach, occupational exposure and medical cost were significantly associated with the reporting of emphysema in the bivariate analyses. Studies that examined the relationships between indoor environmental factors and emphysema were limited. However, an earlier study by Ruckley et al. (1984) identified an association between coal dust and emphysema among men; they also indicated that emphysema was more frequent among smokers than non-smokers supporting the findings of the current study. This is also supported by another study by Becklake et al. (1987), where they observed smoking and exposure to dust as significant independent predictors of emphysema mortality among gold miners in South Africa.

6.4.3 Mediation Test for Emphysema

The mediation test revealed that mold presence, being a current or former smoker, smoking indoors and exposure to chemicals, fumes and dust in a previous job

completely or partially mediated the relationship between age, marital status, educational level, employment status, income level and the reporting of emphysema among adults. Although evidence is limited, a number of cross-sectional studies have reported an association between demographic, clinical factors and emphysema, these studies also observed the effects of smoking on increased risk of emphysema at a cross-sectional level (Grydeland et al., 2009; Grydeland et al., 2010; Rutten et al., 2011). Conversely, the sex difference in the risk of emphysema among current and former smokers decreased significantly with increased ageing (Grydeland et al., 2009). The reason for this difference might be because the natural ageing of lungs gradually reduces the impact of environmental risk factors of which men are more exposed (Grydeland et al., 2009). This argument was not supported by the current study as the risk of emphysema was observed to increase with age.

The significant predictor-mediator interaction effects revealed that female participants who were former smokers, and participants who were 35 years or older who reported mold, smoked indoors, occupational exposure and were current or former smokers were more likely to report emphysema. Unemployed and unable to work participants who saw mice were more likely to report emphysema. While unable to work participants, who were not exposed to secondhand smoke were less likely to report emphysema. Indicating that the effects of mold, pest infestation, being a current or former smoker, smoking indoors and occupational exposure on the reporting of emphysema varies by the difference in gender, age and employment. Soejima et al. (2000) found no significant differences in emphysema progression between former and current smokers after a five-year follow-up. Becklake et al., (1987) identified age, smoking and exposure to dust as strong and independent predictors of emphysema in South Africa. While in

the U.S., Kuempel et al. (2009) identified coal dust exposure, cigarette smoking, age, and race as significant and additive predictors of emphysema severity.

The findings did not only reveal that the effects of age, marital status, education, employment and income on the reporting of emphysema among ACBS respondents are influenced by mediating inadequate indoor environmental conditions. It also revealed that the effects of mold, pest infestation, smoking, smoking indoors and occupational exposure on the risk of emphysema varies by the difference in gender, age and employment. This is the first study to assess the mediating effects of indoor environmental factors on the relationship between socio-demographic factors and CLRD with predictor-mediator interaction effects. As a result, the findings of the current study are novel and contribute to the existing knowledge on how indoor environmental factors influence the relationship between socio-demographic factors and the reporting of emphysema. Thus, highlighting important factors to be targeted by policymakers to reduce the burden of emphysema among adults in the U.S.

6.5 Study Strengths

The study used combine BRFSS and ACBS secondary data of the adult population in the United States. The focus on adults with current asthma, COPD, chronic bronchitis and emphysema is an important strength of the current study as the majority of epidemiological studies that looked at respiratory illnesses such as asthma, and chronic bronchitis has focused on children, while studies on COPD and emphysema in adults are very limited. An adult population study is also valuable given the interest in the question of how these diseases are distributed among different socio-demographic groups and which factors influence the relationship between socio-demographic factors and increased risk CLRD.

The relatively large sample size and the fact that, three different years of data were examined independently is an important strength for the current study as it gives an opportunity to evaluate and compare the trend of the results, adding plausibility to the findings.

The study used the definitions of asthma that were consistent with several previous studies of adult asthma (Chen et al., 2002; Chen et al., 2005; Burgess at al., 2006).

In most public health research, study populations are often restricted in age. As indicated by Mannino and Buist (2009) most studies on COPD only consider population over the age of 35 years old which might increase the effect size of their results. Also, health inequality research has been identified as a particular area that required more attention directed toward middle adulthood because low socio-economic status has been identified to be associated with the greatest health disparities and higher mortality (Adler and Newman 2002). The current study contributes to this identified need by including male and females aged 18 to over 65 years old and by examining the interaction between age and other factors in the logistic regression models.

The examination of different indoor environmental predictors in relation to socio-economic positions (SEP) was a strength of this study. Many epidemiological studies of respiratory diseases have restricted their investigation on quantifiable physical housing-related characteristics such as allergens, crowding, housing conditions, housing types or tenure or type of neighborhood. The current study contributes to the limited evidence on the mediating effects of indoor environmental predictors and access on the relationship between different socio-demographic groups and the reporting of CLRD among adult ACBS respondents.

Multiple socio-demographic and indoor environmental variables were considered for inclusion in the fully adjusted models. Examining multiple socio-demographic and

indoor environmental factors is important to allow for the identification of additional risk factors for CLRD that have been emphasized repeatedly in the literature (Wright and Fisher 2003; Eisner et al., 2011; Gershon et al., 2012; Zahran et al., 2015).

In the current study, selection of variables and the multivariable logistic regression models were based on a firmly structured social causation of health inequality framework and a mediation model of the relationship between socio-demographic, indoor environmental factors, healthcare access (medical cost) and the reporting of CLRD. Instead of considering each factor as if they individually and directly influence specific respiratory health outcomes, the framework and the mediation model posit that distal risk factors (indoor environmental and healthcare access) might also indirectly mediate the relationship between proximal risk factors (socio-demographic factors) and the reporting of CLRD. According to Victoria et al (1997) and Creswell (2013) building data analyses on a well-defined framework has been identified as a constructive approach to examining determinants of health and disease outcomes, especially for conditions like asthma, COPD, chronic bronchitis and emphysema for which there is consensus that multiple risk factors can work together to influence the outcomes. The current study also contributed towards the recommended need for a more in-depth study to identify additional modifiable predictors of CLRD to develop strategies and targeted interventions that can help reduce the health risk and economic burden of CLRD (Zahran et al., 2015). Also, to improve the health and well-being of individuals and their families who are more susceptible to these diseases.

6.6 Limitations

The cross-sectional nature of the survey data means that it is not possible to determine the temporal sequence or make any causal interpretation of the mediation relationships identified. Since the presence or absence of risk factors and CLRD were determined at

the same time for each study respondent, the temporal relationship between most of the risk factors and CLRD cannot be determined. Despite this limitation, the use of secondary cross-sectional data from the BRFSS and ACBS provides a realistic, convenient and economical method through which many different hypotheses can be tested or evaluated. Furthermore, during the construction of the conceptual framework, methodology and interpretation of the findings of the current study, findings from relevant longitudinal studies that evaluated mediation, similar risk factors and disease outcomes were taken into consideration (Lynch et al., 1997; Mackenbach et al., 1999; Lantz et al., 2000; Mackenbach et al., 2003; Hsu and Cossman 2013; Hystad et al., 2013; Washington et al., 2017).

The definition of ever asthma and current asthma in the BRFSS and ACBS do not provide information about asthma onset among the study respondents. Also, there might be a likelihood of misclassification of childhood asthma due to poor recall by adults, especially women (Burgess at al., 2006). As a result, as previously mentioned in the methodology section, current asthma a subcategory of ever asthma was used in the current analyses to minimize such misclassification and to increase the possibility that current exposures such as mold growth, pest infestation and other indoor environmental factors temporally precedes the development of CLRD. Furthermore, self-reported doctor-diagnosed asthma has been widely used to define asthma in other epidemiological studies, including two studies that used the combined BRFSS and ACBS data (Brunekreef 1992; Wang et al., 2001; Manfreda et al., 2001; Liss et al., 2003; Willemsen et al., 2008; Zahran et al., 2014; Zahran et al., 2015).

The sample of the current study only contained participants who reported current asthma. As a result, the population prevalence of CLRD could not be examined because of the absence of respondents without CLRD. However, the current study examined

mediation with interaction effects which is important because the findings identified important indoor environmental factors and access to healthcare that fully or partially explains the relationships between socio-demographic factors and the reporting of CLRD among adult ACBS respondents in the U.S.

The response rate for participating states was around 47.5% to 49.7%. The low response rate might affect the results by introducing non-response bias if the survey respondents differed from non-responders on the characteristics studied. However, the low response rate was not systematic because the BRFSS response rate was around 66.7% to 68.8%, and the design, weighting procedure and varying response rates among states reduced the effects of non-response on the study results (Kelsey at al., 1996; CDC 2013).

The cross-sectional data were collected through telephone interviews. Although according to CDC, approximately 94.1% of households in the United States have telephones, many studies have shown that the characteristics of the telephone and non-telephone populations differ regarding demographic, economic, and health characteristics (Groves and Kahn 1979; Banks 1983; Thornberry and Massey 1988). Although the exclusion of households without telephones is unlikely to affect total population estimates significantly, some of the sub-population estimates could be biased. However, post-stratification adjustments for age, race, and sex, and other weighting adjustments used for the BRFSS and ACBS data minimizes the impact of differences in non-coverage, under-coverage, and non-response at the state level (CDC 2013). Despite the above limitations, there are consistencies and similarities between the prevalence estimates from the BRFSS and findings from surveys that used face-to-face interviews (Frazier et al., 1992; Nelson et al., 2003).

The data for 2009, 2010 and 2011 used in the current study included only participants with landline telephones. So households with only cellular telephones and no traditional

telephone line in their home were not included in the study. As a result, the findings may be biased, particularly as the number of cellular-telephone-only households continues to upsurge (Link and Mokdad 2004; Link et al., 2004).

6.7 Unanswered Questions and Further Research

The current study examined multiple risk factors for self-reported current asthma, COPD, chronic bronchitis and emphysema among adult ACBS respondents in the U.S. Several socio-demographic, indoor environmental factors and healthcare access correlates were identified for CLRD. The findings also revealed that indoor environmental factors and access to healthcare mediated the relationships between socio-demographic factors and the reporting of CLRD among ACBS respondents and that the relationships between socio-demographic factors and the reporting of CLRD depends on indoor environmental factors and access to healthcare. Given the limited amount of previous research that consistently looked at the association between these factors and CLRD outcomes in adults and the fact that no study was identified in the literature that examined the mediating effects of these factors on CLRD with predictor-mediator interaction effects, the findings from the mediation test contribute to knowledge. However, more in-depth studies that examine additional risk factors for CLRD are needed to support the findings of the current study. It should be recognized that the identification of these predictors is an initial step towards gaining a better understanding of the complex relationships and underlying mechanisms between these risk factors and adult asthma, COPD, chronic bronchitis and emphysema. Although previous studies confirmed the relationships between these risk factors and increased risk of CLRD, none examined the magnitude and significance of multiple risk factors on asthma, COPD, bronchitis and emphysema. As emphasized by Postma (2007) to better understand the etiology of these diseases, it is important to investigate the

interacting role of social, environmental, biological and personal factors on specific adult health conditions such as CLRD. Given this, further studies should, therefore, aim to investigate how indoor environmental, biological, personal factors and healthcare access influence the effects of social, economic and demographic factors on the risk of CLRD among adults.

The current cross-sectional study can only hypothesize about the temporal association between the multiple risk factors examined and CLRD. To disentangle the causal pathway of these risk factors, additional longitudinal studies are required. According to Davey Smith et al. (2002) and Steinbach (2009), the health outcomes of individuals reflect the pattern of exposure to favorable and unfavorable social, environmental, psychosocial and biological conditions over time. Therefore, longitudinal studies that examine the effect of socio-demographic, indoor environmental, personal and biological factors across the life course could provide valuable information on the difference in lifetime health outcomes and CLRD among individuals in different social, economic and demographic groups from early childhood to adulthood (Ben-Sholomo and Kuh 2002). The life course approach could not be examined in the current study due to lack of sufficient data on early life socio-economic status and health outcomes. Although longitudinal datasets such as the 1970 UK birth cohort study and Whitehall ll study were identified, these datasets lack enough information on all the indoor environmental factors that were required to answer the research questions of the present study; as a result, these datasets were not considered.

CHAPTER 7

7.0 CONCLUSION

This study is the first to use three different years of cross-sectional data and structured social causation of health inequality framework to explore whether one or more indoor environmental factors mediate the relationship between socio-demographic factors and the reporting of CLRD with predictor-mediator interaction effects. It is clear from the previous evidence that some socio-demographic factors and indoor environmental conditions are related to increased risk of current asthma, COPD, chronic bronchitis and emphysema. However, an important unanswered question about which risk factors influence the relationships between socio-demographic factors and CLRD remain (Prescott and Vestbo1999). Also, evidence from the literature also revealed increasing need to identify all relevant risk factors of CLRD because most studies did not only control for specific or general risk factors, the findings of some of these studies were inconsistent. Given these gaps, the findings of the current study are novel and contribute to existing knowledge on the disparity of CLRD among adults in different social, economic and demographic group based on their living conditions and access to healthcare. The findings revealed that mold, pest infestation, being a current or former smoker, smoking indoors, occupational exposure and medical cost, fully or partially mediated the relationship between age, marital status, education, employment, income and the reporting of current asthma, COPD, chronic bronchitis and emphysema. Significant predictor-mediator interaction effects also revealed that the effects of gender, age, education, employment and income on the reporting of CLRD depends on mold, mice presence, being a current or former smoker, smoking indoors, occupational exposure and medical cost. This indicates that socio-demographic factors, gender, age,

marital status, education, employment status, income level, and indoor environmental factors mold, exposure to tobacco smoke, being a current or former smoker, pest infestation, occupational exposure and medical cost are significant predictors of current asthma, COPD, chronic bronchitis and emphysema. The findings reveal that indoor environmental factors and access to healthcare fully or partially explains disparities in the reporting of CLRD among adult ACBS respondents in different social, economic and demographic groups. However, no etiological conclusions or causal interpretation of the relationships were possible because the current findings were derived from the analysis of cross-sectional datasets and due to the uncertainty surrounding the temporal associations between these risk factors and the development of CLRD. However, the results of the current study do not only contribute to existing knowledge on this topic; the findings are in accordance with the theoretical concept that disparities in the increased risk of CLRD among adults in different socio-demographic groups are influenced by mediating inadequate indoor environmental factors and medical cost. Confirming that these factors play a significant role in the increased risk of respiratory diseases such as CLRD in adults (Schulz et al., 2002; Northridge and Sclar 2003; Schulz and Northridge 2004; Cockerham 2007). As highlighted by Marmot and Wilkinson (2006) and Schraufnagel (2010), to develop effective ways to lessen the burden of diseases such as CLRD and to improve public health, it is important to first identify high risk populations groups and determinants of environmental and biological markers of disease outcomes by first understanding the social determinants of risk factors that are responsible for the unequal distribution of disease and poor health in different population groups. The current study contributes to the suggestion of Marmot and Wilkinson (2006) and Schraufnagel (2010) in that individuals that were more at risk and mediating factors that were more likely to influence the risk of CLRD among adults

were identified in the bivariate and mediating analysis. Another important finding of the current study was the difference in the reporting of CLRD observed among survey respondents in different SEP. High proportions of all CLRD were observed among non-high school graduates, unable to work participants and those with a household income of <$15000. These findings also contribute to existing knowledge by highlighting the importance of examining socio-demographic, indoor environmental factors and healthcare access individually and also by examining the mediating and interaction effects in an attempt to better understand the complex interrelationships amongst these risk factors and respiratory diseases such as CLRD.

The conceptual framework that was used to guide the current study and the multivariable analyses contextualized the risk factors included in the analyses by classifying them into organized groups. Although many different individual risk factors for CLRD were identified in the literature, no study was identified in the literature that examined how indoor environmental factors and access to healthcare mediates the relationship between socio-demographic factors and CLRD with interaction effects. To produce stronger evidence regarding the extent of the effects of the relationships between these risk factors and CLRD and to identify policies and interventions that can reduce CLRD disparities, researchers need to use a clear and concise theoretical framework of social determinants of health inequalities in examining the mediating effects with interaction terms. As emphasized by Iacobucci (2012) and Valeri and Vanderweele (2013), understanding the mediating mechanism is important as it help design policies and interventions that could impact the outcomes of interest by targeting potential predictors and mediating factors that are related to the outcomes of interest. This approach could be a first step towards clarifying the direction of the relationships between these risk factors and respiratory diseases among adults. Also, mediation test

with interaction effects can also provide a clear understanding of how these modifiable risk factors influence CLRD outcomes. Also, it provides an understanding of how these factors interact with each other to influence CLRD outcomes which can provide new insights on how to prevent and reduce the public health burden of current asthma, COPD, bronchitis and emphysema. As emphasized by Adler and Newman (2002), to reduce health inequalities a broad and well-structured approach is required to identify and eliminate the multiple determinants of health inequalities.

7.1. Policy Implications

The findings indicate that to reduce or eliminate disparities in the prevalence of CLRD among adults in different socio-demographic groups requires attention to all socio-demographic factors and how they influence health and disease outcomes. This is in accordance with the observation that to effectively tackle health disparities a policy approach is required that focuses on multiple social determinants of health inequalities (Adler and Newman (2002). Though evidence on policies to reduce health inequalities strongly emphasize the importance of tackling the multiple social determinants of health inequalities (Adler and Newman 2002; Graham 2004b; Bleich. et al., 2012), many policies have mainly focused on reducing the impact of the social determinants of health (Graham 2004b; NCCHPP 2016). Low SEP and poor health outcomes are as a result of both the social determinants of health and social determinants of health inequalities (Solar and Irwin 2010). Also, SEP is the key component linking social determinants of health inequalities to the social determinants of health (Solar & Irwin, 2010; VicHealth, 2015). As a result, policies that have targeted only the social determinants of health have been identified to have minimal effect on reducing health inequalities among groups and populations than policies that have focused on the wider social determinants of health inequalities (NCCHPP 2016). Some policies continue to focus only on

downstream modifiable determinants, specifically determinants of individual behaviors as a result, although reducing health disparities has been the main focus for several years the impact has not been significant, in many situations disparities have increased (Frank and Fiscella 2008; Scott-Samuel and Smith, 2015). Therefore, to effectively reduce or eliminate health disparities among individuals in different SEP requires targeting the wider social determinants of health inequalities (Bambra et al., 2010; Dankwa-Mullan et al., 2010). This suggestion is in accordance with the findings and policy implications of the current study in that, increased risk of reporting CLRD among study participants in low SEP is as a result of poor indoor environmental conditions and medical cost. As a result, policies to improve the SEP, housing conditions and access to adequate healthcare of the study participants need to highlight multiple components of the social determinants of health inequalities. Previous policies that were designed to reduce health inequalities have had an impact on the level of exposure to poor environmental conditions (Jackson and Garcia 2014). However, most of these policies only targeted specific factors such as education or built environment or neighborhood status or income (Lleras-Muney 2005; Starfield and Birn 2007; Frank and Fiscella 2008). Few policies incorporated multiple factors and the wider social determinants of health inequalities such as social and economic factors (Goldman and Lakdawalla 2005; Starfield and Birn 2007; Frank and Fiscella 2008). The policy implications of the current findings indicate that to adequately reduce disparities in the risk of CLRD among individual in low SEP, multiple socio-demographic, indoor environmental factors and access to adequate healthcare must be incorporated in the policies and the wider social determinants of health inequalities must be the main focus. This is important because policies designed to target social stratification have been identified to have a significant effect on the reduction of health inequalities because of their

actions on structural determinants which is a component of the social determinants of health inequalities (NCCHPP 2016). This is relevant because under the social causation model individuals are assigned to different social positions due to social stratification generated by structural determinants such as gender, ethnicity, education, employment and income (Diderichsen 2004; WHO 2007; Cockerham 2007). Focusing on structural determinants and targeting the wider social determinants of health inequalities will help to reduce or eliminate disparities in CLRD because it will target the socio-economic background of individuals in low SEP and influence the distribution of resources associated with SEP which can directly influence living conditions and healthcare access (Graham 2004b; Adler et al., 2016). Specifically, the policies of the current study should focus on individual needs, targeted towards the needs of specific social, economic and demographic groups. The aim is to improve the health outcomes of individuals in low SEP by improving their socio-economic conditions and physical environment. The policy should focus on reducing disparities in CLRD by targeting social, economic and environmental conditions so as to create more economic and physical resources conducive for improving health outcomes. Indoor environmental conditions should be targeted because mold presence, pest infestation, being a current or former smoker, smoking indoors and occupational exposure were identified to fully or partially mediate the relationships between socio-demographic factors and the reporting of CLRD. Housing refurbishment should be targeted through routine and proactive housing inspections in deprived comminutes so as to promptly identify and correct inadequate indoor environmental conditions. Policies designed to improve the living conditions of individuals in low SEP have been identified to limit the level of exposures to potential risk factors (Adler and Newman 2002). Given that low SEP measured by education, employment and income have been identified as significant

barriers to adequate access to healthcare in the U.S. (Pappas et al., 1997; van Doorslaer et al., 2000; Monheit and Vistries 2000; Fiscella et al., 2003), and the fact that in the current findings, medical cost was identified as a mediator of the relationship between socio-demographic factors and the reporting of chronic bronchitis. The policy should focus on improving access to adequate healthcare; specific emphasis should focus on health education, cost and accessibility of adequate health services in deprived neighborhoods. The policy goals should focus on achieving adequate access to healthcare for all identifiable groups and communities irrespective of their socio-economic status or background (Frank and Fiscella 2008). To increase the impact of the proposed policies, the participation of the targeted groups and communities should be encouraged so that individuals and communities may take advantage of these new approaches. In addition, these policy implications should not only consider the ability of the social and organizational structure to support the required type of participation among stakeholders but also the long-term sustainability of these new opportunities (Popay et al., 2010).

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APPENDICES

APPENDIX 1: Literature Review Search

Search Strategy

The strategy was to search for published literature on the effect of the relationship between socio-demographic, indoor environmental factors and healthcare access on CLRD. This included a search of electronic databases for all English studies, searching the reference lists of relevant studies, a manual search of all reference lists from included studies, search for key authors and the search for citation through Google Scholar and Web of Science. As Royle and Waugh (2003) suggested that searching reference lists are an important and productive way of identifying additional relevant studies.

Electronic Databases

Searches for literature were carried out using nine electronic databases that were most relevant to the study subject. The databases were selected based on their relevance to the study, their frequent use by other literature review and to yield enough and adequate information on the study subject. To identify relevant studies, the start and end date of the search for each database was the respective start dates and the latest searchable dates. The databases that were searched included CINAHL, EMBASE, Google Scholar, ProQuest, MEDLINE (EBESCO), PsycINFO, PUBMED, University of Lancaster One search, Web of Science. Search for each database was constructed differently, to use all the relevant combination of search terms. All terms found were essentially combined for all searches for the important areas that were the focus of the search: socio-demographic, indoor environment, chronic lower respiratory diseases and access to health care**.**

Examples of Terms used in the Literature Review Search Strategy

Socio-demographic	Indoor Environment	Chronic Lower Respiratory Diseases	Access to Healthcare
Socio-demographic factors *Socioeconomic position* *Social position* *Social Change* *Social* *Economic* *Demographic* *Age* *Adult* *Adolescent* *Gender* *Sex* *Employment* *Occupation* *Income* *Education* *Marital status*	*Indoor environment* *Housing condition* *Living condition* *Inadequate housing* *Substandard housing* *Housing problems* *Mold* *Dampness* *Wood burning stove* *Gas stove* *Carpet* *Pest infestation* *Smoking* *Pets*	*CLRD* *COPD* *Asthma* *Emphysema* *Bronchitis* *Lung function* *Respiratory diseases* *Respiratory system disorders* *Respiratory system disease* *Respiratory disorders* *Pulmonary disease* *Chronic Obstructive pulmonary disease* *Chronic bronchitis* *Lung disease* *Chronic bronchitis* *Cough*	*Access to healthcare* *Access* *Equality of care* *Barriers to care* *Health services accessibility* *Healthcare delivery* *Medical costs*

Inclusion and Exclusion Criteria

All studies in English conducted from 1980 to present in Europe, North American, South America and Asia that investigated the impact of the association between social, economic, demographic and indoor environmental factors and CLRD among adults were included in the review. The main aim of these inclusion criteria was to locate studies that have examined adult populations similar to the current study population.

Studies that were not published in English and did not fall within the date range and geographical location were excluded from the review.

Examples of Search on PubMed

Search	Query	Items found
#58	Search (((socio-economic status) AND Indoor environmental factor) AND COPD)	1
#57	Search ((Socio-economic status) AND Living conditions) AND Emphysema	0
#56	Search ((socio-economic status) AND living conditions) AND emphysema	5
#55	Search ((Socio-economic status) AND living condition) AND Bronchitis	19
#54	Search ((socio-economic status) AND living conditions) AND COPD	31
#53	Search ((socio-economic status) AND Indoor Environmental factor) AND COPD	1
#52	Search ((Socio-economic factors) AND indoor environmental factors) AND COPD	0
#51	Search ((Socioeconomic Status) AND Indoor environmental factors) AND Asthma	16
#50	Search ((Socioeconomic status) AND living condition) AND asthma	125
#49	Search (((socioeconomic status and Chronic Bronchitis)) AND (Indoor environmental factors and Chronic Bronchitis)) AND (Healthcare Access and Chronic Bronchitis)	0
#48	Search (((socioeconomic status and COPD)) AND (Indoor environmental factors and COPD)) AND (Healthcare Access and COPD)	0
#47	Search (((socioeconomic status and Asthma)) AND (Indoor environmental factors and Asthma)) AND (Healthcare Access and Asthma)	3
#46	Search ((socio-demographic factors and Emphysema)) AND (Living Conditions and Emphysema)	0
#45	Search ((socio-demographic factors and Chronic Bronchitis)) AND (Healthcare Access and Chronic Bronchitis)	1
#44	Search ((socio-demographic factors and COPD)) AND (Living Conditions and COPD)	5
#43	Search ((socio-demographic factors and asthma)) AND (Living Conditions and Asthma)	13
#42	Search ((socioeconomic position and Emphysema)) AND (Indoor environmental factors and Emphysema)	0
#41	Search ((socio-demographic factors and Chronic Bronchitis)) AND (Indoor environmental factors and Chronic Bronchitis)	0
#40	Search ((socioeconomic status and COPD)) AND (Indoor environmental factors and COPD)	6
#39	Search ((socioeconomic status and Asthma)) AND (Indoor environmental factors and Asthma)	48
#38	Search (socioeconomic status) AND (Indoor environmental factors and Emphysema)	0

#36	Search (socioeconomic status) AND (Indoor environmental factors and Chronic Bronchitis)	2
#37	Search (socio-demographic) AND (Indoor environmental factors and COPD)	0
#35	Search (socioeconomic status) AND (Indoor environmental factors and COPD)	6
#34	Search (socioeconomic status) AND (Indoor environmental factors and Asthma)	48
#33	Search Living Conditions and Respiratory Symptoms	548
#32	Search Indoor environmental factors and Respiratory Symptoms	432
#31	Search Socio-demographic factors and Respiratory Symptoms	62
#30	Search Socio-demographic factors and Lower respiratory diseases	24
#29	Search Socioeconomic status and Lower respiratory diseases	377
#28	Search Healthcare Access and Lower respiratory diseases	45
#27	Search Healthcare Access and Respiratory Symptoms	140
#26	Search Healthcare Access and Emphysema	13
#25	Search Healthcare Access and Chronic Bronchitis	14
#24	Search Healthcare Access and COPD	297
#23	Search Healthcare Access and Asthma	613
#22	Search Living Conditions and Emphysema	63
#21	Search Living Conditions and Chronic Bronchitis	113
#20	Search Living Conditions and COPD	422
#19	Search Living Conditions and Asthma	931
#18	Search Indoor environmental factors and Emphysema	12
#17	Search Indoor environmental factors and Chronic Bronchitis	45
#16	Search Indoor environmental factors and COPD	87
#15	Search Indoor environmental factors and Asthma	821
#14	Search socioeconomic position and Emphysema	3
#13	Search socioeconomic position and Chronic Bronchitis	8
#12	Search socioeconomic position and COPD	17
#11	Search socioeconomic position and Asthma	49
#10	Search socio-demographic factors and Emphysema	4
#9	Search socio-demographic factors and Chronic Bronchitis	16
#8	Search socio-demographic factors and COPD	57
#7	Search socio-demographic factors and asthma	129
#6	Search socio-demographic	16758
#5	Search socioeconomic status and emphysema	71
#4	Search socioeconomic status and Chronic Bronchitis	142
#3	Search socioeconomic status and COPD	450
#2	Search socioeconomic status and Asthma	1605
#1	Search socioeconomic status	106961

APPENDIX 2: Ethics Approval

Research and Enterprise Services Division | Lancaster University

Applicant: Ayuk Eyong
Supervisor: Dr Elizabeth McDermott
Department: DHR

06 May 2015

Dear Ayuk and Elizabeth

Re: Socio-demographic and indoor environmental correlates of Chronic Lower respiratory diseases

Thank you for submitting your research ethics application for the above project for review by the Faculty of Health and Medicine Research Ethics Committee (FHMREC). The application was recommended for approval by FHMREC, and on behalf of the Chair of the University Research Ethics Committee (UREC), I can confirm that approval has been granted for this research project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research to the Research Ethics Officer (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress);
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please contact the Research Ethics Officer, Debbie Knight (01542 592605 ethics@lancaster.ac.uk) if you have any queries or require further information.

Yours sincerely,

S.C. Taylor

Sarah Taylor
Secretary, University Research Ethics Committee

Cc Fiona Aiken, University Secretary, Professor Roger Pickup (Chair, FHMREC); Prof Stephen Decent (Chair, UREC).

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APPENDIX 3: Questionnaires

BRFSS Questionnaire

Centers for Disease Control and Prevention. Your telephone number has been chosen randomly, and I would like to ask some questions about health and health practices.

Core Sections

I will not ask for your last name, address, or other personal information that can identify you. You do not have to answer any question you do not want to, and you can end the interview at any time. Any Information you give me will be confidential. If you have any questions about the survey, please call (give appropriate state telephone number).

Section 1: Health Status

1.1 Would you say that in general your health is—?

Please read:

1 Excellent
2 Very good
3 Good
4 Fair

Or

5 Poor

Do not read:

7 Don‘t know / Not sure
9 Refused

Section 6: Chronic Health Conditions

Now I would like to ask you some questions about general health conditions.
Has a doctor, nurse, or other health professional EVER told you that you had any of the following? For each, tell me “Yes”, “No”, or you‘re “Not sure”.

6.1 (Ever told) you that you had a heart attack also called a myocardial infarction?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

6.2 (Ever told) you had angina or coronary heart disease?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

6.3 (Ever told) you had a stroke?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

6.4 (Ever told) you had asthma?

1 Yes
2 No [Go to Q6.6]

7 Don‘t know / Not sure [Go to Q6.6]
9 Refused [Go to Q6.6]

6.5 Do you still have asthma?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

Section 7: Tobacco Use

7.1 Have you smoked at least 100 cigarettes in your entire life?

NOTE: 5 packs = 100 cigarettes

1 Yes
2 No [Go to Q7.5]
7 Don‘t know / Not sure [Go to Q7.5]
9 Refused [Go to Q7.5]

7.2 Do you now smoke cigarettes every day, some days, or not at all?

1 Every day
2 Some days
3 Not at all [Go to Q7.4]
7 Don‘t know / Not sure [Go to Q7.5]
9 Refused [Go to Q7.5]

7.3 During the past 12 months, have you stopped smoking for one day or longer because you were trying to quit smoking?

1 Yes [Go to Q7.5]
2 No [Go to Q7.5]
7 Don‘t know / Not sure [Go to Q7.5]
9 Refused [Go to Q7.5]

7.4 How long has it been since you last smoked a cigarette, even one or two puffs?

0 1 Within the past month (less than 1 month ago)
0 2 Within the past 3 months (1 month but less than 3 months ago)
0 3 Within the past 6 months (3 months but less than 6 months ago)
0 4 Within the past year (6 months but less than 1 year ago)
0 5 Within the past 5 years (1 year but less than 5 years ago)
0 6 Within the past 10 years (5 years but less than 10 years ago)
0 7 10 years or more
7 7 Don‘t know / Not sure
9 9 Refused

7.5 Do you currently use chewing tobacco, snuff, or snus every day, some days, or not at all?

Snus (rhymes with „goose“)

NOTE: Snus (Swedish for snuff) is a moist smokeless tobacco, usually sold in small pouches that are placed under the lip against the gum.

1 Every day
2 Some days
3 Not at all

Do not read:

7 Don‘t know / Not sure
9 Refused

Section 8:
Demographic

8.1 What is your age?
_ _ Code age in years
0 7 Don‘t know / Not sure
0 9 Refused
8.2 Are you Hispanic or Latino?
(110)
1 Yes
2 No
7 Don‘t know / Not sure
9 Refused
8.3 Which one or more of the following would you say is your race?
(Check all that apply)
Please read:
1 White
2 Black or African American
3 Asian
4 Native Hawaiian or Other Pacific Islander
5 American Indian or Alaska Native
Or
6 Other [specify]_____
Do not read:
8 No additional choices
7 Don‘t know / Not sure
9 Refused
CATI note: If more than one response to Q8.3; continue. Otherwise, go to Q8.5.
8.4 Which one of these groups would you say best represents your race?
Please read:
1 White
2 Black or Africa American
3 Asian
8.5 Are you…?
Please read:
1 Married
2 Divorced
3 Widowed
4 Separated
5 Never married
Or
6 A member of an unmarried couple
Do not read:
9 Refused
7.6 How many children less than 18 years of age live in your household?
_ _ Number of children
8 8 None
9 9 Refused
8.8 What is the highest grade or year of school you completed?
Read only if necessary:

1 Never attended school or only attended kindergarten
2 Grades 1 through 8 (Elementary)
3 Grades 9 through 11 (Some high school)
4 Grade 12 or GED (High school graduate)
5 College 1 year to 3 years (Some college or technical school)
6 College 4 years or more (College graduate)
Do not read:
9 Refused

8.9 Are you currently…?
Please read:
1 Employed for wages
2 Self-employed
3 Out of work for more than 1 year
4 Out of work for less than 1 year
5 A Homemaker
6 A Student
7 Retired

Or

8 Unable to work

Do not read:

9 Refused

8.10 Is your annual household income from all sources—

If respondent refuses at ANY income level, code „99" (Refused)

Read only if necessary:

0 4 Less than $25,000 If "no," ask 05; if "yes," ask 03
($20,000 to less than $25,000)

0 3 Less than $20,000 If "no," code 04; if "yes," ask 02
($15,000 to less than $20,000)

0 2 Less than $15,000 If "no," code 03; if "yes," ask 01
($10,000 to less than $15,000)

0 1 Less than $10,000 If "no," code 02
0 5 Less than $35,000 If "no," ask 06
($25,000 to less than $35,000)

0 6 Less than $50,000 If "no," ask 07
($35,000 to less than $50,000)

0 7 Less than $75,000 If "no," code 08
($50,000 to less than $75,000)

0 8 $75,000 or more

Do not read:

7 7 Don‘t know / Not sure
9 9 Refused

8.11 About how much do you weigh without shoes?

NOTE: If respondent answers in metrics, put “9” in column 126.

Round fractions up
_ _ _ _ Weight
(pounds/kilograms)
7 7 7 7 Don‘t know / Not sure
9 9 9 9 Refused

8.12 About how tall are you without shoes?

NOTE: If respondent answers in metrics, put “9” in column 130.

Round fractions down

_ _ / _ _ Height
(f t / inches/meters/centimeters)
7 7/ 7 7 Don‘t know / Not sure
9 9/ 9 9 Refused

8.13 What county do you live in?

_ _ _ ANSI County Code (formerly FIPS county code)
7 7 7 Don‘t know / Not sure
9 9 9 Refused

What is the ZIP Code where you live?

_ _ _ _ _ ZIP Code
7 7 7 7 7 Don‘t know / Not sure
9 9 9 9 9 Refused

8.15 Do you have more than one telephone number in your household? Do not include cell phones or numbers that are only used by a computer or fax machine.
(142)

1 Yes
2 No [Go to Q8.17]
7 Don‘t know / Not sure [Go to Q8.17]
9 Refused [Go to Q8.17]

8.16 How many of these telephone numbers are residential numbers?

_ Residential telephone numbers [6 = 6 or more]
7 Don‘t know / Not sure
9 Refused

8.17 Do you have a cell phone for personal use? Please include cell phones used for both business and personal use.

1 Yes [Go to Q8.19]
2 No
7 Don‘t know / Not sure
9 Refused

8.18 Do you share a cell phone for personal use (at least one-third of the time) with other adults?

1 Yes [Go to Q8.20]
2 No [Go to Q8.21]
7 Don‘t know / Not sure [Go to Q8.21]
9 Refused [Go to Q8.21]

8.19 Do you usually share this cell phone (at least one-third of the time) with any other adults?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused
2011 BRFSS/Final/January 27, 2011 20

8.20 Thinking about all the phone calls that you receive on your landline and cell phone, what percent, between 0 and 100, are received on your cell phone?

_ _ _ Enter percent (1 to 100)
8 8 8 Zero
7 7 7 Don‘t know / Not sure
9 9 9 Refused

8.21 Do you own or rent your home?
(150)

1 Own
2 Rent
3 Other arrangement
7 Don‘t know / Not sure
9 Refused

INTERVIEWER NOTE: “Other arrangement” may include group home, staying with friends or family without paying rent.

NOTE: Home is defined as the place where you live most of the time/the majority of the year.

8.22 Indicate sex of respondent. Ask only if necessary.

1 Male [Go to next section]
2 Female [If respondent is 45 years old or older, go to next section]

8.23 To your knowledge, are you now pregnant?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refus

Module 16: Secondhand Smoke

The next questions are about exposure to secondhand smoke.

If Core Q8.9 = 1 (Employed) or = 2 (Self-employed); continue. Otherwise, go to Q2.

1. Now I‘m going to ask you about smoke you might have breathed at work because someone else was smoking indoors. During the past 7 days, that is, since last [TODAY‟S DAY OF THE WEEK], on how many days did you breathe the smoke at your
workplace from someone other than you who was smoking tobacco?

_ _ Number of days [01-07]
8 8 None
7 7 Don‘t know / Not sure
9 9 Refused

2. Not counting decks, porches, or garages, during the past 7 days, that is, since last [TODAY‟S DAY OF WEEK], on how many days did someone other than you smoke tobacco inside your home while you were at home?

_ _ Number of days [01-07]
8 8 None
7 7 Don‘t know / Not sure
9 9 Refused

4. [If Q8.9 = 1 (Employed) or Q8.9 = 2 (Self-employed); say “Not counting times while you were at work,‖] during the past 7 days, that is, since last [TODAY‟S DAY OF WEEK], on how many days did you breathe the smoke from someone else who was smoking in an indoor public place?
(373-374)

_ _ Number of days [01-07]
8 8 None
7 7 Don‘t know / Not sure
9 9 Refused

5. Not counting decks, porches, or garages, inside your home, is smoking…

INTERVIEWER NOTE: The order of the response categories for this question is being randomly reversed.

Please read:

1 Always allowed
2 Allowed only at some times or in some places
3 Never allowed

Do not read:

6 Family does not have a smoking policy
7 Don‘t know / Not sure
9 Refused

6. Not counting motorcycles, in the vehicles that you or family members who live with you own or lease, is smoking…

INTERVIEWER NOTE: The order of the response categories for this question is being randomly reversed.
Please read:

1 Always allowed in all vehicles
2 Sometimes allowed in at least one vehicle
3 Never allowed in any vehicle

Do not read:

6 Family does not have a vehicle smoking policy
8 Respondent‘s family does not own or lease a vehicle
7 Don‘t know / Not sure
9 Refused

7. At workplaces, do you think smoking indoors should be…

INTERVIEWER NOTE: The order of the response categories for this question is being randomly
reversed.
Please read:

1 Always allowed
2 Allowed only at some times or in some places
3 Never allowed

Do not read:
7 Don‘t know / Not sure

9 Refused

Module 17: Adult Asthma History

Previously you said you were told by a doctor, nurse or other health professional that you had asthma.

1. How old were you when you were first told by a doctor, nurse, or other health professional that you had asthma?
(378-379)

_ _ Age in years 11 or older [96 = 96 and older]
9 7 Age 10 or younger
9 8 Don‘t know / Not sure
9 9 Refused

CATI NOTE: If "Yes" to Core Q6.5, continue. Otherwise, go to next module.

2. During the past 12 months, have you had an episode of asthma or an asthma attack?

1 Yes
2 No [Go to Q5]
7 Don‘t know / Not sure [Go to Q5]
9 Refused [Go to Q5]

3. During the past 12 months, how many times did you visit an emergency room or urgent care center because of your asthma?

_ _ Number of visits [87 = 87 or more]
8 8 None
9 8 Don‘t know / Not sure
9 9 Refused

4. [If one or more visits to Q3, fill in “Besides those emergency room or urgent care center visits,”] During the past 12 months, how many times did you see a doctor, nurse or other health professional for urgent treatment of worsening asthma symptoms?

_ _ Number of visits [87 = 87 or more]
8 8 None
9 8 Don‘t know / Not sure
9 9 Refused

5**. During the past 12 months, how many times did you see a doctor, nurse, or other health professional for a routine checkup for your asthma?**

_ _ Number of visits [87 = 87 or more]

8 8 None
9 8 Don‘t know / Not sure
9 9 Refused

6. During the past 12 months, how many days were you unable to work or carry out your
usual activities because of your asthma?

_ __Number of days
8 8 8 None
7 7 7 Don‘t know / Not sure
9 9 9 Refused

7. Symptoms of asthma include cough, wheezing, shortness of breath, chest tightness and phlegm production when you don‘t have a cold or respiratory infection. During the past 30 days, how often did you have any symptoms of asthma? Would you say —

Please read:

8 Not at any time [Go to Q9]
1 Less than once a week
2 Once or twice a week
3 More than 2 times a week, but not every day
4 Every day, but not all the time

5 Every day, all the time
Do not read:

7 Don‘t know / Not sure
9 Refused

8. During the past 30 days, how many days did symptoms of asthma make it difficult for you to stay asleep? Would you say____

Please read:
8 None
1 One or two
2 Three to four
3 Five
4 Six to ten
Or
5 More than ten
Do not read:
7 Don‘t know / Not sure
9 Refused

9. During the past 30 days, how many days did you take a prescription asthma medication to PREVENT an asthma attack from occurring? Please read:

8 Never
1 1 to 14 days
2 15 to 24 days
3 25 to 30 days

Do not read:

7 Don‘t know / Not sure
9 Refused

Module 22: Chronic Obstructive Pulmonary Disease (COPD)

CATI NOTE: If core Q6.8 = 1 (Yes) then continue, else go to next module.

Earlier you said that you had been diagnosed with Chronic Obstructive Pulmonary Disease (COPD).

1. Have you ever been given a breathing test to diagnose your COPD, chronic bronchitis, or emphysema?
(405)

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

2. Would you say that shortness of breath affects the quality of your life?
(406)

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

3. Other than a routine visit, have you had to see a doctor in the past 12 months for symptoms related to shortness of breath, bronchitis, or other COPD, or emphysema flare?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refused

4. Did you have to visit an emergency room or be admitted to the hospital in the past 12 months because of your COPD, chronic bronchitis, or emphysema?

1 Yes
2 No
7 Don‘t know / Not sure
9 Refus

BRFSS/ASTHMA SURVEY
ADULT QUESTIONNAIRE - 2011

Section 1. Introduction
INTRODUCTION TO THE BRFSS Asthma call back for Adult respondents with asthma: BRFSS

Section 3. Recent History

AGEDX (3.1) How old were you when you were first told by a doctor or other health professional that you had asthma?

__ __ __(ENTER AGE IN YEARS)

(777) DON'T KNOW
(888) under one year old
(999) REFUSED

INCIDNT (3.2) How long ago was that? Was it ." READ CATEGORIES

(1) Within the past 12 months
(2) 1-5 years ago
(3) more than 5 years ago

(7) DON'T KNOW
(9) REFUSED

LAST_MD (3.3) How long has it been since you last talked to a doctor or other health professional about your asthma? This could have been in your doctor's office, the hospital, an emergency room or urgent care center.

(88) NEVER
(04) WITHIN THE PAST YEAR
(05) 1 YEAR TO LESS THAN 3 YEARS AGO
(06) 3 YEARS TO 5 YEARS AGO
(07) MORE THAN 5 YEARS AGO

(77) DON'T KNOW
(99) REFUSED

LAST_MED (3.4) How long has it been since you last took asthma medication?

[INTERVIEWER: READ RESPONSE OPTIONS IF NECESSARY]

(88) NEVER
(01) LESS THAN ONE DAY AGO
(02) 1-6 DAYS AGO

(03) 1 WEEK TO LESS THAN 3 MONTHS AGO
(04) 3 MONTHS TO LESS THAN 1 YEAR AGO
(05) 1 YEAR TO LESS THAN 3 YEARS AGO
(06) 3 YEARS TO 5 YEARS AGO
(07) MORE THAN 5 YEARS AGO

(77) DON'T KNOW
(99) REFUSED

INTRODUCTION FOR LASTSYMP:

LASTSYMP (3.5) How long has it been since you last had any symptoms of asthma?

[INTERVIEWER: READ RESPONSE OPTIONS IF NECESSARY]

(88) NEVER
(01) LESS THAN ONE DAY AGO
(02) 1-6 DAYS AGO
(03) 1 WEEK TO LESS THAN 3 MONTHS AGO
(04) 3 MONTHS TO LESS THAN 1 YEAR AGO
(05) 1 YEAR TO LESS THAN 3 YEARS AGO
(06) 3 YEARS TO 5 YEARS AGO
(07) MORE THAN 5 YEARS AGO

(77) DON'T KNOW
(99) REFUSED

Section 4. History of Asthma (Symptoms & Episodes in past year)

SYMP_30D (4.1) During the past 30 days, on how many days did you have any symptoms of asthma?

__ __DAYS

DUR_30D (4.2) Do you have symptoms all the time? "All the time" means symptoms that continue throughout the day. It does not mean symptoms for a little while each day.

(1) YES
(2) NO

(7) DON'T KNOW
(9) REFUSED

ASLEEP30 (4.3) During the past 30 days, on how many days did symptoms of asthma make it difficult for you to stay asleep?

__ __ DAYS/NIGHTS

(88) NONE

(30) EVERY DAY (Added 1/24/08)

(77) DON'T KNOW
(99) REFUSED

YMPFREE (4.4) During the past two weeks, on how many days were you completely symptom-free, that is no coughing, wheezing, or other symptoms of asthma?

__ __ Number of days

(88) NONE

(77) DON'T KNOW
(99) REFUSED

EPIS_INT READ: Asthma attacks, sometimes called episodes, refer to periods of worsening asthma symptoms that make you limit your activity more than you usually do, or make you seek medical care.

EPIS_12M (4.5) During the past 12 months, have you had an episode of asthma or an asthma attack?

(1) YES
(2) NO [SKIP TO INS1 (section 5)]

(7) DON'T KNOW [SKIP TO INS1 (section 5)]
(9) REFUSED [SKIP TO INS1 (section 5)]

EPIS_TP (4.6) During the past three months, how many asthma episodes or attacks have you had?

_ __ __

(888) NONE

(777) DON'T KNOW
(999) REFUSED

DUR_ASTH (4.7) How long did your MOST RECENT asthma episode or attack last?

1_ _ Minutes
2_ _ Hours 3_ _ Days 4_ _ Weeks 5 5 5 Never

7 7 7 Don't know / Not sure
9 9 9 Refused

Section 7. Modifications to Environment

COOK_GAS (7.4) Is gas used for cooking?

(1) Yes
(2) NO
(7) DON'T KNOW
(9) REFUSE

ENV_MOLD (7.5) In the past 30 days, has anyone seen or smelled mold or a musty odor inside your home? Do not include mold on food.

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

ENV_PETS (7.6) Does your household have pets such as dogs, cats, hamsters, birds or other feathered or furry pets that spend time indoors?

(1) YES
(2) NO (SKIP TO 7.8)
(7) DON'T KNOW (SKIP TO 7.8)
(9) REFUSED (SKIP TO 7.8)

PETBEDRM (7. 7) Are pets allowed in your bedroom?

(1) YES
(2) NO
(3) SOME ARE/SOME AREN'T
(7) DON'T KNOW
(9) REFUSED

C_ROACH (7.8) In the past 30 days, has anyone seen a cockroach inside your home?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

C_RODENT (7.9) In the past 30 days, has anyone seen mice or rats inside your home? Do not include mice or rats kept as pets.
(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED
WOOD_STOVE (7.10) Is a wood burning fireplace or wood burning stove used in your home?

(1) YES

(2) NO
(7) DON'T KNOW
(9) REFUSED

GAS_STOVE (7.11) Are unvented gas logs, unvented gas fireplaces, or unvented gas stoves used
in your home?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

S_INSIDE (7.12) In the past week, has anyone smoked inside your home?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

CARPET (7.16) Do you have carpeting or rugs in your bedroom? This does not include throw rugs small enough to be laundered.

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

Section 10. Work Related Asthma

EMP_STAT (10.1) Next, we are interested in things that affect asthma in the workplace. However, first I'd like to ask how you would describe your current employment status? Would you say

[INTERVIEWER: Include self employed as employed. Full time is 40+ hours.]

(1) Employed full-time [SKIP TO WORKENV1]
(2) Employed part-time [SKIP TO WORKENV1]
(3) Not employed
(7) DON'T KNOW [SKIP TO EMPL_EVER (10.3)]
(9) REFUSED [SKIP TO EMPL_EVER (10.3)]

UNEMP_R (10.2) What is the main reason you are not now employed?

(01) KEEPING HOUSE
(02) GOING TO SCHOOL
(03) RETIRED
(04) DISABLED
(05) UNABLE TO WORK FOR OTHER HEALTH REASONS
(06) LOOKING FOR WORK

(07) LAID OFF
(08) OTHER
(77) DON'T KNOW
(99) REFUSED

EMP_EVER (10.3) Have you ever been employed outside the home?

(1) YES [SKIP TO WORKENV3]
(2) NO [SKIP TO SECTION 11]
(7) DON'T KNOW [SKIP TO SECTION 11]
(9) REFUSED [SKIP TO SECTION 11]

WORKENV1 (10.4) Was your asthma CAUSED by chemicals, smoke, fumes or dust in your CURRENT job?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

WORKENV2 (10.5) Is your asthma MADE WORSE by chemicals, smoke, fumes or dust in your CURRENT job?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

WORKENV3 (10.6) Was your asthma CAUSED by chemicals, smoke, fumes or dust in any PREVIOUS job you ever had?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

WORKENV4 (10.7) Was your asthma MADE WORSE by chemicals, smoke, fumes or dust in any PREVIOUS job you ever had?

(1) YES
(2) NO

(7) DON'T KNOW
(9) REFUSED

WORKQUIT (10.75) Did you ever change or quit a job because chemicals, smoke, fumes, or dust caused your asthma or made your asthma worse?

(1) YES
(2) NO

(7) DON'T KNOW
(9) REFUSED

WORKSEN1 (10.8) Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

WORKSEN2 (10.9) Did you ever tell a doctor or other health professional that your asthma was related to any job you ever had?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

Section 11. Comorbid Conditions

COPD (11.1) Have you ever been told by a doctor or health professional that you have chronic obstructive pulmonary disease also known as COPD?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

EMPHY (11.2) Have you ever been told by a doctor or other health professional that you have emphysema?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

BRONCH (11.3) Have you ever been told by a doctor or other health professional that you have Chronic Bronchitis?

(1) YES
(2) NO
(7) DON'T KNOW
(9) REFUSED

[HELP SCREEN: Chronic Bronchitis is repeated attacks of bronchitis over a long period of time. Chronic Bronchitis is not the type of bronchitis you might get occasionally with a cold.]

APPENDIX 4

RESULTS

Individual Association between Socio-demographic, Indoor environmental Factors, Access to healthcare and CLRD.

Univariate Analysis of the relationship between Socio-demographic Factors Related to CLRD for 2010

The results of the individual relationships between socio-demographic factors and CLRD for 2010 are summarized in Table 3.3. Among females, 76.8 % reported current asthma, 18.6% COPD and 32.7% bronchitis (32.7%) which was significantly higher compared to males, except for emphysema where the proportion was higher for males (12.3%) compared to females (9.5%). All four CLRD increased progressively with age except for current asthma where no difference was observed between ages 55-64 and 65+ years. A high proportion of current asthma (77.8%) was observed among blacks, COPD was higher among whites (18.7%) and other race group (18.8%). The reporting of chronic bronchitis was high among blacks (33.7%) and other race group (30.6%) while, emphysema was high among whites (10.6%) and other race participants (10.8%). More singles and widowed/separated participants report current asthma (73.8% 79.4%), COPD (18.5%, 32.5%) bronchitis (32.0%, 42.3%) and emphysema (11.0% 18.4%) compared to married participants. The reporting of current asthma (79.6%), COPD (29.3%), bronchitis (45.1%) and emphysema (22.8%) were significantly higher for non-high school graduates. Retired and unable to work participants reported more CLRD. All CLRD were significantly higher for those with annual household income <$15000, compared to all other income groups.

Univariate Analysis of the relationship between Indoor Environmental Factors, Healthcare Access Related and CLRD for 2010.

The results of the individual relationships between indoor environmental factors, healthcare access and CLRD for 2010 are presented in Table 3.4. A significant relationship was observed between saw/smelled mold in the past 30 days and current asthma (78.2%), COPD (20.7%), bronchitis (37.8%) and emphysema (12.3%). The prevalence of current asthma, COPD, bronchitis and emphysema was higher for current smokers and former smokers compared with never smokers. Smoke indoors was a risk factor for all CLRD. Saw cockroach in the past 30 days was significantly related to chronic bronchitis (34.5%) and emphysema (12.5%), while saw mice inside in the past 30 days was significantly associated to current asthma (77.1%) and chronic bronchitis (32.6%). Exposure to chemicals, smoke, fumes and dust in a previous job and could not see a doctor because of cost (medical cost) were significantly associated with the reporting of asthma, COPD, chronic bronchitis and emphysema.

Univariate Analysis of the relationship between Socio-demographic Factors Related and CLRD for 2011

The results of the relationship between individual socio-demographic factors and CLRD for 2011 are summarized in Table 3.5. Females frequently reported current asthma (78.1%) and chronic bronchitis (33.5%), while more males reported emphysema (13.0%) compared to females. The prevalence of all four CLRD increased progressively with age, except for current asthma where there was no significant difference between age group 45-54 (76.0%) and 55-64-year old (76.3%). More blacks (78.8%) and other race groups (76.0%) reported current asthma, while more whites and other race participants reported COPD (21.0%, 20.2%) and emphysema (11.0%, 12.4%). Being single or widowed/separated was significantly associated with current asthma (76.5% 79.8%), COPD (20.3%, 32.9%), chronic bronchitis (33.6%, 42.6%) and emphysema (11.1% 18.7%) compared to being married. Higher proportions of current asthma (82.0%), COPD (33.8%), bronchitis (45.6%) and emphysema (23.2%) were observed

among non-high school graduates. Retired and unable to work participants reported more CLRD. The lower the total household income, the higher the prevalence of all CLRD, with the highest proportion observed among those with annual household income <$15000.

Relationships between Indoor Environmental Factors, Healthcare Access and CLRD for 2011

The results of the relationship between indoor environmental factors, healthcare access and CLRD for 2011 are presented in Table 3.6. A significant relationship was identified between saw/smelled mold in the past 30 days and current asthma (82.5%), COPD (37.3%) and bronchitis (22.2%). The reporting of current asthma, COPD, chronic bronchitis and emphysema was higher for current smokers (79.0%, 36.2%, 48.0%, 22.4%) and former smokers (76.3%, 28.7%, 35.3%; 16.6%) compared to never smoked participants. Indoor smoking was significantly related to the reporting of all CLRD. Saw cockroach in the past 30 days was significant related to the reporting of COPD (22.1%), bronchitis (33.7%), and emphysema (13.6%) while saw mice in the past 30 days was significantly associated with current asthma (78.8%), and chronic bronchitis (33.8%), a relationship that approaches statistical significances was observed for COPD ($p=0.056$). Occupational exposure and medical cost were significantly associated with all CLRD.

Unadjusted logistic regression of each socio-demographic factors and CLRD 2009

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI) [b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.70 (1.57-1.35) <0.001	1.28 (1.16-1.41) <0.001	1.77 (1.63-1.92) <0.001	.838 (.750-.937) 0.002
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.52 (1.29-1.80) <0.001	5.12 (2.81-9.33) <0.001	1.20 (.978-1.48) 0.081	3.37 (1.53-7.43) 0.003
45-54	1.78 (1.53-2.06) <0.001	14.9 (8.52-26.1) <0.001	2.21 (1.85-2.64) <0.001	12.8 (6.23-26.0) <0.001
55-64	1.95 (1.69-2.25) <0.001	23.7 (13.6-41.3) <0.001	2.78 (2.34-3.30) <0.001	19.9 (9.81-40.2) <0.001
65+	1.93 (1.67-2.22) <0.001	36.7 (21.1-63.7) <0.001	2.81 (2.37-3.33) <0.001	35.3 (17.5-71.3) <0.001
Race/Ethnicity[d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	1.06 (.908-1.23) 0.446	.764 (.625-.933) 0.008	1.20 (1.03-1.39) 0.016	.643 (.493-.837) 0.001
Hispanic	.548 (.378-.532) <0.001	.659 (.544-.799) <0.001	.972 (.846-1.12) 0.694	.766 (.612-.959) 0.020
Other race	1.01 (.874-1.17) 0.882	1.01 (.854-1.20) 0.880	1.26 (1.10-1.45) 0.001	.883 (.709-1.10) 0.267
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	1.21 (1.21-1.32) <0.001	1.42 (1.29-1.57) <0.001	1.46 (1.35-1.59) <0.001	1.41 (1.25-1.57) <0.001
Widowed/Separated	1.48 (1.33-1.65) <0.001	2.73 (2.44-3.05) <0.001	2.13 (1.93-2.34) <0.001	2.84 (2.49-3.24) <0.001
Education				
Did not Graduate High School	1.76 (1.52-2.03) <0.001	4.52 (3.89-5.25) <0.001	4.52 (3.89-5.25) <0.001	6.17 (5.14-7.41) <0.001
Graduated High School	1.50 (1.37-1.65) <0.001	3.00 (2.66-3.39) <0.001	3.00 (2.66-3.39) <0.001	4.01 (3.43-4.69) <0.001
Attended College /Tech School	1.26 (1.16-1.38) <0.001	2.25 (1.99-2.54) <0.001	2.25 (1.99-2.54) <0.001	2.24 (1.90-2.64) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	1.18 (1.02-1.36) 0.030	2.07 (1.70-2.53) <0.001	1.61 (1.39-1.87) <0.001	2.18 (1.68-2.83) <0.001
Homemaker	1.10 (.959-1.27) 0.171	2.31 (1.91-2.79) <0.001	1.48 (1.28-1.72) <0.001	2.43 (1.91-3.10) <0.001
Retired	1.31 (1.20-1.44) <0.001	4.57 (4.06-5.14) <0.001	2.02 (1.85-2.22) <0.001	5.30 (4.56-6.17) <0.001
Unable Work	2.09 (1.87-2.35) <0.001	6.07 (5.36-6.89) <0.001	3.84 (3.48-4.24) <0.001	6.49 (5.53-7.60) <0.001
Income				
<$15000	1.98 (1.73-2.25) <0.001	6.98 (5.90-8.25) <0.001	5.22 (4.61-592) <0.001	7.78 (6.26-9.69) <0.001
$15000-$24999	1.63 (1.45-1.83) <0.001	4.77 (4.03-5.64) <0.001	3.29 (2.91-3.72) <0.001	5.42 (4.35-6.76) <0.001
$25000-$49999	1.24 (1.12-1.37) <0.001	2.97 (2.51-3.51) <0.001	2.14 (1.90-2.41) <0.001	3.46 (2.78-4.32) <0.001
$50000-$74999	1.13 (1.01-1.27) <0.001	1.72 (1.42-2.11) <0.001	1.62 (1.41-1.86) <0.001	1.62 (1.23-2.13) 0.001
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Unadjusted logistic regression of each potential mediator and CLRD 2009

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Mold				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.33 (1.18-1.50) <0.001	1.14 (.996-1.31) 0.056	1.37 (1.23-1.53) <0.001	1.12 (.950-1.32) 0.178
Smoking				
Current smoker	1.41 (1.27-1.57) <0.001	5.22 (4.63-5.89) <0.001	2.94 (2.67-3.23) <0.001	8.60 (7.30-10.1) <0.001
Former smoker	1.21 (1.17-1.31) <0.001	3.76 (3.37-4.18) <0.001	1.77 (1.63-1.91) <0.001	6.13 (5.26-7.13) <0.001
Never smoked	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Smoking Indoors				
No	1.0 (reference0	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.45 (1.31-1.62) <0.001	2.49 (2.25-2.76) <0.001	2.36 (2.15-2.58) <0.001	2.96 (2.63-3.33) <0.001
Saw Cockroach past 30 days				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	.880 (.778-.994) 0.039	1.08 (.936-1.26) 0.284	1.16 (1.02-1.30) 0.018	.991 (.824-1.19) 0.927
Saw Mice past 30 days				
No	1.0 (reference)	1.0(reference)	1.0 (reference)	1.0 (reference)
Yes	1.04 (.905-1.20) 0.556	.984 (.829-1.17) 0.857	1.147 (1.00-1.31) 0.048	1.08 (.882-1.33) 0.452
Asthma cause by Previous				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.33 (2.08-2.60) <0.001	2.30 (2.06-2.56) <0.001	2.35 (2.15-2.58) <0.001	2.42 (2.13-2.75) <0.001
Medical Cost				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.53 (1.14-1.40) <0.001	1.19 (1.07-1.34) 0.002	1.77 (1.62-1.94) <0.001	1.23 (1.08-1.41) 0.003

[a]Unadjusted odd ratio for each socio-demographic, indoor environmental factors and CLRD.
[b]95% Confidence interval for multivariable logistic regression model.
[c]P-value for multivariable logistic regression for all variables included in the model.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic." includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

Unadjusted logistic regression of each socio-demographic factors and CLRD 2010

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI) [b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.85 (1.72-1.98) <0.001	1.65 (1.07-1.27) 0.001	1.63 (1.52-1.76) <0.001	.754 (.673-.825) <0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.32 (1.19-1.60) <0.001	2.62 (1.65-4.17) <0.001	1.70 (1.41-2,06) <0.001	1.53 (.874-2.68) 0.136
45-54	1.60 (1.40-1.82) <0.001	11.1 (7.40-16.7) <0.001	2.85 (2.42-3.37) <0.001	6.23 (3.92-9.86) <0.001
55-64	1.80 (1.59-2.04) <0.001	15.8 (10.5-23.6) <0.001	3.56 (2.86-3.94) <0.001	9.65 (6.12-15.1) <0.001
65+	1.78 (1.57-2.01) <0.001	26.4 (17.7-39.4) <0.001	3.79 (3.24-4.45) <0.001	17.5 (11.2-27.3) <0.001
Race/Ethnicity[d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	1.29 (1.14-1.48) <0.001	.851 (.699-.949) 0.009	1.21 (1.08-1.37) 0.001	.889 (.736-1.07) 0.222
Hispanic	.791 (.691-.906) 0.001	.452 (.366-.559) <0.001	.890 (.772-1.03) 0.105	.618 (.428-.791) <0.001
Other race	.992 (.867-1.14) 0.907	1.01 (.862-1.17) 0.943	1.05 (.925-1.20) 0.432	1.02 (.842-1.24) 0.838
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	1.18 (1.09-1.27) <0.001	1.53 (1.40-1.70) <0.001	1.47 (1.37-1.59) <0.001	1.58 (1.40-1.77) <0.001
Widowed/Separated	1.61 (1.46-1.78) <0.001	3.25 (2.94-3.60) <0.001	2.29 (2.10-2.51) <0.001	2.89 (2.55-3.27) 0.020
Education				
Did not Graduate High School	1.82 (1.60-2.07) <0.001	3.73 (3.26-4.26) <0.001	3.28 (2.93-3.68) <0.001	6.77 (5.73-8.01) <0.001
Graduated High School	1.57 (1.45-1.72) <0.001	2.78 (2.50-3.10) <0.001	2.18 (2.00-2.38) <0.001	3.77 (3.23-4.37) <0.001
Attended College /Tech School	1.28 (1.18-1.39) <0.001	2.01 (1.88-2.34) <0.001	1.87 (1.71-2.03) <0.001	2.56 (2.59-3.07) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	1.14 (.998-1.30) 0.053	2.40 (2.00-2.88) <0.001	1.92 (1.67-2.20) <0.001	2.76 (2.18-3.48) <0.001
Homemaker	1.26 (1.10-1.45) 0.001	1.78 (1.46-2.18) 0.001	1.44 (1.25-1.66) <0.001	1.89 (1.45-2.47) 0.001
Retired	1.48 (1.36-1.61) <0.001	5.57 (4.98-6.23) <0.001	1.24 (2.06-2.43) <0.001	5.80 (5.01-6.73) <0.001
Unable Work	2.36 (2.21-2.63) <0.001	7.25 (6.44-8.17) <0.001	3.94 (3.60-4.32) <0.001	7.02 (6.01-8.20) <0.001
Income				
<$15000	2.25 (2.00-2.54) <0.001	8.03 (6.82-9.45) <0.001	5.00 (4.42-5.62) <0.001	8.64 (6.95-10.8) <0.001
$15000-$24999	1.72 (1.54-1.92) <0.001	6.27 (5.33-7.38) <0.001	3.81 (3.39-4.29) <0.001	6.67 (5.36-8.30) <0.001
$25000-$49999	1.34 (1.21-1.48) <0.001	3.42 (2.90-4.02) <0.001	2.45 (2.18-2.74) <0.001	3.53 (2.82-4.41) <0.001
$50000-$74999	1.14 (1.02-1.27) 0.021	1.97 (1.63-2.39) <0.001	1.49 (1.30-1.71) <0.001	1.72 (1.31-2.25) <0.001
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Unadjusted logistic regression of each potential mediator and CLRD 2010

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Mold				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.36 (1.21-1.53) <0.001	1.22 (1.09-1.39) 0.001	1.50 (1.35-1.67) <0.001	1.26 (1.09-147) 0.002
Smoking				
Current smoker	1.23 (1.12-1.36) <0.001	5.70 (5.10-6.37) <0.001	2.81 (2.57-3.07) <0.001	9.01 (7.70-10.5) <0.001
Former smoker	1.08 (1.00-1.16) <0.001	4.00 (3.63-4.42) <0.001	1.71 (1.58-1.84) <0.001	6.74 (5.83-7.80) <0.001
Never smoked	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Smoking Indoors				
No	1.0 (reference0	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.48 (1.33-1.64) <0.001	2.89 (2.63-3.17) <0.001	1.28 (1.07-1.52) 0.006	3.00 (2.65-3.30) <0.001
Saw Cockroach past 30 days				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	.940 (.838-1.06) 0.299	1.14 (1.00-1.30) 0.051	1.27 (1.39-1.42) <0.001	1.27 (1.08-1.49) 0.003
Saw Mice past 30 days				
No	1.0 (reference)	1.0 (reference)	1	1.0 (reference)
Yes	1.26 (1.10-1.45) 0.001	1.05 (.900-1.22) 0.559	1.15 (1.02-1.31) 0.026	1.13 (.936-1.35) 0.208
Asthma cause by Previous				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.52 (2.27-2.80) <0.001	2.29 (2.08-2.52) <0.001	2.39 (2.20-2.60) <0.001	2.38 (2.13-2.68) <0.001
Medical Cost				
No	1.0 (reference)	1.0 (reference)	1.0(reference)	1.0 (reference)
Yes	1.30 (1.19-1.43) <0.001	1.17 (1.06-1.30) 0.002	1.75 (1.61-1.91) <0.001	1.16 (1.02-1.31) 0.024

[a]Unadjusted odd ratio for each socio-demographic, indoor environmental factors and CLRD
[b]95% Confidence interval for multivariable logistic regression model.
[c]P-value for multivariable logistic regression for all variables included in the model.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic." includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

Unadjusted logistic regression of each socio-demographic factors and CLRD 2011

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI) [b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.62 (1.51-175) <0.001	1.02 (1.02-1.11) 0.594	1.55 (1.43-1.67) <0.001	.724 (.625-.804) < 0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.33 (1.13-1.57) <0.001	5.58 (3.22-9.68) <0.001	1.70 (1.39-2.07) <0.001	3.58 (1.84-6.95) <0.001
45-54	1.54 (1.33-1.79) <0.001	16.6 (9.88-27.9) <0.001	2.86 (2.40-3.42) <0.001	9.81 (5.33-18.1) <0.001
55-64	1.57 (1.37-1.81) <0.001	24.5 (14.6-40.9) <0.001	3.19 (2.69-3.78) <0.001	14.8 (8.09-27.0) <0.001
65+	1.70 (1.48-1.94) <0.001	36.9 (22.9-61.7) <0.001	3.31 (2.80-3.91) <0.001	24.5 (13.5-44.5) <0.001
Race/Ethnicity[d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	1.23 (1.07-1.41) 0.004	.854 (.738-.990) 0.036	1.15 (1.02-1.30) 0.022	.790 (.648-.964) 0.020
Hispanic	.911 (.793-1.05) 0.185	.469 (.389-.569) <0.001	.823 (.717-.944) 0.005	.698 (.557-.873) 0.002
Other race	1.05 (.906-1.21) 0.532	.954 (.818-1.11) 0.004	1.11 (.976-1.27) 0.109	1.14 (.948-1.38) 0.162
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	1.20 (1.11-1.30) <0.001	1.42 (1.20-1.55) 0.611	1.51 (1.40-1.63) <0.001	1.35 (1.35-1.70) <0.001
Widowed/Separated	1.45 (1.31-1.61) <0.001	2.73 (2.47-3.01) 0.115	2.21 (2.03-2.42) <0.001	2.79 (2.46-3.15) <0.001
Education				
Did not Graduate High School	1.90 (1.65-2.19) <0.001	4.28 (3.70-4.90) <0.001	3.16 (2.81-3.56) <0.001	6.67 (5.61-7.93) <0.001
Graduated High School	1.58 (1.44-1.73) <0.001	3.02 (2.71-3.36) <0.001	2.16 (1.97-2.36) <0.001	4.30 (3.70-5.00) <0.001
Attended College /Tech School	1.29 (1.18-1.41) <0.001	2.28 (2.04-2.53) <0.001	1.93 (1.77-2.10) <0.001	2.34 (2.00-2.74) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	1.18 (1.01-1.36) 0.034	2.21 (1.82-2.67) <0.001	2.00 (2.71-2.27) <0.001	2.57 (1.98-3.34) <0.001
Homemaker	1.19 (1.03-1.38) 0.160	1.90 (1.57-2.30) 0.001	1.34 (1.16-1.55) <0.001	2.20 (1.69-2.87) <0.001
Retired	1.33 (1.22-1.45) <0.001	4.65 (4.17-5.20) <0.001	2.04 (1.88-2.22) <0.001	5.58 (4.77-6.52) <0.001
Unable Work	2.19 (2.00-2.45) <0.001	7.00 (6.21-7.86) <0.001	3.89 (3.55-4.30) <0.001	7.37 (6.26-8.67) <0.001
Income				
<$15000	2.34 (1.97-2.53) <0.001	6.87 (5.88-8.03) <0.001	4.30 (3.82-4.84) <0.001	7.73 (6.24-9.59) <0.001
$15000-$24999	1.69 (1.51-1.90) <0.001	5.49 (4.70-6.40) <0.001	3.69 (3.28-4.14) <0.001	6.13 (4.94-7.61) <0.001
$25000-$49999	1.36 (1.23-1.51) <0.001	3.29 (2.81-3.84) <0.001	2.08 (1.86-2.34) <0.001	3.29 (2.63-4.10) <0.001
$50000-$74999	1.19 (1.05-1.34) <0.004	1.70 (1.41-2.05) <0.040	1.39 (1.22-1.60) <0.001	1.71 (1.31-2.24) <0.001
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Unadjusted logistic regression of each potential mediator and CLRD 2011

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI)[b] P-Value [c]
Mold				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.62 (1.42-1.84) <0.001	1.64 (1.03-1.31) 0.013	1.38 (1.24-1.53) <0.001	1.12 (.963-1.31) 0.139
Smoking				
Current smoker	1.35 (1.21-1.50) <0.001	5.64 (5.05-6.29) <0.001	3.14 (2.87-3.45) <0.001	8.91 (7.64-10.4) <0.001
Former smoker	1.15 (1.07-1.25) <0.001	4.00 (3.64-4.40) <0.001	1.86 (1.72-2.00) <0.001	6.17 (5.35-7.11) <0.001
Never smoked	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Smoking Indoors				
No	1.0 (reference0	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.44 (1.29-1.61) <0.001	2.78 (2.52-3.06) <0.001	2.32 (2.12-2.54) <0.001	3.32 (3.00-3.71) <0.001
Saw Cockroach past 30 days				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0(reference)
Yes	1.05 (.927-1.18) 0.454	1.15 (1.02-1.31) 0.026	1.15 (1.03-1.28) 0.015	1.36 (1.16-1.58) <0.001
Saw Mice past 30 days				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.23 (1.07-1.43) 0.006	1.15 (.996-1.34) 0.056	1.15 (1.01-1.31) 0.036	1.12 (.926-1.35) 0.245
Asthma cause by Previous				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.16 (1.94-2.39) <0.001	2.49 (2.27-2.73) <0.001	2.46 (2.27-2.67) <0.001	2.31 (2.05-2.60) <0.001
Medical Cost				
No	1.0 (reference)	1.0 (reference)	1.0(referemce)	1.0(reference)
Yes	1.37 (1.23-1.52) <0.001	1.21 (1.09-1.34) <0.001	1.89 (1.73-2.05) <0.001	1.31 (1.56-1.49) <0.002

[a]Unadjusted odd ratio for each socio-demographic, indoor environmental factors and CLRD.
[b]95% Confidence interval for multivariable logistic regression model.
[c]P-value for multivariable logistic regression for all variables included in the model.
[d]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" include Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

Socio-demographic factors and CLRD 2009 – Model 1

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI) [b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.67 (1.51-1.84) <0.001	1.03 (1.07-1.27) 0.001	1.53 (1.37-1.71) <0.001	.621 (.529-.729) <0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.67 (1.40-2.01) <0.001	5.79 (3.01-11.1) <0.001	1.35 (1.07-1.70) <0.001	3.53 (1.58-7.88) 0.002
45-54	1.72 (1.46-2.02) <0.001	14.9 (8.01-27.5) <0.001	2.20 (1.80-2.68) <0.001	10.2 (2.94-20.9) <0.001
55-64	1.89 (1.61-2.22) <0.001	22.0 (12.0-40.5) <0.001	2.55 (2.10-3.09) <0.001	15.8 (7.74-32.2) <0.001
65+	2.01 (1.66-2.44) <0.001	28.9 (15.6-53.4) <0.001	2.13 (1.88-2.87) <0.001	23.6 (11.5-48.6) <0.001
Race/Ethnicity [d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	.888 (.726-1.09) <0.249	.571 (.438-.744) <0.001	.900 (.740-1.09) 0.289	.441 (.311-6.25) <0.001
Hispanic	.453 (.381-.537) 0.001	.495 (.381-.644) <0.001	.740 (.612-895) 0.002	.570 (.419-.777) 0.570
Other race	1.00 (.836-1.20) 0.971	.689 (.543-.875) 0.002	1.06 (.888-1.26) 0.536	.656 (.288-.881) 0.656
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	1.12 (.992-1.25) <0.069	1.06 (.909-1.24) 0.457	1.05 (.940-1.19) 0.349	1.25 (1.03-1.51) 0.021
Widowed/Separated	.945 (.808-1.11) <0.478	1.14 (.966-1.36) 0.119	1.09 (.938-1.26) 0.269	1.31 (1.03-1.67) 0.018
Education				
Did not Graduate High School	1.38 (1.12-1.70) 0.002	2.37 (1.90-2.96) <0.001	2.02 (1.68-2.43) <0.001	3.16 (2.41-4.14) <0.001
Graduated High School	1.22 (1.07-1.39) 0.003	1.89 (1.59-2.24) <0.001	1.65 (1.44-1.89) <0.001	2.61 (2.09-3.26) <0.001
Attended College /Tech School	1.12 (.991-1.26) 0.069	1.65 (1.40-1.96) <0.001	1.50 (1.32-1.70) <0.001	1.73 (1.28-2.17) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	1.03 (.851-1.26) 0.741	1.51 (1.16-1.98) 0.002	1.15 (.951-1.40) 0.146	1.68 (1.20-2.36) 0.003
Homemaker	.851 (.701-1.03) 0.101	1.63 (1.25-2.12) 0.001	1.04 (.854-1.28) 0.655	1.68 (1.18-2.36) 0.004
Retired	.926 (.794-1.08) 0.325	1.67 (1.39-2.01) <0.001	1.16 (.996-1.35) 0.056	1.85 (1.47-2.33) <0.001
Unable Work	1.63 (1.38-1.92) <0.001	3.07 (2.55-3.70) <0.001	1.81 (1.57-2.10) <0.001	3.24 (2.57-4.09) <0.001
Income				
<$15000	1.34 (1.10-1.63) 0.004	2.52 (1.94-3.27) <0.001	2.69 (2.20-3.28) <0.001	2.42 (1.72-3.39) <0.001
$15000-$24999	1.30 (1.09-1.55) 0.003	1.97 (1.55-2.52) <0.001	2.07 (1.73-2.48) <0.001	1.94 (1.41-2.66) <0.001
$25000-$49999	1.08 (.942-1.23) 0.264	1.76 (1.42-2.20) <0.001	1.71 (1.46-2.00) <0.001	1.68 (1.25-2.25) 0.001
$50000-$74999	1.04 (.893-1.20) 0.645	1.44 (1.12-1.84) 0.040	1.37 (1.15-1.64) <0.001	1.15 (.814-1.62) 0.428
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Adjusted for gender, age, race/ethnicity, marital status, education, employment and income.

Socio-demographic factors and CLRD 2010 – Model 1

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI) [b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.77 (1.63-1.93) <0.001	.943 (.854-1.05) 0.303	1.44 (1.32-1.59) <0.001	.548 (.477-.619) <0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.52 (1.30-1.78) <0.001	2.93 (1.78-4.84) <0.001	1.93 (1.56-2.37) <0.001	1.61 (.878-2.97) 0.123
45-54	1.51 (1.31-1.74) <0.001	10.5 (6.72-16.2) <0.001	2.84 (2.36-3.41) <0.001	5.60 (3.42-9.18) <0.001
55-64	1.72 (1.49-1.97) <0.001	13.6 (8.85-21.0) <0.001	3.11 (2.60-3.73) <0.001	8.62 (5.31-14.0) <0.001
65+	1.42 (1.21-1.67) <0.001	18.3 (11.8-28.6) <0.001	2.91 (2.39-3.54) <0.001	13.5 (8.23-22.1) <0.001
Race/Ethnicity [c]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	1.03 (.885-1.21) 0.679	.488 (.404-.591) 0.001	.798 (.690-.923) 0.002	.574 (.457-.722) <0.001
Hispanic	.701 (.599-.822) <0.001	.311 (.240-.403) <0.001	.664 (.559-.689) <0.001	.395 (.291-.536) <0.001
Other race	.913 (.785-1.06) 0.238	.889 (.736-1.07) 0.222	.923 (.792-1.08) 0.308	.845 (.670-1.07) 0.153
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	0.97 (.878-1.07) 0.491	1.03 (.904-1.17) 0.676	1.01 (.921-1.11) 0.885	1.15 (.978-1.34) 0.093
Widowed/Separated	1.07 (.940-1.23) 0.294	1.33 (1.16-1.52) <0.001	1.14 (1.02-1.49) 0.028	1.14 (.962-1.35) 0.131
Education				
Did not Graduate High School	1.40 (1.18-1.67) <0.001	1.80 (1.49-2.16) <0.001	1.66 (1.42-1.94) <0.001	3.17 (2.54-3.97) <0.001
Graduated High School	1.29 (1.16-1.44) <0.001	1.60 (1.02-1.69) <0.001	1.36 (1.22-1.52) <0.001	2.19 (1.82-2.64) <0.001
Attended College /Tech School	1.11 (1.00-1.22) 0.046	1.53 (1.34-1.75) <0.001	1.36 (1.21-1.49) <0.001	2.02 (1.68-2.43) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	1.03 (.876-1.20) 0.747	1.85 (1.49-2.30) <0.001	1.45 (1.24-1.94) <0.001	1.93 (1.46-2.54) <0.001
Homemaker	1.07 (.901-1.27) 0.452	1.41 (1.02-1.95) 0.007	1.02 (.848-1.23) 0.858	1.33 (.955-1.84) 0.091
Retired	1.34 (1.18-1.52) <0.001	2.16 (1.85-2.52) <0.001	1.45 (1.27-1.63) <0.001	2.00 (1.63-2.44) <0.001
Unable Work	1.82 (1.58-2.10) <0.001	4.06 (3.47-4.76) <0.001	2.33 (2.06-2.64) <0.001	3.09 (2.52-3.78) <0.001
Income				
<$15000	1.40 (1.18-1.66) <0.001	3.02 (2,41-3.79) <0.001	2.54 (2.14-3.01) <0.001	2.28 (2.28-4.10) <0.001
$15000-$24999	1.23 (1.07-1.42) 0.005	2.74 (2.23-3.37) <0.001	2.34 (2.02-2.74) <0.001	2.02 (2.03-3.51) <0.001
$25000-$49999	1.12 (.997-1.26) 0.056	2.04 (1.69-2.48) <0.001	1.86 (1.63-2.13) <0.001	1.90 (1.46-2.46) <0.001
$50000-$74999	1.06 (.938-1.20) 0.346	1.54 (1.24-1.91) <0.001	1.28 (1.10-1.49) <0.001	1.26 (.934-1.71) 0.128
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Adjusted for gender, age, race/ethnicity, marital status, education, employment and income

Socio-demographic factors and CLRD 2011 – Model 1

Factors	Current Asthma OR [a] (95% CI)[b] P-Value [c]	COPD OR (95% CI) P-Value	Bronchitis OR (95% CI) P-Value	Emphysema OR [a] (95% CI) [b] P-Value [c]
Sex				
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	1.66 (1.50-1.80) <0.001	.844 (.755-.944) 0.003	1.41 (1.28-1.56) <0.001	.529 (.462-.605) <0.001
Age, year range				
18-34	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
35-44	1.32 (1.11-1.58) <0.001	7.06 (3.82-13.1) <0.001	1.81 (1.46-2.26) <0.001	3.36 (1.70-6.64) <0.001
45-54	1.49 (1.27-1.75) <0.001	16.3 (9.05-29.2) <0.001	2.70 (2.21-3.28) <0.001	7.54 (4.01-14.0) <0.001
55-64	1.48 (1.27-1.73) <0.001	25.6 (14.3-45.7) <0.001	2.98 (2.47-3.61) <0.001	11.5 (6.34-21.2) <0.001
65+	1.68 (1.40-2.01) <0.001	34.8 (19.4-62.5) <0.001	2.93 (2.38-3.60) <0.001	16.3 (8.81-30.3) <0.001
Race/Ethnicity[d]				
Whites	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Blacks	.968 (.842-1.15) 0.860	.541 (.453-.647) 0.001	.770 (.667-.890) 0.001	.481 (.381-.608) 0.001
Hispanic	.804 (.684-.946) 0.009	.327 (.258-.413) <0.001	.646 (.547-.763) 0.001	.476 (.363-.625) <0.001
Other race	1.02 (.864-1.20) 0.820	.851 (.703-1.03) 0.099	.962 (.882-1.13) 0.613	.986 (.783-1.24) 0.904
Marital Status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Single	.923 (.831-1.03) 0.133	.988 (.870-1.12) 0.847	1.02 (.922-1.13) 0.683	1.13 (.964-1.33) 0.129
Widowed/Separated	.924 (.805-1.06) 0.266	1.12 (.078-1.29) 0.100	1.15 (1.02-1.30) 0.028	1.38 (1.13-1.68) 0.001
Education				
Did not Graduate High School	1.35 (1.12-1.63) 0.002	2.04 (1.67-2.46) <0.001	1.71 (1.45-2.00) <0.001	3.43 (2.72-4.33) <0.001
Graduated High School	1.30 (1.15-1.47) <0.001	1.75 (1.52-2.02) <0.001	1.36 (1.21-1.53) <0.001	2.70 (2.24-3.37) <0.001
Attended College /Tech School	1.01 (.951-1.18) 0.298	1.58 (1..38-1.81) <0.001	1.39 (1.25-1.55) <0.001	1.67 (1.37-2.02) <0.001
Graduated College /Tech School	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Employment				
Employed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Unemployed	.948 (.824-1.18) 0.862	1.55 (1.23-1.95) <0.001	1.45 (1.23-1.73) <0.001	1.65 (1.21-2.23) 0.001
Homemaker	.917 (.726-1.10) 0.358	1.24 (.970-1.60) 0.086	.936 (.775-1.13) 0.489	1.34 (.957-1.87) 0.089
Retired	1.02 (.888-1.16) 0.832	1.72 (1.47-2.01) <0.001	1.20 (1.06-1.37) 0.005	1.94 (1.58-2.39) <0.001
Unable Work	1.49 (1,29-1.72) <0.001	3.84 (3.28-4.50) <0.001	2.30 (2.02-2.61) <0.001	3.18 (2.58-3.93) <0.001
Income				
<$15000	1.58 (1.32-1.90) <0.001	2.74 (2.20-3.40) <0.001	2.12 (1.78-2.51) <0.001	2.45 (1.83-3.27) <0.001
$15000-$24999	1.28 (1.10-1.50) <0.001	2.57 (2.10-3.13) 0.001	2.29 (1.96-2.67) <0.001	2.31 (1.76-3.03) <0.001
$25000-$49999	1.18 (1.04-1.34) <0.001	1.81 (1.51-2.18) 0.001	1.47 (1.28-1.69) <0.001	1.58 (1.22-2.05) 0.001
$50000-$74999	1.09 (.949-1.24) 0.230	1.18 (.954-1.46) 0.101	1.14 (.975-1.33) <0.001	1.16 (.859-1.57) 0.330
≥$75000	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

Adjusted for gender, age, race/ethnicity, marital status, education, employment and income

Bivariate analyses of selected Indoor Environmental Factors related to Socio-demographic Factors -2009

Factors	Mold P-value [a] n(%) [b]	Cockroach P-value n(%)	Mice P-value n(%)	Smoke Indoor P-value n(%)	Medical Cost P-value n(%)	Work Environment P-value [a] n(%)[b]
Gender	<0.001	0.111	0.487	0.932	<0.001	0.258
Male	401 (8.7)	392 (8.4)	307 (6.6)	697 (15.0)	577 (12.4)	788 (20.1)
Female	1225 (11.4)	992 (9.2)	742 (6.9)	1617 (15.0)	1842 (17.2%)	1762 (19.3)
Age, year range	<0.001	0.242	0.008	<0.001	<0.001	<0.001
18-34	149 (12.2)	136 (11.2)	104 (8.5)	221 (18.1)	255 (21.0)	117 (10.6)
35-44	166 (12.9)	113 (8.8)	90 (7.0)	228 (17.7)	204 (19.1)	169 (15.2)
45-54	336 (14.6)	246 (10.7)	197 (5.6)	468 (20.3)	480 (20.9)	400 (20.7)
55-64	317 (11.1)	293 10.2)	220 (7.7)	511 (17.9)	502 (17.6)	582 (24.5)
65+	205 (6.6)	301 (9.7)	190 (6.1)	311(10.0)	200 (6.5)	514 (20.2)
Race/Ethnicity [c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Whites	1236 (10.1)	724 (5.2)	773 (6.3)	1717 (14.0)	1751 (14.3)	1932 (18.2)
Blacks	122 (13.9)	153 (17.2)	75 (8.5)	219 (24.7)	183 (20.6)	201 (27.4)
Hispanic	141 (13.0)	288 (26.5)	105 (9.6)	126 (11.6)	261 (24.0)	190 (23.6)
Other race	117 (11.6)	207 (20.4)	87 (8.6)	228 (22.5)	212 (20.9)	205 (25.0)
Marital Status	<0.001	<0.001	0.092	<0.001	<0.001	<0.001
Married	749 (9.5)	590 (7.5)	540 (6.8)	791 (10.0)	985 (12.5)	1199 (17.5)
Single	681 (13.8)	537 (10.8)	360 (7.2)	1123 (22.6)	1076 (21.7)	914 (21.9)
Widowed/Separated	193 (7.8)	235 (10.3)	145 (5.9)	391 (15.9)	352 (14.2)	434 (21.6)
Education	0.422	<0.001	<0.001	<0.001	<0.001	<0.001
Did not Graduate High School	151 (11.0)	224 (16.4)	142 (10.3)	436 (31.4)	314 (22.6)	299 (31.2)
Graduated High School	391 (9.9)	378 (9.5)	257 (6.5)	800 (20.2)	761 (19.3)	726 (22.3)
Attended College /Tech School	479 (10.8)	355 (7.9)	308 (6.9)	726 (16.2)	811 (18.1)	801 (20.7)
Graduated College /Tech School	603 (10.9)	426 (7.7)	341 (6.1)	349 (6.3)	530 (9.5)	718 (14.5)
Employment	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Employed	756 (10.8)	546 (7.8)	475 (6.8)	785 (11.2)	978 (14.0)	768 (12.8)
Unemployed	528 (15.3)	386 (11.1)	311 (8.9)	1052 (30.3)	374 (36.0)	900 (30.9)
Homemaker	124 (11.1)	135 (11.9)	85 (7.5)	134 (11.8)	186 (16.5)	143 (15.4)
Retired	215 (5.7)	315 (8.4)	175 (4.7)	337 (9.0)	233 (6.2)	737 (23.1)
Unable to work	379 (15.5)	379 (11.0)	224 (9.1)	766 (31.0)	648 (26.2)	766 (31.9)
Income	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
<$15000	326 (14.9)	335 (15.5)	216 (9.8)	688 (31.2)	643 (29.2	527 (30.3)
$15000-$24999	274 (10.9)	274 (10.8)	182 (7.2)	558 (22.0)	627 (24.8)	556 (26.5)
$25000-$49999	376 (10.7)	272 (7.8)	226 (6.4)	471 (13.4)	585 (16.7)	603 (20.2)
$50000-$74999	190 (9.0)	143 (6.8)	111 (5.3)	180 (8.5)	197 (9.3)	260 (14.0)
≥$75000	298 (8.6)	195 (5.6)	210 (6.1)	189 (5.4)	158 (4.6)	373 (12.0)

[a]P-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.
[b]Sub-sample (n) is the number of observation for each variable followed by the proportion in percentages (%).
[c]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.4.1 Distribution of Indoor Environmental Factors among different Socio demographic groups for 2009

The results show that high proportion of females (11.4%), blacks (13.9%), Hispanics (13.0%), other race groups (11.6%), singles (13.8%), unemployed (15.3%), unable to work participants and those with annual household income <$15000 (14.9%) reported seeing mold in the past 30 days. Those age 18-34 reported cost as a barrier to healthcare; aged group 45-54 reported more mold and smoke indoors, age group 55-64 reported more occupational exposures. More blacks (17.2%), Hispanics (26.5%) and other race groups (20.4%), singles (10.8%) and widowed/separated (10.3), non-high school graduates (16.4%), and those with annual household income <$15000 (15.5%) reported seeing cockroach in the past 30 days, while high proportions of non-high school graduates (10.3%), unable to work participants (9.1%) and those with annual income <$15000 (9.8%) reported seeing mice in the past 30 days. More blacks (24.7%) and other race groups (22.5%), singles (22.6%), and widow/separated (15.9%), non-high school graduates (31.4%), unemployed (30.1%), unable to work participants (31.0%) and those with annual household income <$15000 (31.2%) reported smoking indoor. More females, Hispanics, those that did not graduate high school, unemployed and those with annual household income <$15000 reported medical cost as a barrier to healthcare. Occupational exposure was identified by more males, blacks (27.4%), Hispanics (23.6%), other race (25.5%), singles (21.9%), widowed/separated participants (21.6%), non-high school graduates (31.2%), unemployed (30.9%), unable to work participants (31.9%) and those with household income <$15000 (30.3%).

Bivariate analyses of selected Indoor Environmental Factors related to Socio-demographic Factors 2010

Factors	Mold P-value [a] n(%) [b]	Cockroach P-value n(%)	Mice P-value n(%)	Smoke Indoor P-value n(%)	Medical Cost P-value n(%)	Work Environment P-value [a] n(%)[b]
Gender	<0.001	0.097	0,403	0.138	<0.001	0.013
Male	434 (8.2)	503 (9.5)	380 (7.2)	804 (15.2)	878 (12.8)	979 (22.3)
Female	1387 (11.2)	1088 (8.7)	850 (6.8)	1784 (14.3)	2236 (18.0)	2141 (20.4)
Age, year range	<0.001	<0.001	<0.001	<0.001	<0.001	<0..001
18-34	184 (11.6)	178 (11.2)	125 (7.9)	249 (15.6)	395 (24.8)	182 (12.9)
35-44	220 (12.8)	154 (8.9)	132 (7.6)	256 (14.8)	378 (21.9	235 (15.6)
45-54	488(14.2)	308 (9.7)	245 (7.7)	645 (20.4)	710 (22.4)	548 (20.9)
55-64	482 (`11.4)	435 (10.3)	341 (8.0)	722 (17.0)	761 (17.9)	825 (23.3)
65+	309 (11.8)	476 (9.9)	285 (5.9)	455 (9.5)	336 (7.0)	906 (23.1)
Race/Ethnicity [c]	<0.001	<0.001	<0.001	<0.001	<0..001	<0.001
Whites	1332 (9.6)	819 (5.6)	904 (6.5)	1849 (13.2)	1998 (14.3)	2280 (19.2)
Blacks	152 (11.2)	236 (17.3)	137 (10.0)	364 (26.6)	361 (26.5)	308 (28.4)
Hispanic	175 (16.7)	279 (26.3)	75 (7.1)	130 (12.3)	275 (26.0)	220 (27.0)
Other race	137 (11.7)	238 (20.2)	100 (8.5)	218 (18.5)	253 (21.4)	274 (27.5)
Marital Status	<0.001	<0.001	0.057	<0.001	<0.001	<0.001
Married	791 (8.9)	675 (7.5)	595 (6.6)	840 (9.4)	1136 (12.7)	1435 (18.6)
Single	768 (13.3)	601 (10.4)	440 (7.6)	1247 (21.5)	272 (11.0)	1115 (23.3)
Widowed/Separated	255 (8.7)	311 (10.6)	193 (6.5)	496 (16.8)	224 (9.1)	562 (24.0)
Education	<0.001	<0.001	0.011	<0.001	<0.001	<0.001
Did not Graduate High School	224 (13.1)	315 (18.3)	153 (8.8)	513 (29.6)	467 (27.1)	442 (36.3)
Graduated High School	408 (8.9)	401 (8.7)	316 (6.9)	919 (20.0)	821 (17.9)	909 (24.4)
Attended College /Tech School	540 (10.6)	414 (8.1)	344 (6.8)	779 (15.3)	985 (19.4	951 (21.8)
Graduated College /TechSchool	644 (10.3)	460 (7.3)	415 (6.6)	372 (5.9)	637 (10.1	813 (14.7)
Employment	<0.001	<0.001	<0.001	<0.001	<0..001	<0.001
Employed	725 (9.8)	529 (7.1)	519 (7.0)	776 (10.4)	1070 (14.4)	818 (12.8)
Unemployed	198 (15.9)	140 (11.2)	113 (9.0)	301 (24.0)	476 (37.9)	300 (27.4)
Homemaker	151 (12.3)	130 (10.6)	86 (7.0)	136 (11.1)	214 (17.5)	171 (17.2)
Retired	278 (5.9)	380 (8.0)	255 (5.3)	452 (9.5)	302 (6.3)	976 (24.5)
Unable to work	469 (15.6)	412 (13.6)	257 (8.5)	923 (30.5)	852 (28.1)	855 (35.6)
Income	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
<$15000	428 (16.0)	407 (15.1)	258 (9.6)	787 (29.1)	804 (29.9)	713 (33.9)
$15000-$24999	353 (11.9)	315 (10.5)	208 (6.9)	633 (21.1)	773 (25.8)	699 (28.3)
$25000-$49999	392 (9.6)	306 (7.4)	261 (6.3)	554 (13.5)	658 (16.0)	690 (19.8)
$50000-$74999	220 (9.1)	154 (6.3)	156 (6.4)	205 (8.4)	235 (9.7)	314 (15.1)
≥$75000	263 (7.2)	219 (6.0)	218 (5.9)	129 (3.5)	147 (4.0)	374 (11.3)

[a]P-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.
[b]Sub-sample (n) is the number of observation for each variable followed by the proportion in percentages (%).
[c]Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race.

5.4.2 Distribution of Indoor Environmental Factors among different Socio-demographic group for 2010

Table 4.2 summarizes the distribution of selected indoor environmental factors among selected socio-demographic groups for 2010. The results were consistent with the findings for 2009. Saw or smelled mold in the past 30 days was reported by more females (11.2%), Hispanics (16.7 %), singles (13.3%), non-high school graduates (13.1%), unemployed (15.9%), unable to work participants (15.6) and those with annual income <$15000 (16.0%). Saw cockroach inside the home in the past 30 days, was reported by more Hispanics (26.3%), other race (20.2%), singles, widowed/separated, participants, non-high school graduates, unable to work participants and participants with annual household income <$15000. Saw mice inside the home in the past 30 days was reported by 10.3% of blacks, 8.8% of non-high school graduates and 9.6% of those with annual income <$15000. Smoke indoors was reported by more blacks (26.6%) and other race (18.5%), singles (21.5%), non-high school graduates (29.6%), unemployed (24%), unable to work (30.5) and participants with annual household income <$15000 (29.1%). Medical cost was reported by more females, blacks, Hispanic, non-high school graduate, unable to work and those with income <$15000. Occupational exposure was reported by more males (22.3%), blacks (28.4%), Hispanics (27.0%) other race (27.5%), singles (23.3%) widowed/separated (24.0%), non-high school graduates (36.3%), unemployed (33.1%), and among participants with annual household income <$15000 (33.9%). These findings suggest that more females except for occupational exposure, blacks, Hispanics, other race groups, singles, non-high school graduates, unable to work, unemployed and those with annual household income <$15000 were more likely to report poor indoor environmental conditions such as mold, pest infestation, indoor smoking, occupational exposure and cost as a barrier to medical care.

Bivariate Analyses of selected Indoor Environmental Factor Related to Socio-demographic Factors -2011

Factors	Mold P-value [a] n(%) [b]	Cockroach P-value n(%)	Mice P-value n(%)	Smoke Indoors P-value n(%)	Medical Cost P-value n(%)	Work Environment P-value [a] n(%) [b]
Gender	<0.001	0.699	0.055	0.045	<0.001	<0.001
Male	427 (9.0)	454 (9.5)	352 (7.4)	709 (14.8)	610 (12.7)	987 (24.7)
Female	1352 (11.4)	1151 (9.7)	776 (6.5)	1618 (13.6)	2125 (17.9)	2144 (21.4)
Age, year range	<0.001	0.557	<0.001	<0..001	<0.001	<0..001
18-34	152 (11.8)	138 (10.7)	95 (7.4)	187 (14.5)	306 (23.7)	182 (12.9)
35-44	192 (12.7)	147 (9.7)	96 (6.3)	231 (15.3)	343 (22.7)	235 (15.6)
45-54	365 (14.2)	295 (11.5)	217 (8.4)	534 (20.7)	604 (23.4)	548 (20.9)
55-64	500(12.6)	431 (10.8)	284 (7.1)	692 (17.4)	747 (18.8)	825 (23.3)
65+	357 (7.5)	515 (10.8)	274 (5.7)	416 (8.7)	337 (7.0)	906 (23.1
Race/Ethnicity [c]	<0.001	<0.001	0.004	<0.001	<0.001	<0.001
Whites	1248 (9.6)	804 (6.2)	832 (6.4)	1665 (12.8)	1853 (14.3)	2308 (20.8)
Blacks	162 (12.5)	262 (20.0)	112 (8.6)	304 (23.1)	]338 (25.7)	299 (28.6)
Hispanic	221 (19.6)	301 (26.6)	83 (7.3)	124 (11.0)	266 (23.5)	239 (27.6)
Other race	133 (12.1)	218 (19.8)	90 (8.1)	207 (18.8)	247 (22.4)	252 (27.5)
Marital Status	<0.001	<0.001	0.917	<0.001	<0.001	<0.001
Married	824 (10.0)	668 (8.1)	554 (6.7)	761 (9.2)	1065 (12.9)	1393 (19.6)
Single	656 (12.2)	598 (11.1)	370 (6.8)	1111 (20.6)	1212 (22.4)	1092 (24.4)
Widowed/Separated	293 (10.0)	335 (11.4)	203 (6.9)	448 (15.2)	448 (15.2)	637 (26.5)
Education	<0.001	<0.001	0.012	<0.001	<0.001	<0.001
Did not Graduate High School	205 (13.3)	289 (18.6)	134 (8.6)	437 (28.2)	403 (26.00	415 (38.1)
Graduated High School	411 (9.6)	404 (9.4)	297 (6.9)	808 (18.8)	546 (17.3)	887 (25.5)
Attended College /Tech School	534 (11.0)	406 (8.3)	323 (6.6)	723 (14.8)	971 (19.9)	990 (23.7)
Graduated College/Tech School	627 (10.6)	506 (8.6)	373 (6.3)	358 (6.0)	613 (10.4)	835 (15.9)
Employment	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Employed	699 (10.8)	493 (7.6)	458 (7.1)	661 (10.2)	947 (14.7)	755 (13.8)
Unemployed	179 (16.9)	123 (11.6)	83 (7.8)	251 (23.6)	410 (38.5)	262 (28.1)
Homemaker	135 (11.9)	140 (12.3)	79 (6.9)	108 (9.4)	193 (16.9)	161 (17.8)
Retired	305 (6.2)	450 (9.1)	265 (5.4)	417 (8.4)	317 (6.4)	1125 (26.3)
Unable to work	461 (15.2)	399 (13.0)	243 (7.9)	890 (29.1)	868 (28.4)	828 (34.0)
Income	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
<$15000	434 (16.5)	428 (16.2)	212 (8.0)	750 (28.3)	757 (28.6)	732 (34.7)
$15000-$24999	309 (10.7)	333 (11.5)	225 (7.7)	563 (19.3)	793 (27.2)	654 (27.5)
$25000-$49999	383 (10.3)	332 (8.9)	248 (6.7)	451 (12.1)	596 (16.0)	728 (23.0)
$50000-$74999	221 (10.1)	143 (6.5)	147 (6.7)	173 (7.9)	183 (8.3)	318 (16.6)
≥$75000	274 (8.1)	205 (6.0)	191 (5.6)	146 (4.3)	149 (4.4)	399 (13.1)

[a] *P*-value for the Chi-square test to determine whether there is a significant relationship between two categorical variables.
[b] Sub-sample (n) is the number of observation for each variable followed by the proportion in percentages (%).
[c] Race categories included "white, non-Hispanic" "blacks, non-Hispanics" included only persons who indicated only a single race group. "Other races, non-Hispanic" includes Asian, American Indians Alaska Native, Native Hawaiian, Other Pacific Islander, persons reporting more than one race or any other race

5.4.3 Distribution of Indoor Environmental Factors among different Socio demographic groups for 2011

Table 4.3 summarizes the results of the distribution of selected indoor environmental factors among selected socio-demographic groups for 2011. The results from 2011 are consistent with the findings of 2009 and 2010. Saw or smelled mold in the past 30 days was reported by more females (11.4%), Hispanics (19.6%), single participants (12.2%), non-high school graduates (13.3%), unemployed (15.6%) and those with income <$15000 (16.5%). Saw cockroach in the past 30 days, was reported by more blacks (20.0%), Hispanics (26.6%) and other race (19.8%), singles (11.1%) and widowed/separated participants (11.4), non-high school graduates (18.6%), unable to work participants (13.0%), and those with income <$15000 (15.1%). For saw mice in the past 30 days, only a small difference in proportion was observed within groups for race/ethnicity, marital status, education, employment status and income. Smoke indoors was reported by more blacks (23.1%), singles (20.6%), non-high graduates (28.2%), unable to work participants (29.1%), and participants with annual income <$15000 (28.3%). Medical cost was reported by more females, single, non-high school graduates, unemployed participants and those with income <$15000. Occupational exposure was reported by more males (24.7%), blacks (28.6%), Hispanics (27.6%) other race (27.5%), singles (24.4%), widowed/separated (26.5%), non-high school graduates (38.1%), unable to work participants (34.0%), and among subjects with annual household income <$15000 (34.7%). These results revealed that more females, except for occupational exposure, blacks, Hispanics, other race groups, singles, non-high school graduates, unemployed, unable to work participants and those with annual household income <$15000 were more likely to report poor indoor environmental conditions such as mold, pest infestation, indoor smoking, occupational exposure and cost as a barrier to medical care.