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North Minneapolis Residents' Knowledge and Awareness of Indoor Air Quality in Older
Residences

By

Blisse Cajacob

A Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of
Community Health Education

Minnesota State University, Mankato

Mankato, Minnesota

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North Minneapolis Residents' Knowledge and Awareness of Indoor Air Quality in Older Residences

Blisse Cajacob

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Abstract

North Minneapolis Residents' Knowledge and Awareness of Indoor Air Quality in Older Residences

Blisse Cajacob, M.S. Minnesota State University, Mankato, May 2016

Older housing stock is one suspected cause of poor indoor air quality and poor indoor air quality can cause many negative health conditions. Four hazardous conditions related to indoor air quality were examined for this study: lead, asbestos, dampness causing mold and radon. North Minneapolis residents, specifically low-income, disproportionately live in older stock houses and have higher rates of asthma compared to other parts of the state. In this study, data was collected to understand North Minneapolis residents' knowledge and awareness of indoor air quality in older residences. Fifteen minute interviews followed by a brief sociodemographic questionnaire were used to explore North Minneapolis residents' level of knowledge and awareness. The results suggest a lack of awareness and knowledge around indoor air quality as well as its causes and effects. Most of the participants wanted more information on how to test their indoor air quality and simple things that could be done to improve it. Recommendations for health education specialists include providing and promoting education on indoor air quality. This would include ways to test and to improve indoor air quality. Health educators could also help residents and neighborhood organizations with grant applications to replace older hazardous materials.

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Chapter One: Statement of the Problem

Introduction

As evidence connecting negative health effects to poor indoor air quality (IAQ) continues to grow, effective strategies to improve IAQ are becoming a serious and growing challenge for the public health sector. Poor IAQ can cause negative health conditions, including asthma, allergies, lead poisoning, respiratory illness and cancer (Laquatra, Maxwell, & Pierce, 2005). One suspected cause of poor IAQ is hazardous conditions related to older housing stock, certain aspects of which have been found to cause adverse health effects (Dales, Liu, Wheeler, & Gilbert, 2008). Low-income residents in North Minneapolis disproportionately occupy residences with older housing stock (Metropolitan Council, 2015). This thesis endeavored to give insight on North Minneapolis residents regarding their housing conditions as well as related health concerns.

Statement of the Problem

Low-income residents in the Twin Cities Metropolitan area are more likely to live in older housing stock with hazardous materials and conditions. According to Metropolitan Council (2015) these residents disproportionately occupying residences with older housing stock are often minorities. A number of hazardous conditions have been found in older housing stock including lead, asbestos, mold caused by dampness, and radon (Metropolitan Council, 2015). These conditions negatively impact the IAQ of the home and, in turn, the health of the residents. Families that fall below the federal poverty threshold of \$24,250 for a family of four are more likely to be exposed to hazardous conditions resulting from older housing stock. This exposure leads to higher rates of hospitalizations, emergency room visits, premature death and long-term

behavioral consequences among low-income minority populations (Johnson, Nriago, Hammad, Savoie, & Jamil, 2008).

Lead poisoning is a serious health issue, especially for children. Exposure to lead is primarily due to lead-based household paint; however it can also be found in water and soil. Although lead-based paint was banned in 1977, 83-86% of houses in the U.S. built before 1978 have lead-based paint. Older houses with lead-based paint are of concern as exposure can come when the paint is chipped or peeled. Lead poisoning can cause loss of biological and neurologic functions which can impact intelligence levels and cause behavioral issues (Laquatra, Maxwell, & Pierce, 2005). On average, 70% of childhood lead exposure is from lead based paint in the household (Gould, 2009).

Lead can also contaminate water. In 2014, the city of Flint, Michigan, changed its water supply to the Flint River. This older system with higher amounts of lead pipes and plumbing caused lead to leak into the drinking water. Since 1986 lead has not been allowed in plumbing materials; however, older homes may still have lead-based plumbing materials (Hanna-Attisha, LaChance, Sadler, & Schnepf, 2016).

Another hazardous building material, asbestos, was used from 1940 into the 1970's. It can be found in insulation, floor tiles, roofing tiles, ceiling texture materials and siding in older homes (Spear et al., 2012). After finding that asbestos was a carcinogen and could cause multiple health issues when inhaled, it was banned from many products in the 1970's. However, housing stock from this era which has not been maintained or upgraded can pose substantial risk to IAQ and the health of residents (Laquatra, Maxwell, & Pierce, 2005).

Older houses have many conditions that can lead to dampness (Laquatra & Maxwell, 2005). A moist and warm atmosphere from a damaged foundation, roof or heating and cooling equipment in older houses can be the perfect place for mold to grow (Centers for Disease Control & Prevention [CDC], 2015). Similarly, Mendell, Mirer, Cheung, Tong, and Douwes (2011) found evidence of a sufficient association between indoor dampness and many respiratory or allergic health effects. Dampness related risk factors in residences were associated with a 50% increase in asthma (Mendell et al., 2011). Epidemiologic studies found increased asthma and upper respiratory tract symptoms to be associated with indoor dampness or mold (Fisk, Lei-Gomez, & Mendell, 2007).

Radon gas is another potential IAQ health concern. Radon is a known carcinogen and long-term exposure causes 21,000 deaths each year in the U.S., making it the second leading cause of lung cancer behind tobacco smoke (Laquatra, Maxwell, & Pierce, 2005). The Environmental Protection Agency (EPA) states that exposure is preventable with awareness and testing (EPA, 2016). Better ventilation and drainage systems lead to lower radon levels in housing (Sundell, 2004); poor ventilation and drainage systems are common issues with older housing stock (Laquatra, Maxwell, & Pierce, 2005).

It should be noted that there are many potential factors that can contribute to poor IAQ and have resulting negative effects on human health. These factors include (but are not limited to): carbon dioxide, poor outdoor air intake, contaminated outdoor air, temperature, chemicals, bacteria, gases, dust, maintenance activities, and human activity such as cooking, smoking, and remodeling (Brandt et al., 2006; CDC, 2015). This study did not attempt to conclusively link the independent variables to poor IAQ and adverse health effects. Instead, this study attempted to ascertain the awareness of residents to the existence of these variables, the potential impacts they

have on human health, and the ability to act on this knowledge. In fact, this study methodology could be used to assess numerous potential factors of IAQ in addition to lead, asbestos, dampness, and radon. These specific factors were chosen for this study because of their prevalence in the literature review and the overwhelming conclusive links to adverse human health effects.

Significance of the Problem

Up to 90% of the day is spent indoors (Wellington, Kozak, & Cohen, 2008). While IAQ is directly connected to respiratory infections, allergies and lung cancer (Sundell, 2004), poor IAQ was found to be one of the main causes in the increase of respiratory illnesses (Wellington, Kozak, & Cohen, 2008). In the last 30 years rates of asthma & allergies have increased in developed countries. Since 2001, the number of Americans with asthma increased by 28% (Okada, Kuhn, Feillet, & Bach, 2010).

In North Minneapolis, areas of concentrated poverty (ACP 50) are defined as areas where at least 50% of the population is of color and at least 40% have family incomes that are less than 185% of the federal poverty threshold. In addition, these communities have a high number of houses built before 1960 (Metropolitan Council, 2015) as well as disproportionately high rates of certain health conditions; asthma is one condition that is higher among low income minorities in urban communities (Johnson et al., 2008).

Research shows many North Minneapolis residents live in neighborhoods with older housing stock. This older housing stock increases the probability of substandard conditions, materials and integrity of the building structure. Many of these conditions have been found to negatively impact indoor air quality. The populations who most often live in houses with lead paint are poor, urban minorities. There are certain groups of individuals who are more likely to

have above average exposure to lead. These include males, Hispanics, African Americans and children in households with annual incomes below 200% of the federal poverty line (Gould, 2009). The goal of this research was to gather information on selected residents' knowledge and awareness about their homes' indoor air quality and potential health effects.

This topic is important to the health science discipline because of the adverse conditions that result from poor IAQ. Health disparities result when there are limitations or barriers to a population's ability to secure a healthy living environment. Many factors impact the accessibility to healthy housing, including: socioeconomic status, race or ethnicity and geographic location (Office of Disease Prevention & Health Promotion, 2015). Overall health equality can only be achieved by providing all citizens with healthy living environments and healthy IAQ. It is the responsibility of health professionals to help improve people's health. In order to do this, there needs to be a better overall understanding of barriers to action facing low-income minority populations living in these conditions. This study gave insight into perceptions of low-income minorities regarding their housing conditions as well as related health concerns.

This information can encourage the continuation of understanding residents' current knowledge of environmental health threats and perceptions of health effects. By having an understanding of this population sample's knowledge and awareness of this topic, health professionals can develop programs aimed at improving indoor air quality as well as interventions for populations with high rates of respiratory illness. One outcome of this study was to highlight the areas that need improvement in terms of education about indoor air quality and health risks.

Research Questions

The following were addressed through this research:

- 1) What are participants' awareness of the relationship between IAQ and health?
- 2) Are participants aware of materials and conditions commonly found in older housing stock that can impact IAQ?
- 3) What are participants' perceptions of severity and related concern regarding adverse health effects of IAQ?
- 4) What are participants' barriers to improving IAQ?

The independent variables of this research were socioeconomic status, race and type of housing stock. The dependent variables were adverse health effects, poor indoor air quality and awareness of indoor air quality and potential health effects.

Limitations

This study presented some limitations. It was difficult to identify and recruit participants. The original goal was to recruit 20 participants. However, this number was decreased to ten during the recruitment process because to this population was hard to reach even with a variety of outreach practices, including recruitment flyers at various locations and on social media. Another limitation was only having one coder analyze the data.

Participants' knowledge on IAQ could have been an issue. Many participants did not know much about IAQ, especially if they were renters. There could have been an issue of self-selection bias; since the participants decided whether or not to do the interview. In addition, obstacles and limited resources that many North Minneapolis residents face were a factor for participants' ability to be interviewed.

The fact that this study didn't attempt to conclusively link the independent variables to poor IAQ adverse health effects was another limitation. Also, the results cannot be generalized to populations different than the ones examined in this study.

Delimitations

One delimitation was related to resources; specifically not being able to offer a monetary incentive to respondents to participate in the interview. In addition to funding, time was a limitation as interviews take more time to conduct than other research methods. The amount of time available impacted the number of interviews. Another delimitation was that only English-speaking participants were included.

As for the geographical location, the focus was low-income minority neighborhoods with older stock housing in North Minneapolis where there was a high percentage of minorities and rental housing (City Data, 2015).

Assumptions

There were several assumptions made for this research. The first, it was assumed that a sufficient number of participants be identified and would agree to complete an interview. It was also assumed that all participants would be able to understand the interview questions and respond honestly.

Additionally, it was assumed that many participants lived in older residences, since 61.2% of residences in the selected area were built before 1940 (City Data, 2015). These houses were assumed to have some degree of poor IAQ.

Definitions

Indoor air quality: Indoor air quality is the environmental quality of a building. Characteristics that make up good IAQ include proper air ventilation, temperature and humidity.

Poor indoor air quality is defined as not “enough ventilation, leaks that cause dampness, chemical exposure and contaminated air” (Occupational Safety & Health Administration, 2015).

Low-income: According to the Assistant Secretary for Planning and Evaluation (2015) the federal poverty threshold is \$24,250 for a family of four; which establishes designation of an area of racially concentrated poverty at \$44,862.50.

Minorities: Any race other than Caucasian.

Older housing stock: Housing stock are the materials that make up the building. For this research, older housing stock is any building that was built before 1960 or has materials produced before 1960 (Governing, 2015).

Chapter Two: Literature Review

Introduction

Over the last few decades the focus of environmental concerns has shifted from the importance of outdoor air quality to indoor air quality (IAQ). Researchers, as well as residents, are placing increasing importance on indoor air quality as its relationship to certain health concerns is continually discovered. Poor IAQ can cause physical, psychological and social impacts (Lee & Kim, 2015). Research has found a relationship between the pollutants of dampness, mold, asbestos, radon and lead to health issues such as asthma and allergies (Johnson et al., 2008). The Metropolitan Council (2015) found that low income minorities are more likely to live in residences with older housing stock which are more likely to have poor IAQ. The following will highlight certain issues, specifically lead, asbestos, dampness & mold and radon, as well as health effects caused by poor IAQ, as well as environmental and socio-demographic risk factors.

This study will use the Health Belief Model (HBM) constructs to identify participants' perceptions and barriers of IAQ and related health effects. The HBM has six constructs: perceived ability, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy. These six constructs were used to identify current barriers of improving IAQ and findings from this study revealed potential health education needs. The qualitative nature of this study provides data-rich perspectives that can inform health education programs to improve outreach strategies to low-income populations who live in older housing and may be at risk for poor IAQ.

Indoor Air Quality

Most respiratory illnesses due to environmental exposure are from IAQ (Sundell, 2004). There are many factors that contribute to IAQ of a building including climate, site, building system, contaminant sources and the building occupants (CDC, 2015). Beyond these factors, culture plays a role in terms of building characteristics, indoor activities, the amount of time spent indoors and ambient air (Madureira et al., 2015).

Poor Indoor Air Quality. In their study, Escobedo, Champion, Li, and Montoya (2015) found concentrations of pollutants can be several times higher indoors compared to outdoors. These high levels of pollutants have consequences. Over half of all deaths caused by air pollution are from indoor air pollution (Ray & Leung, 2015) and indoor air pollutants can lead to both short and long-term health issues (Madureira et al., 2015).

Lead. Many older buildings still have lead pipe or lead- soldered plumbing. This can dramatically increase the amount of lead in the water supply. In 1998, the Environmental Protection Agency banned the use of solder and other lead-containing materials in connecting household plumbing to public water supplies (Hanna-Attisha, LaChance, Sadler, & Schnepf, 2016).

Regarding lead-based paint and contaminated water, children ages 1-6 years old have the greatest exposure and vulnerability to lead; this is also the age range where the most severe health consequences occur (Gould, 2009). Research shows that blood lead levels (BLLS) as low as 2 to 10 ug/dL can cause cognitive damage. In the U.S., almost 25% of children under the age of 6 have BLLs in this range (Gould, 2009).

Gould (2009) examined the cost-effectiveness of lead hazard control compared to cumulative lifetime costs of lead exposure. Health care costs include screening and treatment for

lead exposure. The total costs of screening and treatment for children with BLLs from 10 to above 70 is between \$10.8 and \$53.1 million.

Children's intelligence quotients (IQ) are affected by low levels of exposure. Gould (2009) found that 20% of children with BLLs greater than 25 ug/dL required special education. Furthermore, individuals with increased BLLs have lower rates of graduating high school, lower lifetime earning potential and higher rates of crime for young adults who were exposed to lead during childhood (Gould, 2009).

Gould calculated the total cost of lead exposure in children as between \$192-270 billion annually. Each dollar put towards lead hazard control will produce \$17- \$221 in health benefits, increased IQ, higher lifetime earnings, less spending on special education and decreased criminal activity (Gould, 2009).

Hanna-Attisha, LaChance, Sadler, & Schnepf (2016) researched children's health before and after the water source change in Flint, Michigan. They found the percentage of children with elevated blood levels (EBLLs) increased significantly, from 2.4% to 4.9%. Water lead levels (WLLs) increased from 4.0% to 10.6%. They also found the change in water supply impacted low-income and minority children disproportionately (Hanna-Attisha, LaChance, Sadler, & Schnepf, 2016).

Asbestos. Worldwide, 120,000 deaths each year are caused by exposure to asbestos. These deaths are the result of pleural plaques, lung cancer and mesothelioma. Autoimmune diseases, and other noncancerous illnesses, have been associated with asbestos. All types of asbestos contain cancer causing materials (LaDou et al., 2010).

Recently, several studies have linked asbestos exposure due to vermiculite insulation. One study in Montana surveyed participants' homes that were denied weatherization benefits due

to asbestos in the home. A visual inspection of the insulation and surface dust samples revealed a majority of houses had contamination of surface dust asbestos above the allowed levels (Spear et al., 2012).

Taking that study a step further, Noonan, Pfau, Larson and Spence (2006) looked at the relationship between asbestos exposure and risk of autoimmune disease. It was a case-control with more than 7,000 subjects in Libby, Montana, which has a history of asbestos- contaminated vermiculite through occupational and environmental exposure. Specifically, three systemic autoimmune diseases (SAIDs) were of interest: systemic lupus erythematosus, scleroderma and rheumatoid arthritis (RA). Their findings supported the theory that asbestos exposure and risk of autoimmune disease are associated with up to a 65% increase risk for developing RA (Noonan et al., 2006).

Dampness and mold. Mold is usually not a significant health threat on its own, but can be a concern to those who have weakened immune systems or mold allergies (CDC, 2015). Mold only needs two things to grow: moisture and nutrients. In fact, lack of dampness is the one thing that restricts the growth of mold. This moisture can come from a foundation leak, condensation or a leak in the roof, gutters or plumbing (Dales, Liu, Wheeler, & Gilbert, 2008), which are all common in older housing stock.

Fisk, Lei-Gomez and Mendell (2007) describe quantitative meta-analyses of previous studies (Emenius et al., 2004; Norback et al., 1999; Williamson et al., 1997) of the health effects of dampness. It was found that building dampness and mold were associated with the 30-50% increase in many respiratory and asthma related issues in sample subjects. However, building dampness alone was not the cause of adverse health effects; rather, it was the dampness-related

exposures to other pollutants such as mold, bacteria and chemical pollutants from building materials that likely caused of adverse health effects (Fisk, Lei-Gomez, & Mendell, 2007).

Furthering this research, Mendell et al., (2011) found indoor dampness to be a risk factor for asthma, allergies and respiratory disease in America. Childhood asthma also became more severe and more frequent for children exposed to dampness and mold (Mendell et al., 2011).

Radon. The EPA categorizes the U.S. by counties into three zones. Zone one has a predicted average indoor radon screening level greater than 4pCi/L (picoCuries per liter), zone two is from 2 to 4pCi/L and zone three is less than 2pCi/L. The national average is 1.3pCi/L. Almost 80% of counties in Minnesota are in zone one which has the highest rated radon levels, including Hennepin County where North Minneapolis is located. Two out of five homes in Minnesota have levels of radon that are high risk compared to one out of 15 homes nationally (EPA, 2015).

Radon may be present in houses due to building materials used and soil and ground water contaminated with radon. Laquatra, Maxwell, and Pierce (2005) investigated a variety of indoor air pollutants in 24 New York childcare facilities and found higher levels of radon in lower income households. This relationship between income and radon levels was reportedly due to lower quality housing that presents more options for radon to get into the building, such as cracked foundations and dirt basements (Laquatra, Maxwell, & Pierce, 2005).

Environmental & Socio-Demographic Risk Factors

Older housing Stock. In Minneapolis, 48% of residences were built before 1940 and 65% before 1960 (Govering, 2015). Many of these older residences have not been updated due to the amount of time and money required (Taylor, 2011). Older residences often have faulty foundations and ventilation that can lead to dampness and certain toxic exposures. For example,

in houses built before 1960 in Sweden, 22% reported dampness, 32% reported odor in the housing stock as well as high indoor air humidity (Engvall, Norrby, & Norback, 2001).

In addition to asbestos found in ventilation, older homes can have asbestos in floor and roofing tiles, siding and ceiling texture materials (Spear et al., 2012). Furthermore, lead is an issue in older houses, as lead-based paint was used until its government ban in 1978. Houses built before 1950 have the highest levels of lead concentration, while houses built from 1950-1978 have less, but still a considerable amount (Gould, 2009). Radon gas is another hazard often present in older houses due to cracks in foundations and poor ventilation. Cracks in foundation can allow radon, which is found in the ground, to pass into the building (Sundell, 2004).

Socioeconomic Status & Race. People of color often have lower incomes than Caucasians, making race a determinant in housing choice (Metropolitan Council, 2015). Furthermore, Gould (2009) found that poor, urban minorities are more likely to live in houses that have lead based paint. Low income neighborhoods typically have more residences with older housing stock (Govering, 2015) which often contains lead based paint and plumbing. Besides older houses, lower income families often have less access to air conditioning and live in lower quality housing, all of which contribute to poor indoor air quality (Dales, Liu, Wheeler, & Gilbert, 2008; Johnson et al., 2008). Sundell (2004) found that urban living is a risk factor for allergies. Asthma affects low income minorities in urban communities more than other populations; African American rates of hospitalization and deaths from asthma are three times higher than the rates for whites (Johnson et al., 2008).

Adverse Health Effects of Poor Indoor Air Quality

Awareness. Several studies have investigated residents' awareness or valuation of IAQ. First, Kim and Lee (2015) surveyed almost 300 apartment residents to find their satisfaction

levels with their housing. They also asked questions about the indoor environmental quality and awareness of energy efficiency. Overall, residents were satisfied with the housing quality, indoor environment quality and were aware of the need to conserve energy. Further, they found that improvement of energy conservation positively impacted the indoor environmental quality as well as resident satisfaction (Lee & Kim, 2015).

Cho, Kim, and Kim (2015) wanted to identify residents' perceptions of their apartment's indoor environment. They surveyed 40 households from two different apartment buildings; one built in 1978 and one in 2000. Besides finding decreased energy efficiency in the older building, they found the comfort level of the residents in the older building was not low as they predicted. The older building's occupants reported better comfort levels around IAQ than those who lived in the residences built in 2000. However, these occupants also reported more discomforts than those in the newer building. These discomforts included dry, itchy and irritated eyes (Cho, Kim, & Kim, 2015). The discrepancy between perceptions of good IAQ while showing symptoms of poor IAQ further exemplifies the importance of perceptions, awareness and education of IAQ.

Futher, Kozak and Cohen (2008) surveyed over 800 households in Canada. Using a Likert scale, they asked participants' opinions on 16 statements regarding air pollutants such as radon, lead and mold. The objective was to determine participants' valuation of indoor environmental quality and energy efficiency, since indoor air quality is a causal and contributing factor in the rise of respiratory related illnesses, specifically allergies and asthma. They found that younger people (under 40 years old) and baby boomers (41-60 years old) were more likely than the oldest group (61 years and over) to value the indoor environment of their home. Participants who had respiratory health issues were less likely to feel satisfied with the health and energy efficiency of their residence (Kozak & Cohen, 2008).

Respiratory Illness. As of 2015, 25 million Americans (or 8% of the total population) have asthma, over a quarter of which are children. Minnesota has a prevalence rate of 7.7%, which makes it the third most common chronic disease. Asthma was the reason for 1.8 million emergency room visits nationally in 2011. Black, non-Hispanic children and adults have higher rates of asthma than any other ethnicity (CDC, 2015). From 2001 to 2009, rates of asthma increased by almost 50% in African American children (American Academy of Allergy Asthma & Immunology, 2016).

These rates increase dramatically among low-income minority populations. Families under the federal poverty threshold had higher rates of asthma (11.1%) than those above the federal poverty threshold (7.7-8.5%) (CDC, 2015). Furthermore, low-income African Americans experience more ER visits, hospitalizations and higher mortality rates from asthma compared to whites (Johnson, Nriago, Hammad, Savoie & Jamil, 2008).

In a study conducted in Stockholm, 7,500 people participated in a survey to investigate relationships between the diagnosis of asthma and allergies and building characteristics. The study categorized the buildings into six groups, those built: 1) before 1961, 2) 1961-1975, 3) 1976-1984, 4) 1985-1990, 5) 1991-1997 and 6) 1998-2003 (Norback, Lampa, & Engvall, 2014). Building dampness and mold were associated with asthma and to a lesser degree allergies and eczema (Norback, Lampa, & Engvall, 2014); dampness and mold are both prevalent in older buildings (Dales, Liu, Wheeler, & Gilbert, 2008). Participants were more likely to be diagnosed with allergies if they had recently redecorated or had odors from mold. Those who reported humid air and mold odors were associated with pollen allergy. This study did have a smaller proportion of older buildings compared to new buildings; however, age or gender of the participant was not related to the results (Norback, Lampa, & Engvall, 2014).

Dales, Liu, Wheeler, & Gilbert (2008) also found that building dampness and molds were associated with asthma and allergies. They found humid air in these buildings was associated with a diagnosis of asthma and pollen allergy; humid air can be a product of poor ventilation. Mold odors were associated with a diagnosis of allergies as well as the onset of asthma (Norback, Lampa, & Engvall, 2014).

Summary

Hazardous conditions in older housing stock directly contribute to poor IAQ and result in serious health problems. North Minneapolis residents are more likely to live in older and hazardous housing stock, exposing them to higher rates of indoor air pollutants and health consequences. As the concern for indoor air quality grows, additional research will continue to explore how indoor air quality impacts human health and identify changes to prevent adverse health effects. While studies are beginning to investigate people's perspectives on indoor environment quality, more information, education and resources are needed in order to understand the drivers and constraints to improve hazardous housing conditions and IAQ.

Chapter Three: Methodology

Introduction

This research aimed to gather information on the knowledge and awareness of the selected sample on IAQ and potential health risks. The following sections will describe the methodology of the research; including research design, participant selection, instrumentation, collection and analysis of data.

Research Design

This research was conducted by in-depth personal interviews, with a design that is descriptive and cross-sectional. The data were collected by in person interviews. This qualitative approach was an attempt to get a thorough understanding of the beliefs, attitudes and knowledge of the population sample in terms of IAQ and associated health effects. Interviews are an effective way to compile individual perspectives and connect them to larger issues. Another benefit of this method was the ability to make sure the interviewee understood the questions being asked and, if not, the question could be rephrased.

Participant Selection

The study sample inclusion criteria allowed for North Minneapolis residents to be eligible to participate in this research. The goal for sample size was 10 participants. The sample population of this study was North Minneapolis residents who visited the Hennepin County North-Regional Library during February through April 2016 and those who responded to recruitment flyers (Appendix B) and social media postings from various locations. Quota sampling was used since a probability sample was not possible. The criterion for this sample was being an adult living in North Minneapolis. Participants were selected in an effort to represent the traits of the study population.

Instrumentation

The level of measurement used was ordinal. This allowed for categorizing as well as ranking. A measure of reliability is important when conducting the interviews. To ensure reliability the interviewer kept each interview identical to the previous and each interview was analyzed under the same standards to ensure reliability.

Due to the design of this study, internal validity could be compromised by the location of the data collection or the Hawthorne effect; where participants alter their answers due to the attention being brought to the issue of their IAQ. Securing internal validity is important as it is needed for external validity. External validity could be impacted by overgeneralizing or selection treatment interaction. Another concern for external validity is setting treatment interaction. This study investigates location with older housing stock and high numbers of low income individuals who reside there. Other research studies may not use these same settings so external validity may be compromised.

Data Collection Procedures

Before the interviews were conducted, approval from the Institutional Review Board was received (see Appendix A). Participants were recruited from February through April 2016 through several channels. Recruitment flyers were posted at The Hennepin County North-Regional Library, Jordan Area Community Council, Hawthorne Community Council, Shiloh Temple, Wayman A.M.E. Church, Neighborhoods Organizing for Change (NOC) and Urban Research Outreach-Engagement Center (UROC). The Shiloh Temple and Wayman A.M.E. Church also listed the study opportunity in their bulletins. Both the Hawthorne and Jordan Area Community Councils posted the study on their Facebook page and newsletters. The interviewer was at the Hennepin County North-Regional Library with a sign describing and requesting

participation of the study. The interviewer was at this location at various days and times; during the work week in the morning, afternoon and evening and also during the day on the weekends. All of the interviews were conducted at this location; the interviews continued until 11 had been completed.

Before each interview, participants were given a consent form and were informed that the interview was voluntary and confidential. The interview used mostly open ended questions to gather more specific information; refer to Appendix D. Following the interview, a survey was used to gather demographic questions. Afterwards, all participants were given a free radon test and brochures on IAQ provided by the Minnesota Department of Health.

Data Analysis

Data analysis is described by Bernard (2005) as “the search for patterns in data and for ideas that help explain why those patterns are there in the first place” (p. 42). With this qualitative data, the grounded theory was used to find and code data related to the research questions. All answers for each question on a certain topic, for instance, awareness of IAQ, were grouped together. This is done through finding themes and subthemes, then identifying which are important (Bernard, 2005). Coding is used to organize the data into subthemes; this shows how a researcher categorized the data (Charmaz, 2006).

The researcher developed the following study materials: a consent form (Appendix C), an interview guide (Appendix D) and a sociodemographic form (Appendix E). Each was approved by the Institutional Review Board. The interview guide was used to keep the interview on track and make sure that the research questions were being addressed. The guide had mostly open ended questions; however, there were a few yes or no questions. These interview questions included probing questions.

All of the interviews were tape recorded and then transcribed. Once this step was complete, coding was used to extract, summarize, and analyze the data related to the four research questions. Coding is the organization of data regarding the subthemes that show how the data was selected, separated and sorted. The researcher read through all the transcribed interviews and found phrases or ideas that were repeated and these became themes. Each interview was looked over twice to make sure the coding was done correctly. All of the answers for a question on a certain topic, for instance awareness of IAQ, were grouped together. This method of grouping the responses together by topic allows categorization. The qualitative data collected on the socioeconomic form was tallied by hand. The frequencies, mean and median were all calculated to describe different aspects of the participant profile.

Chapter 4: Findings of the Study

Introduction

This study explored the understanding of indoor air quality among residents in North Minneapolis. Qualitative analysis of 11 interviews with North Minneapolis residents examined knowledge and awareness of IAQ. This research aimed to bridge the gap between current policies to promote healthy IAQ and the needs of the residents in North Minneapolis by providing insight to inform outreach and education programs. Four research questions frame this study:

- 1) What are participants' awareness of the relationship between IAQ and health?
- 2) Are participants aware of materials and conditions commonly found in older housing stock that can impact IAQ?
- 3) What are participants' perceptions of severity and related concern regarding adverse health effects of poor IAQ?
- 4) What are participants' barriers to improving IAQ?

Participant Profile

Of the 11 North Minneapolis participants, all were either African-American or white. Two thirds of the participants were white. The age of the participants ranged from 22 to 64 with a median age of 38.6. Over a third of the participants were in their twenties; a quarter were 55 years old or above.

Table 4.1: Participants' Race and age

Race	Frequency	Percent
African American	4	36
White	7	64
Age		
Youngest	22	
Oldest	64	
Mean	38.6	
Median	31	

The Assistant Secretary for Planning and Evaluation (2015) states the federal poverty threshold is \$24,250 for a family of four. Sixty percent of participants reported annual household incomes as less than \$20,000. Of these households, three participants reported household income under \$10,000, with three to five people living in the residence and three participants reported household income between \$10,000-\$19,999 with one to four people living in the residence. The participant who reported total household income in the \$40,000-\$49,000 range reported five people living in the residence. Numbers are based on 10 participants as one participant preferred not to report household income information.

Table 4.2: Participant income

Income	Frequency	Percent
Under \$10,000	3	30
\$10,000-\$19,000	3	30
\$20,000-\$29,000	0	0
\$30,000-\$39,000	0	0
\$40,000-\$49,000	1	10
\$50,000-\$59,000	1	10
\$60,000-\$69,000	0	0
\$70,000 or more	2	20
Total	10	100%

The education of the participants ranged from high school diploma to graduate degree. More than half of the participants had a college degree or higher.

Table 4.3: Participant education

Education	Frequency	Percent
Did not finish high school	0	0
Completed high school	2	18
Some college but no degree	2	18
Associate degree or vocational degree	0	0
College bachelor's degree	4	36
Some graduate work	1	10
Completed graduate degree (Masters or PhD)	2	18

The number of years the participants lived in North Minneapolis ranged from two to 35 years. The average number of years lived in North Minneapolis was 12 and the median number of years was eight.

Table 4.4: Participant's years lived in North Minneapolis

Years lived in North Minneapolis	Frequency	Percent
5 or less	3	27
6-10	5	45
11-20	0	0
21-30	1	10
30 +	2	18

All of the participants lived in a house, duplex, or apartment; the house was the most common with nine of the participants living in a house. More than 80% of the participants owned their residence.

Table 4.5: Type of building participants reside in and if owned or rented

Type of building	Frequency	Percent
House	9	80
Duplex	1	10
Apartment	1	10
Own	9	81
Rent	2	19

The number of people living in the participant's residence ranged from one to five. Both the mean and the median number were three. Sixty-four percent had three or more people living in the residence.

Table 4.6: Number of people living in the residence

Number of People	Frequency	Percent
1	2	18
2	2	18
3	3	27
4	1	10
5	3	27

Four of the 11 participants reported tobacco use within their residence.

Table 4.7: Tobacco use in residence

Tobacco Use	Frequency	Percent
No	7	64
Yes	4	36

Findings

The four research questions were: 1) What are participants' awareness of the relationship between IAQ and health? 2) Are participants aware of materials and conditions commonly found in older housing stock that can impact IAQ? 3) What are participants' perceptions of severity and related concern regarding adverse health effects of poor IAQ? 4) What are participants' barriers to improving IAQ? Findings are reported by research question.

Awareness of Relationship between IAQ and Health.

Participants' awareness of the relationship between IAQ and health were assessed by two questions: 1) Are you familiar with the term IAQ? 2) How would you describe the quality of air in your residence? Participant responses revealed varying definitions and understandings of IAQ. One response was, "It's the quality of air that you breathe in within your house. Like if

you don't clean the air ducts or change your vents on your central air when they say every six months and stuff like that." After IAQ was defined to participants unfamiliar with the term, all participants agreed that IAQ and health are connected, but to different and varying degrees. The most common health issues that were brought up regarding IAQ were asthma and respiratory related issues. However, other maladies, including sleep issues, allergies, coughing attacks, sinus infections, congestion, lung cancer and lead poisoning were also mentioned.

Another theme that surfaced was the connection between house cleanliness and IAQ. Half of all participants noted that house cleanliness (defined as dust, dirt, and germs in the house) directly impacted IAQ and corresponding health issues of asthma and allergies. One participant responded that the quality of their residents was "also probably linked to how often you dust and vacuum."

Another theme that appeared from these questions was a lack of awareness of residential IAQ. When one participant was asked to rank the quality of air in their residence on a scale of 1-5 with 5 being the healthiest, the participant stated it was a four since "I know I don't feel like I have any breathing issues. Very rarely does anybody come to my house have any sort of reaction." Another response to this question about the quality of air was I'm "not really sure how I would measure it" and "I actually have no idea."

Awareness of materials and conditions in older housing stock impacting IAQ.

Participants' awareness of materials and conditions commonly found in older housing stock that can impact health were assessed by two questions: 1) Do you have any questions or concerns about your IAQ? 2) Do you think the building materials in your residence affect IAQ? The factors participants mentioned which impact IAQ included lead, asbestos, old windows, mold, air ducts, old furnace filters, and radon. Analysis of the data revealed that while

this range of materials was mentioned throughout the interviews, only lead, asbestos, and old windows were mentioned by more than one participant. Only one participant mentioned mold and one other participant mentioned radon. Seven of the participants stated they did not think that materials found in housing stock can impact health. One participant stated, “A lot of building materials can and will affect quality of life in the long-term. It might not affect you now, right away, but it’s going to affect you.”

Several participants responded that individuals with certain characteristics are more susceptible to IAQ related health issues. When asked if building materials in their residence affect IAQ, one participant stated “I think it probably depends on maybe what you are sensitive to”.

Perceptions of severity and related concerns regarding IAQ adverse health effects.

Participant perceptions of severity of health conditions and concern for the impact of those health conditions on them and their families were assessed in one interview question and two sociodemographic questionnaire questions: What health problems do you think poor IAQ can cause, rate how serious the following issues are and how concerned are you that the following issues may impact your or your family’s health? When asked about what health risks poor IAQ can cause, answers centered on different breathing and respiratory issues. One participant mentioned lung cancer and another mentioned lead poisoning. Another participant mentioned that their poor IAQ “triggers my son’s asthma more.” While another thought, “I would probably say congestion. Probably, I would think there’s breathing related problems. I always kind of think of emphysema or things that are associated with smoking. That people get from that kind of thing. Even people who work in industrial areas, they often times have breathing issues, lung issues, that are related to their environments.”

On the socioeconomic form, the health conditions mentioned were: asthma, allergies, lung cancer and lead poisoning. Data analysis revealed participants thought asthma was the most serious health condition with an average rating of 9 on a scale of 1-10 (10 being the most serious). Allergies was next with a rating of 7.64, followed by lung cancer as the third most serious with 5.90. Lead poisoning was considered least serious with a rating of 5.72.

When asked about their concern for their and their family's health regarding these conditions, responses were rated in the same order as the previous question. However, concern for each health condition was rated lower severity. For example, asthma was rated highest with 5.45, allergies next with 4.72, followed by lung cancer with 3.9 and lead poisoning at 3.2. This data suggests that even though participants perceive these health conditions as serious, they are less concerned about the likelihood of the conditions impacting themselves or their family.

Barriers to improving IAQ. Participants perceptions of constraints to their ability to make changes to improve their IAQ were assessed in four questions: 1) Do you think your IAQ needs to be improved? 2) Have you made any changes to improve the IAQ? 3) If no, what's preventing you from taking action? 4) What health benefits do you think improved IAQ might have? Analysis of the data revealed time, money, it not being a priority, and a lack of awareness as barriers to participants' ability to improve their IAQ. When asked what was stopping them from taking action to improve their IAQ, participants responded: "I guess I don't really know what to do about it," and "lack of awareness as well as finances." Several others indicated concern over making changes that would not help IAQ since they aren't sure what the issues are. One participant lived in Section 8 housing and stated that she doesn't feel any changes to improve IAQ need to be done since the house has passed the inspection each year. Another response when asked about what was preventing action and the health benefits improved IAQ

may have was, “ I wish it was more information on how to get it done. And hopefully at a reasonable price. I mean, to me the things that healthiest cost more, which, to me, it should be costing us less.”

Discussion

Data analysis of interview responses suggests that participants were limited in their awareness of a connection between IAQ and health. Most participants thought that asthma and allergies were the only health effects that could come from poor IAQ while many thought that adverse health effects could be improved by having a cleaner house.

Assessment of participant awareness of how materials and conditions can impact IAQ found that participants mentioned a range of materials and conditions commonly found in older housing stock with lead, asbestos, and old windows being the most common. However, only half of the participants thought any of the materials and conditions in the building could impact their health. When asked about materials that can impact IAQ, the only participants who brought up asbestos are those who said they thought the asbestos had been removed before they moved in. Participants know that dust can be a cause of poor IAQ, but not much was reported about how building materials can impact IAQ.

In terms of severity of health consequences due to poor IAQ, participants' viewed asthma as the most serious health concern. Allergies were also considered serious, but to a lesser degree. Lung cancer and lead poisoning were reported to be somewhat less serious. Participant concern for themselves and their family's health was rated in the same order but significantly lower than the health consequences of poor IAQ. This may suggest that while participants perceive health consequences of poor IAQ to be severe, they are unaware of the conditions and materials that may be present in their housing environment that pose direct threats to them and their families.

Increasing awareness of the prevalence of common materials and conditions identified by residents as known contributors to poor IAQ may serve to increase immediate health concerns and actions. In addition, expanding awareness of unknown materials and conditions that contribute to poor IAQ and are common in North Minneapolis housing stock may increase resident concern and spur motivation to act to improve conditions.

This study found that participants identified similar barriers when it came to improving IAQ. Not knowing how to make improvements, time, money, and the fact that it was not a priority were the reasons why participants had not made or have not continued to make changes. However, a few participants asked for easy things that can be done to make improvements and easy tests to check for poor IAQ. In combination with increased knowledge of hazardous conditions and materials, easy and cost-effective measures that take relatively little time and expertise may be effective in outreach efforts.

Overall, participants seem to want more information on indoor air quality as eight out of 11 stated on the sociodemographic questionnaire. When asked how they prefer to get this information, the answers included emails (the most common request) mailings, and in-person and online workshops.

Summary

This study found that participants are aware of some of the main health effects that are connected to IAQ. Participants seem to be aware of how IAQ can be impacted by dust and germs but unaware of how building materials can affect IAQ and potentially cause health conditions. Asthma and allergies were found to be the health conditions thought as the most serious when it comes to IAQ, yet participants were not overly concerned about these conditions or lung cancer and lead poisoning. The barriers that participants face when trying to improve

IAQ, including money, time and lack of knowledge as to what can be fixed, were reported by all participants.

Chapter 5: Summary, Conclusions, and Recommendations

Introduction

Indoor air quality is becoming a more serious issue for the public health sector. Poor IAQ can be caused by different factors and can lead to a range of health conditions (Laquatra, Maxwell, & Pierce, 2005). Hazardous conditions related to older housing stock can be one cause of poor IAQ (Dales, Liu, Wheeler, & Gilbert, 2008). Residents in North Minneapolis disproportionately occupy older houses. This study investigated the level of knowledge and awareness these residents have about IAQ in terms of what materials can cause it and the health effects.

Summary

Older housing stock has hazardous conditions that directly contribute to poor IAQ and lead to health problems. In North Minneapolis, low- income individuals are more likely to live in older and hazardous housing stock (Metropolitan Council, 2015). This causes more exposure to indoor air pollutants and higher rates of health consequences. The conditions often found in older houses that this study covered included: lead, asbestos, mold caused by dampness, and radon (Metropolitan Council, 2015). Exposure to these can lead to higher rates of hospitalizations, emergency room visits, premature death and long-term behavioral consequences among low-income minority populations (Johnson, Nriago, Hammad, Savoie, & Jamil, 2008).

A qualitative study was designed to gather information on the knowledge and awareness of IAQ and its impact. Participants were recruited through a number of channels, including flyers, social media postings and in person at the HCNR Library. This study interviewed 11 participants who live in North Minneapolis.

Conclusions

This study found that there is a lack of awareness and knowledge around IAQ as well as the causes and effects of poor IAQ. It also found that all participants expressed similar constraints to improving their IAQ, which means there could be effective solutions for many individuals. This study also pointed out the challenge of being able to reach this population and talk about IAQ, even though over half of the participants did want more information on this topic. The difficulty reaching this population paired with the lack of information on the importance of IAQ shows the need for more outreach, education and resources for this health issue.

Recommendation for Further Study

There are many suggestions for future studies on this topic. Most of these recommendations have to do with the recruitment process, as it was difficult to identify and retain participants. The first recommendation is to spend time developing relationships with neighborhood organizations. This would help build trust and form ways to recruit individuals interested in participating since the organization would have outreach processes and relationships with residents. In addition, working closely with an organization would provide a safe and trusted space for interviews to occur. Presence at a local organization allows an interviewer to establish trust and legitimacy with organization staff and neighborhood residents while providing a close and secure location frequently visited by potential neighborhood participants. This also erases the chance of the participant not showing up to a scheduled interview. Offering monetary incentives for interviews is another option to increase participation.

Recommendation for Health Education

This study found that participants want more information on IAQ, including how to test and improve it. My recommendation is to partner with neighborhood organizations and non-profits in the North Minneapolis area to promote education on IAQ. This education could include how to test IAQ and things to improve IAQ. There could also be information and assistance on grants that could help residents replace older hazardous materials.

Interpretations of Findings

Data analysis suggests that IAQ is not a priority for residents of North Minneapolis, which may have contributed to the difficulty in interview participant recruitment and outreach. Some participants stated that they have more pressing issues than the quality of their indoor air.

The sample population reported generally high awareness of the impacts of poor IAQ on human health. However, that was the extent of knowledge and awareness on IAQ for most participants. When asked if they had concerns about their IAQ or if building materials are able to impact IAQ, participants were not familiar with many of the materials found in older houses and half of those who responded didn't think these materials could impact health.

The level of knowledge and awareness among the study's participants show that more education and outreach around this topic would be beneficial and many residents in the area would be interested. The findings give insight to future researchers on how to reach and educate this population.

References

- American Academy of Allergy Asthma & Immunology. (2016). *Asthma statistics*. Retrieved from http://www.aaaai.org/about-the-aaaai/newsroom/asthma_statistics.aspx
- Assistant Secretary for Planning and Evaluation. (2015). *2015 poverty guides*. Retrieved from <http://aspe.hhs.gov/2015-povertyguidelines>
- Bernard, H.R. (2005). *Research methods in anthropology: Qualitative and quantitative approaches*. Lanham, MD: AltaMira Press.
- Brandt, M., Brown, C., Burkhart, J., Burton, N., Cox-Ganser, J., Damon, S.,... Weissman, D. (2006). Mold prevention strategies and possible health effects in the aftermath of hurricanes and major floods. *Morbidity and Mortality Weekly Report*, 55, 1-27.
- Centers for Disease Control and Prevention. (2015, October). *Factors affecting indoor air quality*. Retrieved from http://www.cdc.gov/niosh/pdfs/sec_2.pdf
- Centers for Disease Control and Prevention. (2015, November). *Most recent asthma data*. Retrieved from http://www.cdc.gov/asthma/most_recent_data_states.htm
- Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. London, England: Sage Publications.
- Cho, M.E., Kim, M.J., & Kim, J.T. (2015). User's perception of indoor environment associated with energy performance in apartment complexes with different service life. *Energy and Buildings*, 98, 106-112.
- City Data. (2015, January). *55411 zip code detailed profile*. Retrieved from <http://www.city-data.com/zips/55411.html>
- Dales, R., Liu, L., Wheeler, A.J., & Gilbert, N.L. (2008). Quality of indoor residential air and health. *Canadian Medical Association Journal*, 179(2), 147-152.

- Emenius, G., Svartengren, M., Korsgaard, J., Nordvall, L., Pershagen, G., & Wickman, M. (2004). Indoor exposures and recurrent wheezing in infants: A study in the BASME cohort. *Acta Paediatrica*, *93*, 899-905.
- Engvall, K., Norrby, C. & Norback, D. (2001). Asthma symptoms in relation to building dampness and odour in older multifamily houses in Stockholm. *Plos One*, *5*(5), 468-477.
- Environmental Protection Agency. (2016, February). *Find information about local radon zones and radon programs*. Retrieved from <http://www.epa.gov/radon/findinformation-about-local-radon-zones-and-radon-programs>
- Escobedo, L.E., Champion, W.M., Li, N., & Montoya, L.D. (2014). Indoor air quality in Latino homes in Boulder, Colorado. *Atmospheric Environment*, *92*, 69-75.
- Fisk, W., Lei-Gomez, Q., & Mendell, M.J. (2007). Meta-analyses of the associations of respiratory health effects with dampness and mold in homes. *Indoor Air*, *17*(4), 842-296.
- Gould, E. (2009). Childhood lead poisoning: Conservative estimates of the social and economic benefits of lead hazard control. *Environmental Health Perspectives*, *117*(7), 1162-1167.
- Governing. (2015). *Cities with oldest homes: Age of housing stock data*. *Governing Data*. Retrieved from <http://www.governing.com/gov-data/transportationinfrastructure/ageyear-built-for-homes-in-cities.html>
- Hanna-Attisha, M., LaChance, J., Sadler, R.C. & Schnepf, A.C. (2016). Elevated blood lead levels in children associated with the Flint drinking water crisis: A spatial analysis of risk and public health response. *American Journal of Public Health*, *106*(2), 283-290.

- Johnson, M., Nriago, J., Hammad, A., Savoie, K. & Jamil, H. (2008). Asthma, environmental risk factors, and hypertension among Arab Americans in metro Detroit. *Immigrant Minority Health, 12*, 640-651.
- Kozak, R., & Cohen, D. (2008). How consumers value healthy houses: A preliminary segmentation of Canadian households. *Journal of Housing and the Built Environment, 23*(1), 37-52.
- LaDou, J., Castleman, B., Frank, A., Gochfeld, M., Greenberg, M., Huff, J., ... Watterson, A. (2010). The case for global ban on asbestos. *Environmental Health Perspectives, 118* (7), 897-901.
- Laquatra, J., Maxwell, L. & Pierce, M. (2005). Indoor air pollutants: Limited-resource households and child care facilities, *Journal of Environmental Health, 86-91*.
- Lee, T.K. & Kim, J.T. (2015). Residents' responses on indoor environment quality and energy use in apartments. *Energy and Buildings, 98*, 34-38.
- Madureira, J., Paciencia, I., Rufo, J., Ramos, E., Barros, H., Teixeira, J.P., & de Oliveira Fernandes, H. (2015). Indoor air quality in schools and its relationship with children's respiratory systems. *Atmospheric Environment, 118*, 145-156.
- Mendell, M.J., Mirer, A.G., Cheung, K., Tong, M., & Douwes, J. (2011). Respiratory and allergic health effects of dampness, mold, and dampness related agents: A review of the epidemiologic evidence. *Environmental Health Perspectives, 119*(6), 748-756.
- Metropolitan Council. Section five: Racially concentrated areas of poverty in the region. *Choice, Place and Opportunity: An Equity Assessment of the Twin Cities Region, 5*, 1-26.

- Noonan, C.W., Pfau, J.C., Larson, T.C., & Spence, M.R. (2006). Nested case-control study of autoimmune disease in an asbestos-exposed population. *Environmental Health Perspectives, 114*(8), 1243-1247.
- Norback, D., Bjornsson, E., Janson, C., Palmgren, U., & Boman, G. (1999). Current asthma and biochemical signs of inflammation in relation to building dampness in dwellings. *International Journal of Tuberculosis and Lung Disease, 2*, 368-376.
- Norback, D., Lampa, E. & Engvall, K. (2014). Asthma, allergy and eczema among adults in multifamily houses in Stockholm (3-HE study)- Associations with building characteristics, home environment and energy use for heating. *Plos One, 9*(12).
- Occupational Safety & Health Administration. (2015). *Indoor air quality*. Retrieved from <https://www.osha.gov/SLTC/indoorairquality/faqs.html>
- Office of Disease Prevention and Health Promotion. (2015). *Disparities*. Retrieved from <http://www.healthypeople.gov/2020/about/foundation-healthmeasures/Disparities>
- Okada, H., Kuhn, C., Feillet, H., & Bach, J.F. (2010). The ‘hygiene hypothesis’ for autoimmune and allergic diseases: An update. *Clinical and Experimental Immunology, 160*(1), 1-9.
- Ray, S., & Leung, L. (2015). Improving indoor air quality: Lessons from two Chinese case studies. *ASHRAE Transactions, 121*(2), 1-8.
- Spear, T.M., Hart, J.F., Spear, T.E., Loushin, M.M., Shaw, N.N. & Elashhab, M.I. (2012). The presence of asbestos contaminated vermiculite attic insulation or other asbestos containing materials in homes and the potential for living space contamination. *Journal of Environmental Health, 75*(3), 24-29.
- Sundell, J. (2004). On the history of indoor air quality and health. *Indoor Air, 14*, 51-58.

Taylor, J. (2011). Assessing Minnesota's housing needs: A local literature review.

Minnesota Housing Finance Agency. Retrieved from

http://www.mnhousing.gov/idc/groups/administration/documents/document/mhf_01183.pdf

Wellington, S., Kozak, R., & Cohen, D. (2008). How consumers value healthy houses: A preliminary segmentation of Canadian households. *Journal of Housing and the Built Environment*, 23(1), 37-52.

Williamson, I.J., Martin, C., McGill, G., Monie, R.D.H., & Fennery, A.G. (1997). Damp housing and asthma: A case-control study. *Thorax*, 52, 229-234.

Appendix A
IRB Approval Letter



February 19, 2016

Dear Judith Luebke:

Re: IRB Proposal entitled "[864134-3] Knowledge and Awareness of Indoor Air Quality"
Review Level: Level [I]

Your IRB Proposal has been approved as of February 17, 2016. On behalf of the Minnesota State University, Mankato IRB, we wish you success with your study. Remember that you must seek approval for any changes in your study, its design, funding source, consent process, or any part of the study that may affect participants in the study. Should any of the participants in your study suffer a research-related injury or other harmful outcome, you are required to report them to the Associate Vice-President of Research and Dean of Graduate Studies immediately.

The approval of your study is for one calendar year less a day from the approval date. When you complete your data collection or should you discontinue your study, you must submit a Closure request (see <http://grad.mnsu.edu/irb/continuation.html>). All documents related to this research must be stored for a minimum of three years following the date on your Closure request. Please include your IRBNet ID number with any correspondence with the IRB.

The Principal Investigator (PI) is responsible for maintaining signed consent forms in a secure location at MSU for 3 years following the submission of a Closure request. If the PI leaves MSU before the end of the 3-year timeline, he/she is responsible for following "Consent Form Maintenance" procedures posted online (see <http://grad.mnsu.edu/irb/storingconsentforms.pdf>).

Sincerely,

A handwritten signature in black ink that reads "Mary Hadley".

Mary Hadley, Ph.D.
IRB Coordinator

A handwritten signature in black ink that reads "Sarah Sifers".

Sarah Sifers, Ph.D. LP
IRB Co-Chair

Appendix B
Recruitment Flyer

IRBNet ID # 864134

Are you a resident of North Minneapolis?

Have you thought about the indoor air quality of your residence?

If so...

The University of Minnesota, Mankato

Department of Health Science is conducting research on:

Indoor Air Quality

At the Hennepin County North-Regional Library

If you are:

- over the age of 18

AND

-live in North Minneapolis

You are invited to participate in a 15 minute interview. The purpose of this research is to gather information on indoor air quality of Minneapolis housing.

Participants will be given a FREE radon test kit and indoor air quality information.

Please contact Blisse Cajacob at 507-330-2568 or blisse.cajacob@mnsu.edu for more information

Appendix C
Consent Form

Consent Form

Knowledge and Awareness of Indoor Air Quality in Older Residences

You are invited to participate in research designed to develop an understanding of knowledge and awareness of indoor air quality in older residences. You were selected as a possible participant because of your residency in the study area. Please read this form and ask any questions you may have before agreeing to be in this research.

Background Information

The purpose of this research is to better understand individuals' knowledge and awareness of indoor air quality in older residences.

Procedures

If you agree to this research, you will be asked to do the following things:

Participate in an interview, lasting approximately 30 minutes. The interview will be audio recorded and transcribed. Complete a brief survey consisting of sociodemographic information.

Risks of being in the Study

The risks you will encounter as a participant in this research are not more than experienced in your everyday life.

Benefits

The benefit is increased awareness about opportunities to improve your indoor air quality.

Compensation

A radon test kit will be offered for participation in an interview. There will also be indoor air quality handouts available.

Initial _____

IRBNet ID # 864134

Confidentiality

The records of this research will be kept private. Any publications derived from data collected in this research will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. Your responses to the interview questions will be audio recorded, transcribed and kept for three years in a locked file cabinet. Afterward, these tapes will be destroyed. Only those directly involved with the project will have access to the audio tape of the interview notes. No names will be recorded other than the consent forms. All participants will be assigned an ID number to provide additional confidentiality.

Voluntary Nature of the Research

Participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota- Mankato. If you decide to participate, you are free to not answer any questions or withdraw at any time with no penalty or loss of benefits.

Participants have a right to a copy of this consent form. If you would like a copy, please ask the researcher and one will be provided.

Contacts and Questions

This research is being directed by Dr. Judith Luebke. You can contact Dr. Luebke at 507-389-5938 or at judith.luebke@mnsu.edu about any concerns you have about this project. You may also contact the Minnesota State University, Mankato Institutional Review Board Administrator, Dr. Barry Ries, at 389-1242 or barry.ries@mnsu.edu with any questions about research with human participants at Minnesota State University, Mankato. You may ask any questions you have now.

You will be given a copy of this information to keep for your records.

Statement of Consent

I have read the above information and have been allowed time to ask questions. I consent to participate in this research.

“I agree _____ I disagree _____ to have my responses recorded on audio tape”

Name (please print): _____

Signature: _____ Date: _____

Signature of Investigator: _____ Date: _____

Appendix D
Interview Guide

Interview Questions

I'd like to start by asking you about your neighborhood.

1. How long you have lived in North Minneapolis?
2. What do you enjoy about living in North Minneapolis? What do you not like about living in North Minneapolis?

Next, I'd like to talk about your current living environment.

3. Do you know what year the building you're currently living in was built?
 - a. (if no) Do you know if it was built before 1960?
4. Are you familiar with the term IAQ?

Indoor Air Quality is defined as: The presence (or lack of) pollutants in a building that have adverse effects on human health such as tobacco smoke, carbon monoxide, radon, mold, lead and asbestos.

5. How would you describe the quality of air in your residence?
 - a. On scale of 1 to 5 (5 being the healthiest), how would you rate the quality of air in your residence?
6. Do you have any questions or concerns about your indoor air quality?

The following questions explore your health.

7. What health problems do you think poor IAQ can cause?
8. Do you think the building materials in your residence affect IAQ?
9. Do you think your IAQ needs to be improved?
10. Have you made any changes to improve the IAQ?

11. If yes, what's preventing you from taking action to improve IAQ?
12. What health benefits do you think improved IAQ might have?

To close I have one final interview question for you.

13. Is there anything you would like to add about your home, IAQ or health that we haven't covered?

Appendix E
Sociodemographic Form

ID# _____

To better understand the perspectives of participants, please complete this short background information worksheet. All responses will be kept confidential.

1. What is your age? _____.
2. What is your race?
 - a. Black or African American
 - b. Native American or American Indian
 - c. Hispanic or Latino
 - d. Asian/Pacific Islander
 - e. White
 - f. Other, please state _____
 - g. Prefer not to answer
3. Do you have any children? a. Yes b. No
4. If yes, how many? _____.
5. If yes, what are their ages? _____.
6. What is the highest level of school you have completed?
 - a. Did not finish high school
 - b. Completed high school
 - c. Some college but no degree
 - d. Associate degree or vocational degree
 - e. College bachelor's degree
 - f. Some graduate work
 - g. Completed graduate degree
(Masters or PhD)
7. What is your total household income?
 - a. Under \$10,000
 - b. \$10,000-\$19,999
 - c. \$20,000-\$29,999
 - d. \$30,000-\$39,999
 - e. \$40,000-\$49,999
 - f. \$50,000-\$59,999
 - g. \$60,000-\$69,000
 - h. \$70,000 or more

8. What type of residence do you live in?

a. House

c. Condominium

b. Apartment

d. Other (please describe) _____

9. Do you rent or own? (Circle one) Rent Own

10. How many people are living in the residence? _____.

11. Does anyone in your household smoke tobacco? a. Yes b. No

12. Rate how serious the following issues are on a scale of 1-10 with 10 being very serious.

Asthma 1 2 3 4 5 6 7 8 9 10

Allergies 1 2 3 4 5 6 7 8 9 10

Lung cancer 1 2 3 4 5 6 7 8 9 10

Lead poisoning 1 2 3 4 5 6 7 8 9 10

13. How concerned are you that the following issues may impact your or your family's health? Please rank on a scale of 1-10, with 10 being very concerned.

Asthma 1 2 3 4 5 6 7 8 9 10

Allergies 1 2 3 4 5 6 7 8 9 10

Lung cancer 1 2 3 4 5 6 7 8 9 10

Lead poisoning 1 2 3 4 5 6 7 8 9 10

14. Would you like more information on indoor air quality? a. Yes b. No

15. If so, how would you like to receive information?

_____.