ASSESSMENT OF HEALTH AND ENVIRONMENTAL RISK PERCEPTIONS IN SOMERVILLE, TX

A Dissertation

By

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ABSTRACT

Coal tar creosote played a major role in the advancement and expansion of the global transportation system, through the preservation of wood ties and crossties used in the structural development of the trans-continental railroads. Despite these historical and societal advancements, creosote and its varying mixtures of chemicals are a threat to the health and safety of those who work in facilities with creosote and to those living in surrounding communities. Creosote exposure has been associated with several health effects including skin conditions such as dermatoses, various cancers, and immunological, neurological, reproductive and developmental effects. While mitigation options for occupational creosote exposure can be addressed through worker safety training, additional research is needed to better mitigate potential community and domestic exposure.

This project explored three research areas related to residential creosote exposure: to better understand differences in environmental risk perception and concern in a community with known residential creosote exposure, assess the impact of time lived in the community on resident's mental and physical health, and to assess residential perception of home buyout and relocation and understand the factors that impact willingness to be bought out or relocate. Racial and ethnic minorities and low-income residents of environmental justice communities are disproportionately exposed to environmental hazards. Research has also shown that differences in perceived environmental risk exist by gender, age, race and proximity to hazards (Flynn et al. 1994; Greenberg 2012; Lujala et al. 2015). For example, studies have shown that environmental concern is more prevalent among Blacks when compared to their White counterparts (Cutter, 1981).

As seen in prior studies, female respondents were more likely to show high levels of concern regarding environmental pollution or contaminants compared to their male counterparts (OR=4.38; 95%CI=1.24-15.38). When assessing concern by gender and race, Non-White females were approximately 10 times more likely to demonstrate high levels of concern when compared to Non-Hispanic White males (95%CI: 9.75). Mental and physical health scores among the sample population were significantly lower than the U.S. national average even after stratification by gender and race groups. Age was found to be a significant predictor of physical health score after adjusting for gender and time lived in Somerville (coef=-0.16, p-value=0.02). When assessing likeliness to relocate, females were approximately 4 times more likely to consider relocation when given fair value or financial assistance compared to their male counterparts (OR=3.81, p-value=0.03). Being female remained a significant predictor of likeliness to relocate after adjusting for race, age, and time live in the household (OR=4.22; 95%CI=1.18-15.11) or time lived in Somerville (OR=4.74; 95%CI=1.26-17.93). This project shows evidence that gender and racial differences exist in both the perception of environmental risk and likeliness to relocate among residents of Somerville, TX. This shows a need to address inequalities in both environmental exposure and availability of resources. This study also establishes a baseline of self-reported mental and physical health among Somerville residents and highlights the need for longitudinal, cohort-based health studies to improve understanding of how environmental exposures and environmental racism impact the health of communities over time.

DEDICATION

I dedicate this dissertation to my family and the memory of my ancestors. A special thank you to my mom, Carol Dixon, you have been and continue to be my biggest supporter. Thank you for always stressing the importance of education and seeing more in me than I sometimes saw in myself. Thank you to my dad, Andrew Dixon, you've always pushed me to be the best and taught me the importance of standing in my power. To my father, Darnell Ladson, thank you for providing a listening ear throughout this journey. God's timing is perfect. Leah, thank you for our "sister goals" and keeping me going when I felt like I couldn't push anymore. To my Sims, Dixon, and Ladson families, thank you for your constant support of my educational goals…this is OURS!

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Lastly, I dedicate this dissertation to the next generation of Black and Brown disaster and environmental researchers and practitioners.

Let's keep fighting until BLACK LIVES truly MATTER!

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NOMENCLATURE

ATSDR	Agency for Toxic Substances & Disease Registry
BNSF	Burlington Northern Santa Fe
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CI	Confidence Interval
EPA	Environmental Protection Agency
LULU	Locally Unwanted Land Use
MCS	Mental Composite Score
NPL	National Priorities List
OR	Odds Ratio
PAH	Polycyclic Aromatic Hydrocarbon
PCP	Pentachlorophenol
PCS	Physical Composite Score
ROD	Record of Decision
SF-12	12 Item Short Form Health Survey
TRI	Toxic Release Inventory
URA	Uniform Relocation Assistance and Real Property Acquisition Policies Act
WPW	Wood Preserving Waste

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1. INTRODUCTION

The purpose of this study was to investigate the impact of residential creosote exposure in Somerville, TX, home of a Koppers Inc wood treatment facility. This includes describing the role that race, gender, and length of residence play on environmental risk perception and concern, characterizing the health-related quality of life of Somerville residents, and assessing the perception of home buyout and relocation and the factors that may impact these views.

This section covers the key concepts and literature related to creosote exposure and describes the overall rationale for this study. Prior research and gaps in existing literature are investigated and discussed, providing the basis and justification for this research project. While extensive research exists in the areas of environmental justice, differences in environmental risk perception, and home buyout and relocation, there is limited literature focused on creosote exposure.

1.1 Background

1.1.1 Creosote

According to the Centers for Disease Control and Prevention's (CDC) Agency for Toxic Substances and Disease Registry (ATSDR), creosote describes substances that contain a mixture of hundreds or thousands of chemicals (CDC, 2015). Creosotes encompass six major classes of compounds; aromatic hydrocarbons such as polycyclic aromatic hydrocarbons (PAHs), phenolics, nitrogen-containing heterocycles, sulpher-containing heterocycles, oxygen-containing heterocycles, and aromatic amines (NLM, 1985). Of these compounds, PAHs constitute approximately 90% of all creosotes (Melber, Kielhorn & Mangelsdorf, 2004). While many types of creosote mixtures exist, the physical and chemical properties of these creosotes vary depending on their source. The most commonly known creosotes are coal tar creosote and wood creosotes.

Wood creosotes are produced from the use of beechwood or the resin of leaves from creosote bushes, a bush native to Texas and other dry, low-lying areas (HHS, 2002). Wood creosote is formed by high-temperature treatment of wood through the process of fractional distillation (HHS, 2002). Wood creosote is a relatively water soluble, colorless to yellowish greasy liquid that gives off a smoky burnt smell (CDC, 2015). Wood creosote, more specifically beechwood creosote, has a history dating back to the early 1800s including medicinal use as a disinfectant, laxative, and cough expectorant, as well as for the treatment of diseases including diarrhea, leprosy, pneumonia and tuberculosis (CDC, 2015). While wood creosote is no longer a widely used as a pharmaceutical in the U.S., it is still commonly used as a holistic treatment for diarrhea related to acute and chronic digestive disorders throughout Asia (Hiramoto et al., 2012).

Coal tar creosote is an oily liquid which is often brownish-black or yellowish-dark green in color. It is highly flammable and has poor water solubility (CDC, 2015; HHS, 2002). Unlike wood creosote, which primarily contains phenols, coal tar creosote is primarily composed of PAHs. Similar to the process of wood creosote formation, coal tar creosote is the product of treating coal tar at high temperatures by fractional distillation. There are two major types of coal tar creosote, P1/P13 fraction and P2 fraction (Government of Canada, 2017). P1/P13 fraction - known as creosote preservative - is a mixture of 50% creosote and 50% petroleum oil, and P2 fraction is known as creosote solution. The primary use of coal tar creosote is the preservation of wood, which prevents destruction of the wood by insects or microorganisms and leads to an increased service life (Government of Canada, 2017). The use of coal tar creosote to preserve wood dates back to the 1830s, when coal tar creosote was patented for use in several newly developed wood treatment methods. The new methods were developed primarily to support the use of treated wood for railroad construction during the industrial revolution. The process of pressure impregnation, also known as the full-cell process, transformed the field of wood preservation. By the early 1900s, commercial facilities were producing creosote in large amounts for production of railroad crossties, switch ties, utility poles, and bridge timbers (Murphy & Brown, 2005).

Exposure to creosote can occur through the routes of inhalation, ingestion, and dermal exposure. Creosote is toxic to aquatic organisms and is hazardous to the environment (HHS, 2002 ; TCEQ, 2002). Exposure to creosote has been associated with various health effects for both workers in industrial facilities, as well as for people residing in the neighborhoods near them. Short term dermal exposure to creosote can cause skin irritation, itching, burning, redness, sores, or sensitivity to sunlight (TCEQ, 2002). Other known health effects include chemical burns to the eyes, kidney or liver problems, neurological, reproductive, respiratory and digestive issues, cancers, or death (CDC, 2015; CDC, 2003).

Creosote is classified by the Environmental Protection Agency (EPA) as a group B1 carcinogen and by the World Health Organization's International Agency for Research on Cancer as a group 2A carcinogen, meaning it is a probable human carcinogen (EPA, 1988). Creosote's classification and a probable human carcinogen is due to a combination of the limited amount of evidence for the association between direct contact to creosote and tumor development, sufficient evidence of tumor formation in mice, and the presence of existing data on the association of carcinogenicity and human exposure to other coal tar products (EPA, 1988). As for carcinogenicity in animals, there is sufficient evidence of the association between direct dermal contact and tumor formation (EPA, 1988). Although limited, studies have been conducted on creosote exposure and skin cancer, squamous cell carcinoma, renal pelvis and urinary bladder cancers (Karlehagen, Andersen & Ohlson, 1992; Pan, Morrison & Gibbons, 2011).

1.1.2 Occupational Creosote Exposure

Occupational exposure to coal tar creosote has been associated with work in the fields of wood preservation, fence building, bridge construction, utilities, aluminum smelting, and creosote site remediation (Carlsten, Hunt & Kaufman, 2005). Routes of exposure include inhalation, ingestion, and dermal exposure. Occupational exposures can result from direct contact of skin and coal tar creosote and from the wearing of creosote contaminated clothing.

A 1979 health study of workers across nine coal tar plants showed a 20% incidence of skin irritation, eczema and other dermal conditions (HHS, 2002). Though it is heavily underreported, contact dermatitis accounts for 90% of all occupational dermal illnesses with chemical exposure related contact dermatitis accounting for approximately 30% of all reported occupational illness (Sasseville, 1995; NASEM, 1995).

A retrospective cohort study was conducted to assess malignant and nonmalignant relative mortality of workers employed at 11 creosote wood preservative facilities in the U.S. (Wong & Harris, 2005).

Results showed a statistically significant increase in mortality from lymphatic and hematopoietic cancers among hourly workers with 15.0-24.9 years of employment. A statistically significant increase in mortality from nonmalignant respiratory diseases was also reported among hourly workers with 15.0-24.9 years of employment.

A cohort study of workers employed in seven plants in Sweden and six in Norway was conducted to assess cancer incidence and relative risk (Karlehagen, Andersen & Ohlson, 1992). Study participants included 922 men (346 Swedish and 576 Norwegian) with verified exposure to creosote employed at one of the facilities for at least one year between 1950 and 1975 (Karlehagen, Andersen & Ohlson, 1992). Cancer registries of both countries were reviewed to determine cancer incidence among participants (Karlehagen, Andersen & Ohlson, 1992). The observed number of cancer cases was 129, 39 in Sweden and 90 in Norway (Karlehagen, Andersen & Ohlson, 1992). Results also showed an increased risk for lip cancer (RR=2.50), non-melanoma skin cancer (RR= 2.37), and malignant lymphoma (RR=1.9) when compared with the expected number of cases of each cancer (Karlehagen, Andersen & Ohlson, 1992).

1.1.3 Community Creosote Exposure

Non-occupational creosote exposure typically results from creosote in soil, ground water, wastewater, and air. Approximately 1-2% of coal tar creosote used during the wood treatment process is released into the air (CDC, 2015). Improper disposal of treated wood and by-products can lead to its presence in the soil and water surrounding treatment plants. A 2003 study conducted by Dahlgren et al. aimed to evaluate the health status of African American residents in a community in eastern Mississippi residing in close proximity to a wood treatment plant (Dahlgren & Warshaw, 2003). In this community, wood preserving waste (WPW) chemicals including creosote were discharged into ditches which flowed into a local river. When talking with researchers, residents mentioned daily air pollution from the nearby plant and strong odors which caused headaches, eye irritation, nausea, sore throat and other symptoms. Among exposed adults, the severity score for skin irritation was 6.0 compared to 2.7 among controls for an adjusted difference of -3.3 ($p<0.05$). Among children, the severity scores for cases and controls were 6.6 and 2.0 respectively with an adjusted difference of -4.5 ($p<0.05$) (Dahlgren & Warshaw, 2003). Significantly higher severity scores were also seen among the exposed adults and children for other mucous membrane and skin irritation symptoms and neurological symptoms. Study participants reported neighborhood children played in ditches that often flooded with wastewater and run-off from the treatment facility.

A similar study conducted in 2003 in Texarkana, TX investigated the health outcomes of residents living near an abandoned wood treatment plant (Brender et al., 2003). Health outcomes of residents were compared with those of a community located 2.4km from the site. Of the 214 participants residing near the former wood treatment facility 58 (27.9%) reported skin rashes compared to 10 (4.9%) of 212 participants in the comparison community. Those living nearer to the plant had an increased risk of developing a skin rash when compared to those living farther away (RR=5.7 95% CI: 3.0,10.9) (Brender et al., 2003).

When adjusted for community specific environmental concerns, the increased risk of developing a skin rash in the targeted area was 3.8 (95% CI: 1.2,11.5) (Brender et al., 2003). Adjustment for environmental concerns moved the relative risk towards the null because individuals who reported worry about environmental issues had a higher prevalence of reported health problems. Nineteen percent of participants in the exposed population living nearer to the wood treatment facility reported difficulty becoming pregnant for at least one year compared to 5.7% in the comparison community (RR=3.3, 95%CI: 1.3,8.7) (Brender et al., 2003).

While there have been relatively few studies of the potential health impacts of community exposure to creosote, communities bordering existing or abandoned creosote facilities have expressed concerns about higher rates of various cancers, including breast cancer, skin cancer, leukemia, bladder cancer and lung cancer (Karlehagen, Andersen & Ohlson, 1992). Increased cancer rates have been seen among individuals living in environmental justice communities where residents have been exposed to varying hazards including asbestos, chromate, fossil fuels, and agricultural chemicals (White HL, 1998; Maantay, 2001; Brender, Maantay & Chakraborty, 2011; Benedetti, Lavarone & Comba, 2001; Gottlieb, Shear & Seale, 1982).

1.1.4 Take-Home Exposure

Assessing community exposure to creosote is complicated by the potential for non-occupational exposure among family members of workers with occupational exposure, often referred to as take-home exposure.

Take-home exposure may occur when creosote is carried into vehicles and homes on the clothes, shoes, or skin of workers. This is especially of concern to families with young children. Factors that may increase the exposure to young children include a higher frequency of hand-to-mouth activity and their proximity to and time spent on the floor.

Studies on parental occupational exposure have found increased risk of childhood cancers with exposure to wood dust and various chemicals included in coal tar creosote (Feingold, Savitz & John, 1992). Feingold et al. determined that the odds of cancer among children with paternal occupational exposure to creosote during the year prior to the child's birth was 2.5 times the odds of cancer among children with no paternal occupational exposure (Karlehagen, Andersen & Ohlson, 1992). Paternal occupational exposure to creosote was also associated with childhood brain cancer (OR=3.7) (Feingold, Savitz & John, 1992).

In addition to the effects of parental exposure on young children, concern remains that high levels of creosote exposure may be associated with an increased risk of birth defects, infant mortality, still birth, pre-term delivery, and difficulty conceiving. In a case-control study of the association between maternal occupational exposure to PAHs and gastroschisis, a birth defect of the abdominal wall, the odds of having a baby with gastroschisis among mothers with occupational PAH exposure was 1.75 times the odds among mothers with no PAH exposure (95%CI: 1.05, 2.92) (Lupo, Langlois & Reefhuis, 2012; CDC, 2017).

When stratified by age, among those 20 years of age or older, the odds of having a baby with gastroschisis among mothers with occupational PAH exposure was 2.53 times the odds among mothers with no PAH exposure (95% CI: 1.27, 5.04).
The lack of association between PAH exposure among younger mothers and gastroschisis could demonstrate that prolonged occupational exposure may contribute to birth defects.

1.1.5 Relocation and Buy Out

The EPAs Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, was enacted to "provide broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment" (EPA, 2018). Superfund legislation also requires the EPA to clean up contaminated hazardous waste sites. According to the EPA, one of the goals of Superfund is to "make sure that at every cleanup site, the Agency and its partners have an effective process and the necessary tools and information to fully explore future uses, before the cleanup remedy is implemented" (EPA, 2018). Some cleanup and redevelopment projects- such as Emeryville City in Alameda County, Cl - have been successful, with the "Bay Street" redevelopment project bringing shops, restaurants and entertainment to the city while boosting the local economy and providing jobs (Whitney, 2003).

While there are potential community benefits including reduced exposure and economic gains during proper cleanup and redevelopment projects, there are also challenges including the cost and quality of clean up, legal issues, and lack of community involvement in the redevelopment process. Carver Terrace, an African American community in Texarkana, TX, is one example of a clean-up and redevelopment process that did not benefit its residents. Carver Terrace is a 79-unit subdivision that was built in 1964 on 34 acres of the former creosote plant (EPA, 2019). Twenty years after its development, the state of Texas discovered pentachlorophenol (PCP), arsenic, and creosote in the soil and ground water of the community (Bullard & Wright, 1993). In 1984, the community became a Superfund site. In 1988 a Record of Decision (ROD) called for the onsite treatment of contaminated soil and ground water (EPA, 1992; Bullard & Wright, 2012). A subsequent Congressional mandate called for an amendment of the ROD and ordered the buyout and relocation of affected residents and a reclassification of the property for commercial use only (EPA, 2018; EPA, 1992; Bullard & Wright, 2012). Federal buyouts in the U.S. began in the late 1970s, when the Love Canal became one of the first cases of environmental exposure leading to a community buyout (Shriver & Kennedy, 2005).

Perception of and will to relocate or be bought out are influenced by factors such as economic concerns around property values, community attachment, home ownership or renter status, and physical and psychological well-being. Economic concerns may arise due to the facility causing environmental exposure being a source of employment and its financial impact on the community. Economic concerns around property values may be based on the age of the resident or length of residency. For example, Shriver and Kennedy (2005) demonstrated that older residents of the Love Canal wanted to stay in the community due to fears about economic losses and lower property values. However, younger residents felt forced into staying in their homes because of "inversion of home," the inability to afford moving because of depreciation of property values (Shriver & Kennedy, 2005). Younger residents saw a federal buyout as a reasonable solution and a means of economic improvement. (Shriver & Kennedy, 2005).

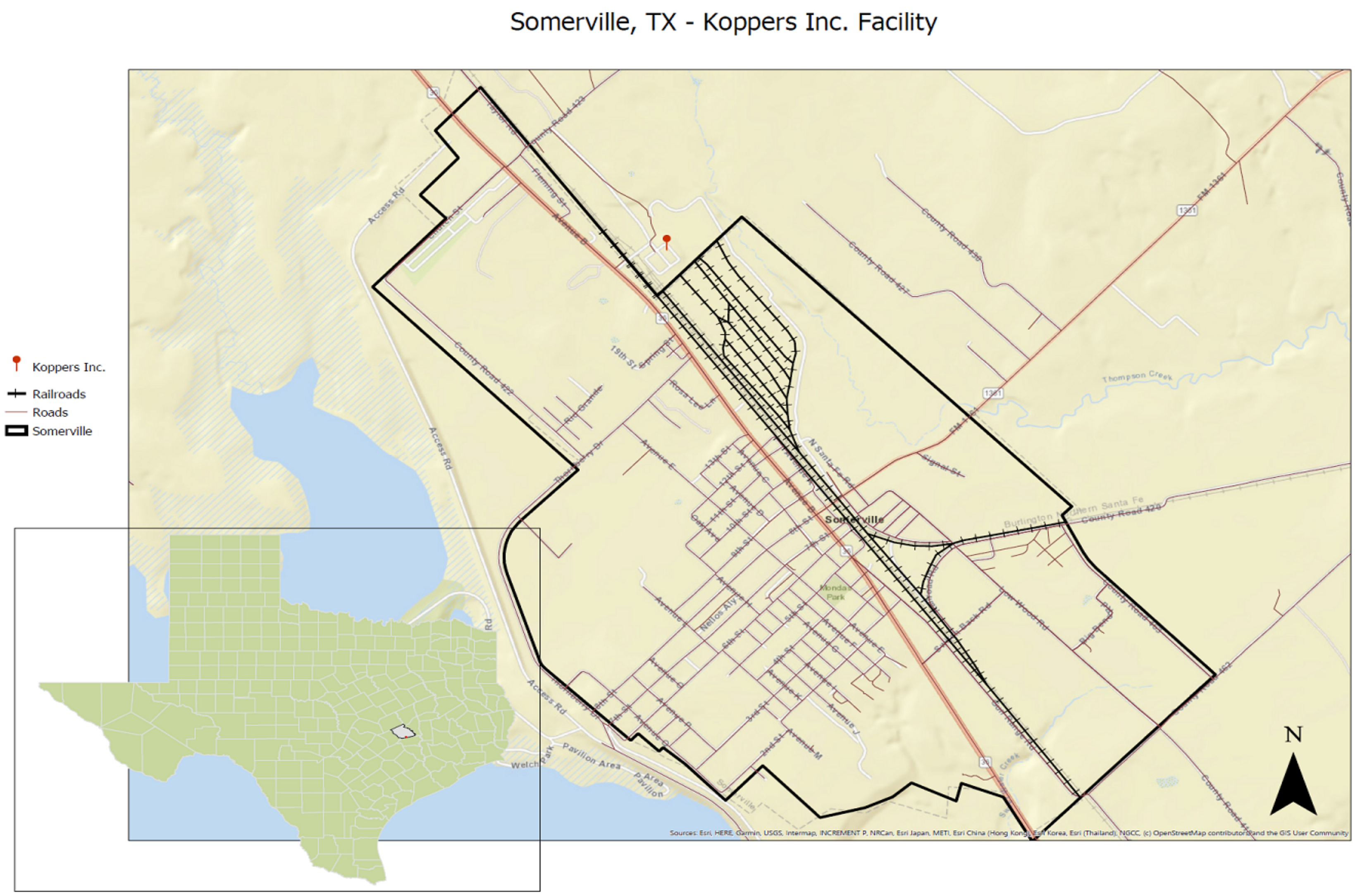
Community attachment is defined as "the emotional investment in place that emerges in the context of residence and belonging (Brehm et al., 2006)." The community attachment model developed by Kasarda and Janowitz (1974) stated that community attachment was the systematic interactions between length of residence, age or stage in the life cycle, and position in the hierarchy of social class (Brehm et al., 2006; Kasarda & Janowitz, 1974). The longer an individual resides in their home or community, the stronger the ties become. While there is limited information on the association with physical and psychological well-being and relocation and buyout, a study looking at technological disaster and chronic community stress found that among residents of a Superfund site community there was an association between perceived threats to physical health and a desire to relocate (Hunter, 2005).

1.1.6 City of Somerville Characteristics

Somerville, TX is located in Burleson County, 80 miles north of Houston and 25 miles west of College Station (Figure 1.1). Somerville is home to approximately 1,483 residents living in 509 households with an average household size of 2.50 and an average family size of 3.05 (U.S Census Bureau, 2019).

Of the 509 households, 337 are owner-occupied housing units. Approximately 62% of Somerville residents are Non-Hispanic White, 25% are Black or African American, and 27% are Hispanic, dissimilar to the state of Texas where residents identify as 41.5% Non-Hispanic White, 12.8% Black or African American, and 39.6 % Hispanic (U.S Census Bureau, 2019). As of 2017, the median household income is relatively low at $42,617, compared to $56,235 for Burleson County, and $59,570 for the State of Texas.

Figure 1.1 Sample Map



Somerville was founded in 1882 when the Santa Fe Railroad Co. established a railroad tie plant and switching yard. Since 1897, several companies have run wood treatment facilities in Somerville, including Burlington Northern Santa Fe Railway Co. (BNSF), one of the largest freight companies in North America. This facility, now known as Koppers Industries Inc., is the only facility in Somerville that reports to the EPA's Toxic Release Inventory (TRI). The Koppers Industries Inc. Somerville facility currently contains four creosote treating cylinders. In 2018, the facilities TRI Facility Profile Report showed a total on-site chemical release of 7,421 pounds of creosote via fugitive or non-point air emissions, stack or point air emission, and discharges to receiving streams or water bodies (EPA, 2018).

On October 25, 2007, current and former residents of Somerville filed a lawsuit against BNSF and Koppers Industries Inc. seeking to represent "all persons who own property or lease property within 1 mile" of the facility. Residents alleged that BNSF and Koppers operated the plant in a manner that released dangerous chemicals into the environment leading to soil, ground water, and air contamination that resulted in physical injuries and property damage. Between February and August of 2008, lawsuits were dismissed or dropped. In 2010, approximately 90 residents filed a class-action suit stating that pentachlorophenol, coal tar creosote, and other chemicals from the plant had contaminated homes, schools, and businesses, with the environmental contamination leading to increases in rates of cases of cancer and birth defects in Somerville. Although several other former wood treatment facilities in Texas have been listed as Superfund sites and have been subject to environmental investigation and remedial actions, the class-action lawsuit was dismissed in December 2010. Although we know a good deal about the health impacts of occupational creosote exposure, little is known about residential exposure. The continuation of the environmental litigation may have provided financial support for residential creosote exposure studies; their dismissal demonstrates the need for this study. These factors led to the selection of Somerville as a study location to assess the risk perceptions of residents to domestic creosote exposure.

1.2 Study Rationale

1.2.1 Environmental Health Risk Perception

Prior research has demonstrated differences in perceived risk of the potential health impacts from environmental exposures by gender, race, age and proximity to hazards (Flynn et al. 1994; Greenberg 2012; Laws et al. 2015). For example, a group of studies have demonstrated that White males perceive their health risk from environmental exposure as lower and are less concerned about exposure to environmental hazards than women or people of other races (Flynn et al. 1994; Finucane et al. 2000; Palmer 2003; Sansom 2019). However, some studies have shown that this association is confounded by physical distance from the exposure (Laws et al. 2015). Toxic and hazardous waste facility host neighborhoods are largely composed of low income and racial minorities (Bullard et al. 2008). These communities are disproportionally impacted by environmental hazards based on race, income, and other social factors. Studies have also found negative correlations between age and environmental concern and risk perception, with older residents reporting lower levels of concern about the health impacts of environmental contamination (Greenberg 2012; Macias 2016).

To our knowledge gender, race, age, proximity to hazards and their correlation with risk perception and concern have not been addressed in communities with residential creosote exposure.

1.2.2 Heath-Related Quality of Life

Environmental justice communities have been shown to face adverse psychological and physiological health effects due to environmental hazard exposure (Martuzzi et al. 2010; Maantay et al. 2010; Mohai et al 2009; Peek et al. 2010). Proximity to waste sites and industrial facilities including nuclear power plants, petrochemical plants, incinerators and landfills have been associated with negative health outcomes including cancer, adverse pregnancy outcomes, respiratory and cardiovascular diseases (Choi 2006; Kaatsch et al. 2008; Langlois et al. 2009; De Roos et al. 2011). A 2005 study conducted by Downey and Van Willigen explored the relationship between residential proximity to industrial sites and mental health. Results demonstrated that residential proximity to industrial facilities has a direct, positive association with symptoms of depression.

More specifically, exposure to creosote has been associated with adverse health outcomes including cancer, cardiovascular and respiratory diseases (Lenson 1956; Karlehagen et al. 1992; Brender et al. 2003; Dahlgren et al. 2003; Carlsten et al. 2005). However, the majority of these creosote exposure health studies occur in occupational settings and there have been no studies to date that investigate the psychological health impacts of creosote exposure.

1.2.3 Home buyout and Relocation Perception

Home buyout programs were designed to facilitate the permanent relocation of residents out of hazard-prone communities and have been a more widely used tool for disaster mitigation (Binder et al., 2015; Binder et al., 2020). Long term relocation is considered to be one of the most effective long-term strategies for adaptation among many coastal communities due to lack of affordability of structural protection measures and other factors (Bukvik et al., 2015). While home buyout and relocation programs may be an effective solution to the environmental exposure issues faced by communities, for some, this solution is socially and economically disruptive (Mohai et al. 2009). Factors such as economic concerns around property values, community attachment, homeownership or renter status, and physical and psychological well-being impact peoples' perception of and will to relocate. Relocation may force families to move a significant distance from the area, leaving jobs and social networks behind (Binder et al. 2015; Seebauer and Winkler, 2020). Prior studies indicate that long-term residents have stronger attachment to their communities (Theodori, 2004; Shriver and Kennedy, 2005). Buyout and relocation programs also have an extensive history of lacking transparency, which may lead to increased public distrust of the process (Siders, 2018).

1.3 Significance

The Somerville plant has been in operation since 1897. Historically, the plant produced railroad parts and bridge timber. Today, the plant is limited to the wood treatment of cross ties and switch ties.

For over 100 years, the residents of Somerville have been exposed to hazardous substances from the plant, such as creosote, chromate copper arsenate, and pentachlorophenol (Rosenfield & Feng, 2011). According to EPA's TRI facility profile report, the facility reports on- and off-site releases of benzo(g, h, i)perylene, creosote, ethylbenzene, naphthalene, polycyclic aromatic compounds and xylene (EPA, 2017). Residents of Somerville have reported negative health impacts including birth defects such as cleft palates, brain tumors, and various types of cancers, which they believe to be associated with these exposures. Existing research has shown that living near hazardous environmental sites is associated with poorer health and increased risk of adverse health outcomes (Brender, Maantay & Chakraborty, 2011; Chakraborty, Maantay & Brender, 2011; Elliott et al., 2000). According to Dr. James Dahlgren of UCLA School of Medicine, dust samples from homes and schools in Somerville had contamination levels higher than those found in Love Canal, PA (Spivak, 2007).

While many former creosote and wood preservation plants like the Kopper Co, Inc. plant in Texarkana, TX and Escambia Treating Company in Pensacola, Fl have been shut down and added to the EPAs Superfund and Superfund National Priorities list, others like the Kopper Co., Inc. facility in Somerville, TX are still operational. Residential neighborhoods surrounding these other facilities have received buyouts or been relocated. This study seeks to further the existing knowledge of the potential physical and psychological impacts of residential proximity to a creosote facility while assessing community interest in relocation or buyout.

1.4 Overview of the Study Design

The overall goal of this study was to collect data and perform analysis to assess community perceptions of creosote risk exposure, self-rated physical and mental health, and perceptions of relocation and buyout among different demographic groups. Utilizing a cross-sectional study design

1.4 Survey Data Collection

A power analysis was conducted to determine the sample size estimation(Figure 1.2). Further type I error rate (α) of 0.05 and a desired statistical power of 80 percent were goals to detect a change of 2.5 points from national norms. This required a sample of 126 participants to be recruited in Somerville, TX.

Figure 1.2 Power Calculation to Estimate Total Sample Size

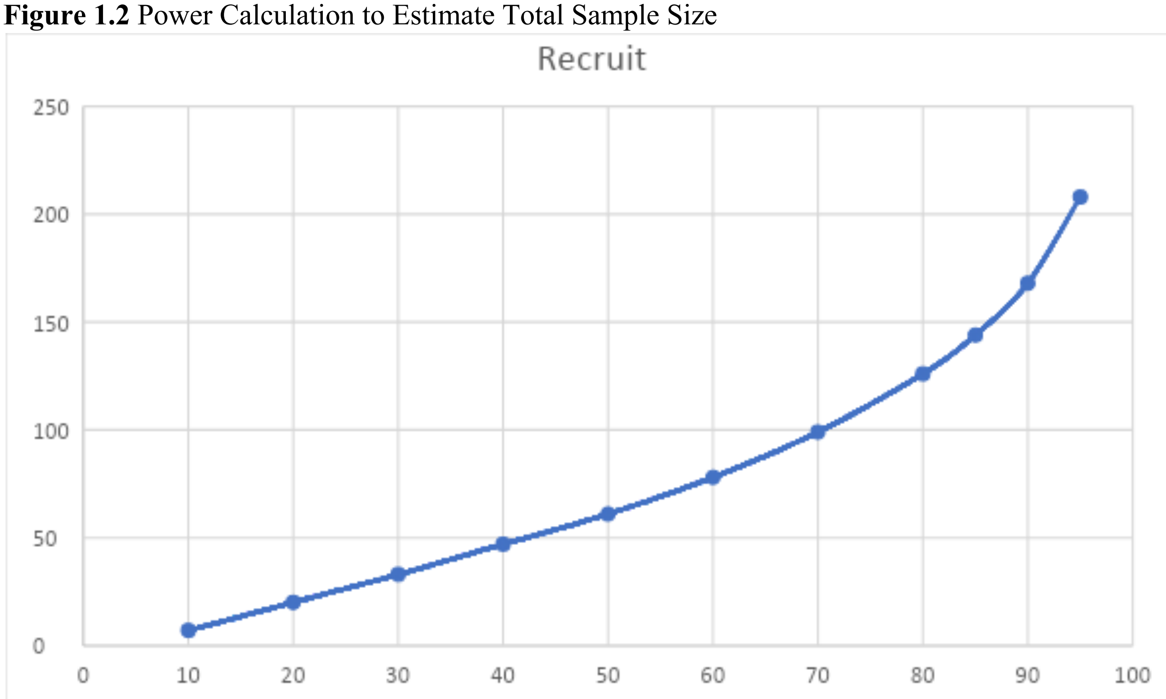


Figure 1.3 Sample Location with Geographic Zones

The study area was divided into nine geographic zones with zone one being the closest in proximity to the Koppers Inc. facility and zone nine being the furthest (Figure 1.3). Survey teams were comprised of student volunteers from the Texas A&M University School of Public Health's EpiAssist program who provide surge capacity for conducting public health field work. A just-in-time training was held to ensure that all volunteers were familiar with the survey and the required consent documents prior to conducting the interviews.

Interviews were conducted over four visits to Somerville between January 11 and March 1, 2020. Interview teams consisting of two or three members were sent to a specific zone to conduct interviews. Homes that were fenced off, abandoned, or deemed unsafe by the team were not approached. Teams kept a record of all completed interviews, refusals, and any language barriers encountered for the calculation of contact (the number of completed interviews divided by the total number of housing units at which contact was attempted), cooperation (the number of completed interviews divided by all eligible housing units that were contacted), and completion (the number of completed interviews divided by the goal number of completed interviews) rates.

The survey included four sections. The first section included eight demographic questions such as gender (male or female); year of birth; race (White, Black or African American, American Indian or Alaska Native; Asian, or Native Hawaiian or Pacific Islander); ethnicity (Hispanic); level of education (at least a high school diploma), employment status; length of residence in the home and length of residence in Somerville. Due to the low number of respondents, race was recoded as Non-Hispanic White or Non-White.

The second section of the survey included 12 items to assess self-rated physical and mental health. The items were adopted from the 12-Item Short-Form Health Survey (SF-12) (Ware et al., 1996). The SF-12 was adapted from the 36-Item Short-Form Health Survey (SF-36), allowing for the measurement of health status in a shorter version. The SF-12 includes items from each of the eight health concepts in the SF-36; physical functioning (PF), Role-Physical (RP), Bodily Pain (BP), General Health (GH), Energy/Fatigue (VT), Social Functioning (SF), Role-Emotional (RE), and Mental Health

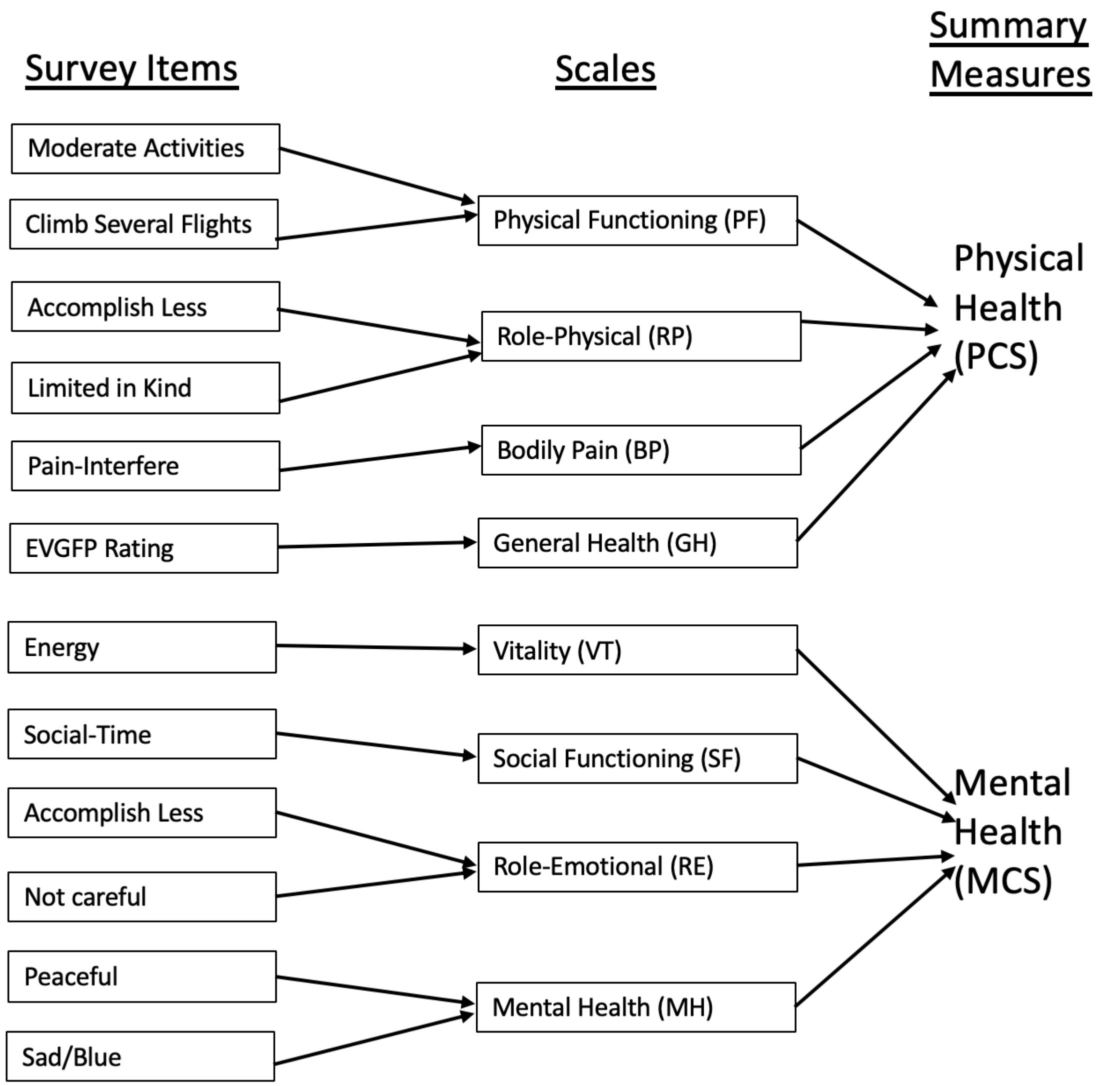
(MH) (Ware et al, 1995). Each of the eight concepts is aligned with the Mental Component Summary (MCS) or the Physical Component Summary (PCS) (Figure 1.4).
Items in the SF-12 have been compared to the SF-36 and tested for reliability and validity among a general population. Results showed that the SF-12 was able to explain at least 90% of the variance in the SF-36 for Mental Component Summary (MCS) (R^2=0.918) and for the Physical Component Summary (PCS) (R^2=0.911) (Ware et al., 1996). The SF-12 has been assessed for reliability and validity among various populations and results have been found to be similar to those of Ware et al., 1995 (Kontodimopoulos et al., 2007; Gandhi et al., 2001).

The third section of the survey contained questions to assess an individual's knowledge and perception of living near the Koppers Inc. creosote facility. Participants were asked if they were aware that the Koppers Inc. facility operated in the city of Somerville (yes or no). If yes, they were asked if they had any personal contact with the site (yes or no). All respondents were asked to rate the overall air quality (Excellent, Very Good, Good, Fair, or Poor) and the surface water quality (Excellent, Very Good, Good, Fair, or Poor) in Somerville; how concerned they were about environmental pollutants or contaminants in the community (Extremely, Quite a bit, Moderately, A little bit, or Not at all); and if they agreed that health problems they experienced were due to exposure to pollution or contaminants in their residential area (Strongly agree, Agree, Neither, Disagree, or Strongly disagree). Responses for each of these four questions were combined to create dichotomous variables.

Section four of the survey contained questions gauging individuals' perceptions on relocation or home buyout. Occupancy type was assessed by asking participants if they or someone else in the household owned or rented the home (I own the home; Another resident owns the home; I rent the home or share equally to pay rent; Another resident rents the home; Other). Likeliness to relocate was assessed based on occupancy type. If the respondent or another resident owned the home, they were asked how likely is it that you or the owner would move out of your residential community if given fair value of a house comparable to a similar home in a low crime area (Very likely, Likely, Unsure, Unlikely, Very Unlikely, Refused). If the respondent or another resident rented the home, they were asked how likely is it that you or the primary renter would move out of your residential community if given the financial assistance to do so (Very likely, Likely, Unsure, Unlikely, Very Unlikely, Refused). Barrier to relocation were assessed by asking respondents to indicate their level of agreement or disagreement with the following statements; moving out of the community would be difficult for me with no additional financial help (Strongly agree, Agree, Neither, Disagree, or Strongly disagree), if relocation were an option I would be concerned about leaving the community because I may lose my social ties (Strongly agree, Agree, Neither, Disagree, or Strongly disagree), and moving out of the community would be difficult for me because of my age (Strongly agree, Agree, Neither, Disagree, or Strongly disagree).

The survey and all accompanying materials were reviewed and approved by the Texas A&M Institutional Review Board (IRB2019-1248). A complete version of the survey questionnaire can be found in Appendix B.

Figure 1.4 SF-12 Measurement Model



1.5 Analysis Plan

Survey responses were recorded by survey teams and entered into a Microsoft Excel spreadsheet. Data from the tracking forms will also be entered into Microsoft Excel to calculate contact, cooperation, and completion rates. Fisher's exact tests were performed to determine the if there was an association between dependent variable (environmental perceptions and concern responses) and independent variable (proximity to facility). Risk differences and 95% confidence intervals for environmental risk perception and concern were calculated . Logistic regression was conducted to estimate the relative effect of race, gender and a combined race/gender variable on environmental risk perception and concern.

The SF-12 section of the survey contained ordinal and binary questions regarding psychological and physiological health. The SF-12 section of the survey was analyzed using the SF-12 Stata code. This analysis included the four steps identified by Ware et al. (1995): data cleaning and item recoding, creating indicator and aggregate variables, weighing of variables, and standardization of scores. Scores for each indicator variable were multiplied by the regression weight for the physical or mental health score. Constants were then added to the weight scores for normalization. One sample t-tests were conducted to compare the resulting mean PCS and MCS scores to the distribution scores in the general U.S. population with an average of 50 and a standard deviation of 10 (Ware, Kosinski, and Keller, 1995). Two-way scatter plots were created to display the correlation between outcome variables (MCS and PCS) and predictor variables (time lived in house and time lived in Somerville). In order to assess the relationship between each covariate and both MCS and PCS, bivariate linear regression was conducted. Multiple linear regression via backward elimination was used to create parsimonious models of MCS and PCS and adjusted for potential confounding.

The home buyout and relocation section of the survey gauged resident's likeliness to relocate and assessed barriers to relocation. Simple logistic regression was used to evaluate associations between the covariates race, gender, and age and resident's likeliness to relocate. Multiple logistic regression was used to estimate the adjusted relative odds of likeliness to relocate. In order to evaluate if there was a relationship between likeliness to relocate and reasons for difficulty relocating, Pearson Chi-Square Test for Independence and Fisher's exact tests were conducted. All analyses were conducted using Stata version 16.0 (StataCorp, College Station, TX).

1.6 Specific Aims

AIM 1: Perform in-person interviews to assess resident knowledge of risks associated with community exposure to creosotes.

SUB AIM 1: Stratify data by gender and race/ethnicity to assess environmental health perceptions and concerns by demographic factors.

Hypothesis: We anticipate that females and racial and ethnic minorities will have higher perceptions of risk and higher levels of concern when compared to their counterparts.

Rationale: Existing research shows that sociodemographic variables such as gender, age, race and education are significantly correlated with environmental risk perception.

AIM 2: Perform in-person interviews to collect data on resident self-rated physical and mental health.

SUB AIM 2 Stratify data by gender and race/ethnicity to assess physiological and psychological impacts of demographic factors.

Hypothesis: We anticipate that Somerville residents will have lower levels of physical and mental health than the U.S. general population. We also anticipate that the longer residents live in Somerville, the lower PCS and MCS scores will be.

Rationale: Research suggests that living in proximity to environmental hazards is associated with adverse health outcomes. Research also shows that racial and ethnic minorities are disproportionately burdened by exposure to environmental hazards.

AIM 3: Perform in-person interviews to assess resident perception of relocation or buyout due to environmental exposure.

SUB AIM 3: Stratify interview data by age of resident, time living in the home, and time living in the Somerville community.

Hypothesis: We anticipate that females and individuals of a racial minority will report increased interest in relocation or buyout.

Rationale: For non-occupational creosote exposure, cleanup, redevelopment and relocation for community members remain viable options; however, little is known about community member's perception of risks or the acceptability of buyouts and relocation. These approaches have been used in other creosote-exposed communities including Carver Terrace in Texarkana, TX and Mount Dioxin in Pensacola, FL. Existing research on relocation or buyouts related to other environmental exposures suggest that age, economic concerns, and community attachment influence community perceptions on relocation and buyout.

2. ASSESSING RISK PERCEPTION OF RESIDENTS OF SOMERVILLE

2.1 Introduction

Prior research has demonstrated differences in perceived risk of the potential health impacts from environmental exposures by gender, race, age and proximity to hazards (Flynn et al. 1994; Greenberg 2012; Laws et al. 2015). For example, a group of studies have demonstrated that White males perceive their health risk from environmental exposure as lower and are less concerned about exposure to environmental hazards than women or people of other races (Flynn et al. 1994; Finucane et al. 2000; Palmer 2003; Sansom 2019). This phenomenon, known as the White male effect, is hypothesized to the results of a combinations of sociopolitical factors including worldviews, trust, and control (Flynn et al. 1994; Finucane et al. 2000). However, some studies have shown that this association is confounded by physical distance from the exposure (Laws et al. 2015). Toxic and hazardous waste facility host neighborhoods are largely composed of low income and racial minorities (Bullard et al. 2008). These communities are disproportionally impacted by environmental hazards based on race, income, and other social factors. For example, both the regulatory and research literature that African Americans and other minority residents are overrepresented in environmental justice communities where sources of environmental pollution are located (Bullard and Wright 1993; Laws et al. 2015; Lujala et al. 2015; Sansom et al. 2016). However, it has been more than 30 years since Bullard's *Dumping on Dixie* (1990) chronicles these disproportionate impacts. Since this time, other studies have found negative correlations between age and environmental concern and risk perception, with older residents reporting lower levels of concern about the health impacts of environmental contamination (Greenberg, 2012; Macias, 2016). These types of generational differences have been attributed to differences in economic involvement, prior exposure experience, and duration of exposure (Greenberg, 2012). Although these demographic variables such as gender, race, age and proximity to hazards and their correlation with risk perception and concern have been studied in communities with municipal waste sites and other hazardous industries such as landfills, incinerators, and petrochemical facilities (Bailey et al. 1992, Wakefield et al. 2000, Hooks et al. 2020); to our knowledge these associations have not been addressed in communities with residential creosote exposure. A cross-sectional study was conducted in the city of Somerville, TX, home of the Koppers Inc. creosote facility, to improve understanding of differences in risk perception among residents.

2.2 Background

Environmental justice communities are communities exposed to inordinate amounts of environmental hazards (Taylor 2014). Black, Hispanic and low-income residents of these environmental justice communities continue to be disproportionately burdened with the presence of toxic waste and hazardous facilities. The disproportionate burden of facility placement is partially due to industries following the path of least resistance by inundating communities known to be economically poor and politically powerless (Bullard 2000). According to Bullard et al. (2008), in 2007 it was estimated that more than 5.1 million people of color, including 2.5 million Hispanics or Latinos, 1.8 million African Americans, 616,000 Asians/Pacific Islanders and 62,000 Native Americans lived in neighborhoods with one or more commercial hazardous waste facilities. Of those neighborhoods with commercial hazardous waste facilities, 56% of residents were people of color compared to 30% in facility free neighborhoods (Bullard et al. 2008).

Poverty of residents also plays a synergistic role with regard to associations between race and hazardous waste facility siting. Mohai et al. (2009) found that Blacks and respondents at lower income levels were significantly more likely to live within a mile of a polluting facility. When assessing the proximity to TRI sites as a function of race and ethnicity, Pollock and Vittas (1995) concluded that low-income Whites live approximately the same distance from facilities as the overall population mean; low-income Hispanics lived closer, and low-income African Americans lived much closer to facilities than the population mean. Faber and Krieg (2002) constructed an exposure rating and ranked 15 communities that have the greatest densities of hazardous industrial facilities and sites in Massachusetts. Of these 15 intensively overburdened communities, seven were both low-income (median household income is less than $30,000) and high minority (people of color are 25% and greater of the total population).

In addition to proximity to hazardous waste and toxic facilities, these racial- and income-based differences can also be seen in differential rates of exposure among poor and minority groups. When assessing the association between ambient air pollution exposure and both race/ethnicity and racial residential segregation, Jones et al. (2014) found that compared to White study participants, Black and Hispanic participants were exposed to higher concentrations of air pollution. Independent of the race/ethnicity of participants, racial composition and racial segregation of a neighborhood were associated with exposure to air pollution (Jones et al. 2014). Living in a majority White neighborhood was associated with lower air pollution exposure while living in a majority Hispanic neighborhood was associated with higher air pollution exposure (Jones et al. 2014). Lopez (1990) found that in 44 observed metropolitan areas, non-Hispanic Blacks were more likely than non-Hispanic Whites to live in a census tract with higher total modeled concentrations of air toxics.

Risk is a combination of the probability of an event occurring and the magnitude of the associated consequences (Kasperson et al. 1988). Risk perception is created by a person's evaluation of or judgment about the severity of hazards they are or may be exposed to (Rohrmann 2008). Environmental risk perception research is grounded in basic cognitive psychology and has its origins in studies of judgement and decision making focusing on how people understand the magnitude of different risks and to what extent people are prepared to accept them (Slovik et al. 1982). Risk perception, although dependent on societal influences, personal experiences, beliefs and attitudes, and the type of hazard being faced, is often used to guide the policy making process, improve communications with communities, anticipate public responses, and guide educational efforts (Rohrmann 2008).

Risk perception and levels of concern vary with regard to environmental pollution and hazards. In general, those demonstrating the highest risk perception and greatest levels of concern are disproportionality female, Black or Hispanic, and live in closer proximity to environmental exposures (Flynn et al. 1994; Greenberg 2012; Lujala et al. 2015). However, early studies on environmental attitudes and perceptions demonstrated a "concern gap" among African Americans and other minority populations who showed a lack of concern for environmental issues. For example, a 1965 study assessing the effects of demographic and social characteristics on the relationship between reality and perception of hazards found that race influenced perception and White respondents were more likely to perceive hazards than Non-Whites (Van Ardsol et al. 1965). The differences in perception seen in the “concern gap” were attributed to the preoccupation of Non-Whites with other societal problems such as unemployment, a faltering economy, and social, political and economic pressures (Jones and Carter 1994; Kazis and Grossman 1982).

By the 1980s, theories of “black disinterest” in the potential health impacts from environmental hazards were being widely challenged (Macias 2016). Although differences in risk perception were real, these differences actually tended to be small and associated with other complex issues faced by African Americans such as lack of uniformity in regulatory guidelines and policies, urbanization, halting rising crime, improving the educational system and not from a lack of concern (Bullard 2001;. Jones and Carter 1994). Cutter (1981) determined that environmental concern is not solely a concern of the White upper and middle class, and that concern on environmental pollution was more prevalent among Blacks when compared to their White counterparts. Over time, racial differences in perceived risk have been understood as an element of environmental racism.

Simultaneously, the White Male Effect, referring to the lower perception of environmental risk and concern among White males, attributed these lower perceptions to power differentials (Finucane et al., 2000). Differences in risk perception were attributed to the political power and confidence in governmental authorities of White men, compared to women and Non-Whites, which potentially decreased perceived vulnerability and concern. In a study examining the environmental risk perceptions of deep-South coastal residents, Marshall et al. (2006) found that White males were more accepting of environmental risks and less concerned about local pollution than Black residents. Similarly, Satterfield et al. (2004) examined the link between demographic patterns of risk perception and vulnerability and injustice, finding that White men had lower mean responses and risk ratings to hazards such as natural disasters, pesticide exposure, stored nuclear waste, and coal or oil burning plants compared to women and Non-White study participants.

2.3 Materials and Methods

2.3.1 Study Location and Population

Somerville, TX is located in Burleson County, 80 miles north of Houston and 25 miles west of College Station. Somerville is home to approximately 1,483 residents living in 509 households with an average household size of 2.50 and an average family size of 3.05 (U.S Census Bureau, 2019). Of the 509 households, 337 are owner-occupied housing units. Approximately 62% of Somerville residents are Non-Hispanic White, 25% are Black or African American, and 27% are Hispanic, dissimilar to the state of Texas where residents identify as 41.5% Non-Hispanic White, 12.8% Black or African American, and 39.6 % Hispanic (U.S Census Bureau, 2019). As of 2017, the median household income is relatively low at $42,617, compared to $56,235 for Burleson County, and $59,570 for the State of Texas.

Somerville was founded in 1882 when the Santa Fe Railroad Co. established a railroad tie plant and switching yard. Since 1897, several companies have run wood treatment facilities in Somerville, including Burlington Northern Santa Fe Railway Co. (BNSF), one of the largest freight companies in North America. This facility, now known as Koppers Industries Inc., is the only facility in Somerville that reports to the EPA's Toxic

Release Inventory (TRI). The Koppers Industries Inc. Somerville facility currently contains four creosote treating cylinders. In 2018, the facilities TRI Facility Profile Report showed a total on-site chemical release of 7,421 pounds of creosote via fugitive or non-point air emissions, stack or point air emission, and discharges to receiving streams or water bodies (EPA, 2018).

On October 25, 2007, current and former residents of Somerville filed a lawsuit against BNSF and Koppers Industries Inc. seeking to represent "all persons who own property or lease property within 1 mile" of the facility. Residents alleged that BNSF and Koppers operated the plant in a manner that released dangerous chemicals into the environment leading to soil, ground water, and air contamination that resulted in physical injuries and property damage. Between February and August of 2008, lawsuits were dismissed or dropped. In 2010, approximately 90 residents filed a class-action suit stating that pentachlorophenol, coal tar creosote, and other chemicals from the plant had contaminated homes, schools, and businesses, with the environmental contamination leading to increases in rates of cases of cancer and birth defects in Somerville. Although several other former wood treatment facilities in Texas have been listed as Superfund sites and have been subject to environmental investigation and remedial actions, the class-action lawsuit was dismissed in December 2010. Although we know a good deal about the health impacts of occupational creosote exposure, little is known about residential exposure. The continuation of the environmental litigation may have provided financial support for residential creosote exposure studies; their dismissal demonstrates the need for this study. These factors led to the selection of Somerville as a study location to assess the risk perceptions of residents to domestic creosote exposure.

2.3.2 Survey Sample

A power analysis was conducted to determine the sample size estimation. Further type I error rate (α) of 0.05 and a desired statistical power of 80 percent were goals to detect a change of 2.5 points from national norms. This required a sample of 126 participants to be recruited in Somerville, TX.

Figure 2.1 Sample Location with Geographic Zones

The study area was divided into nine geographic zones with zone one being the closest in proximity to the Koppers Inc. facility and zone nine being the furthest (Figure 2.1). Survey teams were comprised of student volunteers from the Texas A&M University School of Public Health's EpiAssist program who provide surge capacity for conducting public health field work. A just-in-time training was held to ensure that all volunteers were familiar with the survey and the required consent documents prior to conducting the interviews. Interviews were conducted over four visits to Somerville between January 11 and March 1, 2020. Interview teams consisting of two or three members were sent to a specific zone to conduct interviews. Homes that were fenced off, abandoned, or deemed unsafe by the team were not approached. Teams kept a record of all completed interviews, refusals, and any language barriers encountered for the calculation of contact (the number of completed interviews divided by the total number of housing units at which contact was attempted), cooperation (the number of completed interviews divided by all eligible housing units that were contacted), and completion (the number of completed interviews divided by the goal number of completed interviews) rates.

The survey included four sections. The first section included eight demographic questions such as gender (male or female); year of birth; race (White, Black or African American, American Indian or Alaska Native; Asian, or Native Hawaiian or Pacific Islander); ethnicity (Hispanic); level of education (at least a high school diploma), employment status; length of residence in the home and length of residence in Somerville. Due to the low number of respondents, race was recoded as Non-Hispanic White or Non-White.

The second section of the survey included 12 items to assess self-rated physical and mental health. The items were adopted from the 12-Item Short-Form Health Survey (SF-12) (Ware et al., 1996).

The third section of the survey contained questions to assess an individual's knowledge and perception of living near the Koppers Inc. creosote facility. Participants were asked if they were aware that the Koppers Inc. facility operated in the city of Somerville (yes or no). If yes, they were asked if they had any personal contact with the site (yes or no). All respondents were asked to rate the overall air quality (Excellent, Very Good, Good, Fair, or Poor) and the surface water quality (Excellent, Very Good, Good, Fair, or Poor) in Somerville; how concerned they were about environmental pollutants or contaminants in the community (Extremely, Quite a bit, Moderately, A little bit, or Not at all); and if they agreed that health problems they experienced were due to exposure to pollution or contaminants in their residential area (Strongly agree, Agree, Neither, Disagree, or Strongly disagree). Responses for each of these four questions were combined to create dichotomous variables. Section four of the survey contained questions gauging individuals' perceptions on relocation or home buyout.

The survey and all accompanying materials were reviewed and approved by the Texas A&M Institutional Review Board (IRB2019-1248). A complete version of the survey questionnaire can be found in Appendix B.

2.3.3 Statistical Methods

Descriptive statistics were calculated for all variables. Logistic regression was conducted to assess for statistical associations between risk perception and level of concern, controlling for race and gender. To determine if there was an association between dependent variables and proximity to the facility Fisher's exact tests were performed.

2.4 Results

Sixty-three surveys were completed for a cooperation rate of 58.3% (63/108) and a contact rate of 22.2% (63/284). Of the survey respondents, 54.0 percent (N=36) were Non-Hispanic white individuals, 19.1 percent (N=12) were Hispanic or Latino, and 20.6 percent (N=13) were Black or African American. Approximately half of respondents were male (54.0%; N=34) and 46.0 percent (N=29) were female. The mean age of all respondents was 53.2 (Median: 54; SD: 17.21) years of age. In 84.1 percent (N=53) of households, every adult has at least a high school diploma. The average years lived in households was 13.75 (SD: 14.43) and the average years lived in Somerville was 24.40 (SD:18.35) (Table 2.1).

Table 2.1 Sample Characteristics

Characteristics	N (%)
Gender	
Male	34 (54.0%)
Female	29 (46.0%)
Race	
Non-Hispanic White	36 (57.1%)
Hispanic or Latino/a	12 (19.1%
African American	13 (20.6%)
Other	2 (3.2%)
Age in Years	
Mean (SD)	53.2 (17.21)
Age in Groups	
< 35	13 (20.6%)
36 – 50	15 (23.8%)
51 – 69	21 (33.3%)
70+	14 (22.2%)
Education (HS Diploma)	
Yes	53 (84.1%)
No	9 (14.3%)
Employment (Currently Unemployed)	
Yes	14 (22.2%)
No	49 (77.8%)
Average Years in House	13.75 (14.43)
Average Years in Somerville	24.40 (18.35)

Respondent's perceptions of contamination and levels of concern with environmental pollution and contamination consistently showed that majority of residents demonstrated some level of concern and perceive environmental quality as less than excellent. (Table 2.2). Ninety two percent (N=58) of respondents were aware that the Koppers Inc. creosote facility operates in the City of Somerville. Of those who were aware, 21 of 58 (36.2%) reported direct personal contact with the site such as employment, visiting family members and friends, or playing there as a kid. A majority of respondents rated the overall air quality in Somerville as fair (30.7%, N=19) or poor (24.2%, N=15). Surface water quality was as a major Concern, with approximately 70 percent of respondents rating the quality of the surface water as fair (24.2%, N=15) or poor (45.2%, N=28).

More than four-fifths of respondents (84.1%, N=53) expressed at least some concern about environmental pollution or contaminants in their community. More than a quarter (N=17) of respondent agreed (15.9%, N=10) or strongly agreed (11.1%, N=7) that they have experienced health problems due to environmental pollution or contaminant exposure in Somerville (Table 2.3).

Table 2.2 Awareness

Awareness of Koppers Inc Facility	
Yes	58 (92.1%)
No	5 (7.9%)
Direct Contact with Site	
Yes	21 (36.2%)
No	35 (60.4%)

Table 2.3 Environmental Perceptions

Perception/Concern	N (%)
Air Quality Rating	
Excellent	6 (9.7%)
Very Good	11 (17.7%)
Good	11 (17.7%)
Fair	19 (30.7%)
Poor	15 (24.2%)
Surface Water Quality Rating	
Excellent	1 (1.6%)
Very Good	7 (11.3%)
Good	11 (17.7%)
Fair	15 (24.2%)
Poor	28 (45.2%)
Concern of Environmental Pollution or Contamination	
Extremely	16 (25.4%)
Quite a Bit	19 (30.2%)
Moderately	10 (15.9%)
A Little Bit	8 (12.7%)
Not at All	10 (15.9%)
Belief that Health Problems are Due to Exposure	
Strongly Agree	7 (11.1%)
Agree	10 (15.9%)
Neither	14 (22.2%)
Disagree	15 (23.8%)
Strongly Disagree	17 (27.0%)

Environmental perceptions and concerns were stratified by race and gender (Table 2.4). Female respondents were 27% (95% CI:27%, 50%) more likely to rate air quality as fair/poor compared to their male counterparts. When examining rating of surface water quality, females were 25% (95% CI: 3%, 47%) more likely to rate surface water quality as fair/poor. Non-White respondents were 8% (10%, 33%) more likely to rate air quality and surface water quality as fair/poor than Non-White individuals. Race was not significantly associated with air or surface quality rating. When assessing concern of environmental pollution or contamination and belief that health problems are due to exposure, race and gender were not significantly associated.

Table 2.4 Distribution, Crude Risk Differences and 95% Confidence Intervals (95% CI) for Demographic Factors Potentially Associated with Environmental Risk Perceptions and Concern

	Air Quality				
Variable	Fair/Poor (n=34)		Good/Excellent (n=28)		Risk Difference (95% CI)
Race					
Non-Hispanic White	18	51.43	17	48.57	REF
Non-White	16	59.26	11	40.74	0.08 (-0.1, -0.33)
Gender					
Male	14	42.42	19	57.58	REF
Female	20	68.97	9	31.03	0.27 (0.27, 0.50)
	Surface Water Quality				
Variable	Fair/Poor (n=34)		Good/Excellent (n=28)		Risk Difference (95% CI)
Race					
Non-Hispanic White	24	66.67	12	33.33	REF
Non-White	19	73.08	7	26.92	0.06 (-0.17, 0.29)
Gender					
Male	19	57.58	14	42.42	REF
Female	24	82.76	5	17.24	0.25 (0.03, 0.47)
Concern of Environmental Pollution or Continuation					
Variable	Not at All/A little (n=18)		Moderately/Extremely (n=45)		Risk Difference (95% CI)
Race					
Non-Hispanic White	12	33.33	24	66.67	REF
Non-White	6	22.22	21	77.78	-0.11 (-0.33, 0.11)
Gender					
Male	14	41.18	20	58.82	REF
Female	4	13.79	25	86.20	-0.27 (-0.48, 0.07)
Belief that Health Problems are Due to Exposure					
Variable	Disagree (n=32)		Agree (n=17)		Risk Difference (95% CI)
Race					
Non-Hispanic White	20	71.42	8	28.57	REF
Non-White	12	57.14	9	42.86	-0.14 (-0.41, 0.13)
Gender					
Male	18	72.00	7	28.00	REF
Female	14	58.33	10	41.67	-0.14 (-0.40, 0.13)

Non-Whites were less likely to have positive ratings for air and surface water quality compared to Non-Hispanic Whites (OR = 0.73; 95% CI=0.26-2.01 and OR=0.74; 95%CI=0.24-2.23). Females were less likely to have positive air (OR=0.33; 95%CI=0.98-1.35) and water quality (OR=0.33; 95% CI=0.09-0.93) ratings than their male counterparts. When comparing Non-Hispanic White males to other gender and racial categories, Non-Hispanic White males were more likely to report positive air (OR=0.33; 95% CI=0.98-1.35, OR=0.78; 95% CI=0.19-3.19, OR=0.27; 95% CI=0.06-1.15) and water quality ratings (OR = 0.17; 95% CI=0.03-0.94, OR=0.55; 95% CI=0.13-2.40, OR=0.30; 95%CI=0.06-1.40)). Regarding level of concern about environmental pollution or contaminants, Non-White Females were approximately 10 times more likely to show high levels of concern than Non-Hispanic White males (OR=9.75; 95%CI=1.07-88.87). Although not statistically significant, Non-Hispanic White females, Non-White males and females, were more likely to agree that health problems were due exposure to environmental pollution or contaminants in comparison to their Non-Hispanic White male counterparts. Fisher's exact test results showed a significant association between proximity to the Koppers Inc. facility to both air quality rating (P value = 0.001) and belief that health issues were due to environmental exposure (P value = 0.03).

Table 2.5 Odds Ratios (OR) and 95% Confidence Intervals (CI) of Environmental Perception and Concern

	OR	95%CI	p-Value
Air Quality			
Race			
Non-Hispanic White	1.00	Reference	
Non-White	0.73	0.26-2.01	0.54
Gender			
Male	1.00	Reference	
Female	0.33	0.12-0.94	0.04*
Race and Gender			
Non-Hispanic White Male	1.00	Reference	
Non-Hispanic White Female	0.33	0.98-1.35	0.12
Non-White Male	0.78	0.19-3.19	0.73
Non-White Female	0.27	0.06-1.15	0.08
Surface Water Quality			
Race			
Non-Hispanic White	1.00	Reference	
Non-White	0.74	0.24-2.23	0.59
Gender			
Male	1.00	Reference	
Female	0.28	0.09-0.93	0.04*
Race and Gender			
Non-Hispanic White Male	1.00	Reference	
Non-Hispanic White Female	0.17	0.03-0.94	0.04*
Non-White Male	0.55	0.13-2.40	0.43
Non-White Female	0.30	0.06-1.40	0.13
Concern of Environmental Pollution or Contamination			
Race			
Non-Hispanic White	1.00	Reference	
Non-White	1.75	0.56-5.48	0.34
Gender			
Male	1.00	Reference	
Female	4.38	1.24-15.38	0.02*
Race and Gender			
Non-Hispanic White Male	1.00	Reference	
Non-Hispanic White Female	3.00	0.65-13.88	0.16
Non-White Male	1.20	0.29-4.93	0.80
Non-White Female	9.75	1.07-88.87	0.04*
Belief that Health Problems are Due to Exposure			
Race			
Non-Hispanic White	1.00	Reference	
Non-White	1.88	0.57-6.17`	0.30
Gender			
Male	1.00	Reference	
Female	1.84	0.56-6.05	0.32
Race and Gender			
Non-Hispanic White Male	1.00	Reference	
Non-Hispanic White Female	1.86	0.35-9.80	0.47
Non-White Male	1.95	0.32-12.01	0.47
Non-White Female	2.79	0.58-13.30	0.20

*Significant at <0.05

2.5 Discussion

This cross-sectional study was designed to assess residential environmental exposure perceptions and concerns among residents who live near a creosote facility in the Somerville, Texas community. Although this study was small, it is unique in that it assesses risk perceptions by race and gender among a group with potential residential exposure to environmental contaminants. The greatest environmental risk concerns identified among the survey respondents were seen among women, Blacks or Hispanics, and those in close proximity to an exposure site (Flynn et al. 1994; Greenberg 2012; Lujala et al. 2015). These results support findings from prior research that women and Non-White individuals are more likely to report negative perceptions of environmental risk (Bullard and Wright 1993; Sansom et al. 2019).

The results of this study show a need to address inequalities in environmental exposure and health outcomes in environmental justice communities. Data should be used to develop an action plan to address the environmental risks faced and drive the decision-making process toward improving the lives of residents. Environmental justice communities should be fully engaged in the policy making process to ensure the development, implementation, and enforcement of regulations and policies are equitable. Results from this study, while not generalizable have implications for approaching future creosote exposure and environmental justice research. Additional residential creosote studies are needed to better understand the risk perception and concerns of communities in proximity to these sites. These studies should be followed up by biological sampling to validate the perception of communities.

This study has several important limitations. Although power calculations based on the community's population indicated a necessary sample size of 126, only 63 surveys were completed. Survey administration was suspended early due to the global impact of COVID-19 and the inability to conduct in-person interviews as part of IRB approved research. In addition to a small sample size, this study had a relatively low response rate of 50% (63/126), which presents the potential of selection bias if those who agreed to participate are different than those who refused to participate. To address this, interview teams were trained, and interviews were conducted interviews on weekdays and weekends; however resident concerns about prior studies related to the creosote research in Somerville may have been factors in resident's lack of willingness to participate. Several residents expressed their concern with the lack of results shared from prior surveys conducted in the neighborhood. In addition, a large number of homes were deemed unapproachable by interviewers, which may have contributed to the lower response rate and the potential for selection bias. In addition, since questionnaires were interviewer-administered, response or social desirability bias may have been a factor in responses that could have been prevented with a self-administered survey (Sansom et al. 2019; Hammer et al. 2007; Bowling 2005). Another limitation was the use of zones as a proxy for residential location since individual addresses or spatial coordinates were not recorded to protect the privacy and confidentiality of respondents. The use of zones to spatially designate households implies that all residents within a given zone are equally effected by creosote exposure and could have led to ecological bias.

This study confirms the findings of prior environmental risk perception and concern studies that have shown that women and racial minorities tend to report higher levels of concern about risk perception associated with environmental pollution (Bullard and Wright 1993; Sansom et al. 2019). It also demonstrates the importance of including community knowledge in environmental and public health research. Community input about environmental health issues helps to gauge the perceptions and views of the community while building trust between researchers and community members to ensure effectiveness. This study adds to the growing body of environmental justice literature in which epidemiologists seek to understand the extent to which communities are exposed to toxic wastes or other environmental pollutants. Next steps should include the collection of environmental and biologic samples to assess whether actual exposures align with perceptions of exposure and communication of findings to policy groups to work towards protecting residents of environmental justice neighborhoods from the detrimental health impacts of inequitable industrial siting.

3. THE PHYSICAL AND MENTAL HEALTH OF SOMERVILLE RESIDENTS

3.1 Introduction

The environmental justice literature demonstrates that Black, Hispanic and low-income individuals reside in closer proximity to hazardous waste facilities and are disproportionately impacted by exposure to environmental hazards in the workplace, their homes, and in their neighborhoods (Bullard and Wright 1993; Bullard 2001; Pastor et al. 2001; Mohai et al.2008). Living in close proximity to toxic facilities and exposure to environmental hazards have been associated with poorer health and disproportionate negative health outcomes among these populations (Adeola 1994; Maantay et al. 2010; Brender et al. 2011). For example, excess environmental exposures have been associated with higher rates of a range of health effects including cancer, respiratory and cardiovascular diseases, and adverse pregnancy outcomes. Furthermore, a range of neurological and mental health effects have been seen (Stansfield et al. 2000; Peek et al. 2009). In addition to the physical and mental health effects of environmental hazard exposure, residential proximity to hazardous waste sites has been known to impact overall quality of life (Bullard and Lewis 1996; Passchier-Verneer and Passchier 2000; Santiago-Riviera et al. 2007). While many studies have demonstrated the negative health effects of living in environmental justice communities, rarely have these studies focused on assessing quality of life impacts.

To evaluate the impact of time lived in an environmental justice community on mental and physical quality of life, a cross sectional study was conducted using the SF-12 in the city of Somerville TX, home to a large creosote facility.

3.2 Background

Environmental justice communities are disproportionately exposed to environmental pollutants and toxicants. These communities are made up of low-income and racial/ethnic minority residents who bear the unjust burden of environmental conditions (Taylor et al. 2006). Mohai and Bryant (1991) found that the proportion of residents who are people of color in communities with hazardous waste facilities is twice that of the proportion of people of color in communities without facilities. This proportion triples when more than one hazardous facility is located in the community (Mohai and Bryant 1991). These patterns are consistent when considering other pollutant sources: minority groups are also overrepresented in environmental justice communities where landfills are located (Hooks et al. 2020) and in proximity to industrial scale farming, known as concentrated animal feeding operations (Wing 2000).

Environmental justice communities have been shown to face adverse psychological and physiological health effects due to environmental hazard exposure (Martuzzi et al. 2010; Maantay et al. 2010; Mohai et al 2009; Peek et al. 2010). Exposure to environmental contaminants and toxicants such as pesticides and herbicides have been associated with impacts on physical and psychological health (Morrison et al. 1992; Zahm and Ward 1998; Reynolds 2002; Wigle et al. 2008; Gilden et al 2010).
Exposures to malodors have also been associated with decreased quality of life and increased mental stress (Bullers 2005; Horton et al. 2009). The combination of malodor, noise, and toxicants from processing household waste has been associated with both

physical health impacts (e.g., cancer, birth defects, and respiratory illnesses) as well as quality of life issues (Passchier-Vermeer and Passchier 2000).

Similar negative health impacts have been seen in residents living in close proximity to environmental exposures and toxic facilities. Proximity to waste sites and industrial facilities including nuclear power plants, petrochemical plants, incinerators and landfills have been associated with negative health outcomes including cancer, adverse pregnancy outcomes, respiratory and cardiovascular diseases (Choi 2006; Kaatsch et al. 2008; Langlois et al. 2009; Roos et al. 2011). Ha et al. (2015) found that residential proximity to solid waste facilities was associated with preterm delivery, very preterm delivery, and term low birth weight. Proximity to oil and gas facilities were associated with preterm and very preterm deliveries (Ha et al., 2015). A 2005 study conducted by Downey and Van Willigen explored the relationship between residential proximity to industrial sites and mental health. Results demonstrated that residential proximity to industrial facilities has a direct, positive association with symptoms of depression.

More specifically, exposure to creosote has been associated with adverse health outcomes including cancer, cardiovascular and respiratory diseases (Lenson 1956; Karlehagen et al. 1992; Brender et al. 2003; Dahlgren et al. 2003; Carlsten et al. 2005). However, the majority of these creosote exposure health studies occur in occupational rather than domestic settings. To our knowledge, no studies to date have investigated the psychological health impacts of creosote exposure.

3.3 Materials and Methods

3.3.1 Study Location and Population

Somerville, TX is located in Burleson County, 80 miles north of Houston and 25 miles west of College Station. Somerville is home to approximately 1,483 residents living in 509 households with an average household size of 2.50 and an average family size of 3.05 (U.S Census Bureau, 2019). Of the 509 households, 337 are owner-occupied housing units. Approximately 62% of Somerville residents are Non-Hispanic White, 25% are Black or African American, and 27% are Hispanic, dissimilar to the state of Texas where residents identify as 41.5% Non-Hispanic White, 12.8% Black or African American, and 39.6 % Hispanic (U.S Census Bureau, 2019). As of 2017, the median household income is relatively low at $42,617, compared to $56,235 for Burleson County, and $59,570 for the State of Texas.

Somerville was founded in 1882 when the Santa Fe Railroad Co. established a railroad tie plant and switching yard. Since 1897, several companies have run wood treatment facilities in Somerville, including Burlington Northern Santa Fe Railway Co. (BNSF), one of the largest freight companies in North America. This facility, now known as Koppers Industries Inc., is the only facility in Somerville that reports to the Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI). The Koppers Industries Inc. Somerville facility currently contains four creosote treating cylinders. In 2018, the facilities TRI Facility Profile Report showed a total on-site chemical release of 7,421 pounds of creosote via fugitive or non-point air emissions, stack or point air emission, and discharges to receiving streams or water bodies (EPA, 2018).

On October 25, 2007, current and former residents of Somerville filed a lawsuit against BNSF and Koppers Industries Inc. seeking to represent "all persons who own property or lease property within 1 mile" of the facility. Residents alleged that BNSF and Koppers operated the plant in a manner that released dangerous chemicals into the environment leading to soil, ground water, and air contamination that resulted in physical injuries and property damage. Between February and August of 2008, lawsuits were dismissed or dropped. In 2010, approximately 90 residents filed a class-action suit stating that pentachlorophenol, coal tar creosote, and other chemicals from the plant had contaminated homes, schools, and businesses, with the environmental contamination leading to increases in rates of cases of cancer and birth defects in Somerville. Although several other former wood treatment facilities in Texas have been listed as Superfund sites and have been subject to environmental investigation and remedial actions, the class-action lawsuit was dismissed in December 2010. Although a good deal is known about the health impacts of occupational creosote exposure, little is known about the potential health impacts of residential exposure. The continuation of the environmental litigation may have provided financial support for residential creosote exposure studies; their dismissal in part demonstrates the need for this study. These factors led to the selection of Somerville as a study location to assess the risk perceptions of residents to domestic creosote exposure.

3.3.2 Survey Sample

A power analysis was conducted to determine the sample size estimation. Further type I error rate (α) of 0.05 and a desired statistical power of 80 percent were goals to detect a change of 2.5 points from national norms. This required a sample of 126 participants to be recruited in Somerville, TX.

Figure 3.1 Sample Location with Geographic Zones

The study area was divided into nine geographic zones with zone one being the closest in proximity to the Koppers Inc. facility and zone nine being the furthest (Figure 3.1).

Survey teams were comprised of student volunteers from the Texas A&M University School of Public Health's EpiAssist program who provide surge capacity for conducting public health field work. A just-in-time training was held to ensure that all volunteers were familiar with the survey and the required consent documents prior to conducting the interviews. Interviews were conducted over four visits to Somerville between January 11 and March 1, 2020. Interview teams consisting of two or three members were sent to a specific zone to conduct interviews.

Homes that were fenced off, abandoned, or deemed unsafe by the team were not approached. Teams kept a record of all completed interviews, refusals, and any language barriers encountered for the calculation of contact (the number of completed interviews divided by the total number of housing units at which contact was attempted), cooperation (the number of completed interviews divided by all eligible housing units that were contacted), and completion (the number of completed interviews divided by the goal number of completed interviews) rates.

The survey included four sections. The first section included eight demographic questions such as gender (male or female); year of birth; race (White, Black or African American, American Indian or Alaska Native; Asian, or Native Hawaiian or Pacific Islander); ethnicity (Hispanic); level of education (at least a high school diploma), employment status; length of residence in the home and length of residence in Somerville. Due to the low number of respondents, race was recoded as Non-Hispanic White or Non-White.

The second section of the survey included 12 items to assess self-rated physical and mental health. The items were adopted from the 12-Item Short-Form Health Survey (SF-12) (Ware, Kosinski, Keller, 1996). The SF-12 was adapted from the 36-Item Short-Form Health Survey (SF-36), allowing for the measurement of health status in a shorter version. The SF-12 includes items from each of the eight health concepts in the SF-36; physical functioning (PF), Role-Physical (RP), Bodily Pain (BP), General Health (GH), Energy/Fatigue (VT), Social Functioning (SF), Role-Emotional (RE), and Mental Health (MH) (Ware et al, 1995). Each of the eight concepts is aligned with the Mental Component Summary (MCS) or the Physical Component Summary (PCS). Items in the SF-12 have been compared to the SF-36 and tested for reliability and validity among a general population. Results showed that the SF-12 was able to explain at least 90% of the variance in the SF-36 for Mental Component Summary (MCS) (R^2=0.918) and for the Physical Component Summary (PCS) (R^2=0.911) (Ware, Kosinski, Keller, 1996). The SF-12 has been assessed for reliability and validity among various populations and results have been found to be similar to those of Ware et al., 1995 (Kontodimopoulos et al., 2007; Gandhi et al., 2001).

The third section of the survey contained questions to assess an individual's knowledge and perception of living near the Koppers Inc. creosote facility. Section four of the survey contained questions gauging individuals' perceptions on relocation or home buyout.

The survey and all accompanying materials were reviewed and approved by the Texas A&M Institutional Review Board (IRB2019-1248). A complete version of the survey can be found in Appendix B.

3.3.3 Statistical Methods

Descriptive statistics were calculated for all variables. A one-sample t-test was conducted to assess if differences existed between MCS and PCS and the national mean scores of 50. Differences from the national mean were also assessed by gender and race. Correlation coefficients (r) were calculated and displayed on two-way scatterplots to assess the strength of the linear relationships between MCS and years lived in Somerville, MCS and time lived in the house, PCS and years lived in Somerville, and PCS and years lived in the house. Bivariate linear regression was conducted to evaluate the relationship between each covariate and both MCS and PCS. Multiple linear regression models were fitted with

PCS and MCS as outcomes and time lived in the house and time lived in Somerville as the predictor variables. To assess for confounding of these relationships, a backward elimination process was applied, beginning with a full model including all covariates (e.g., age, gender, and race), which were then removed one at a time. An *a priori* change in coefficient of 10% was chosen and the removal of any variable that resulted in a change of at least 10% resulted in that variable being retained in the model.

3.4 Results

Sixty-three surveys were completed for a cooperation rate of 58.3% (63/108) and a contact rate of 22.2% (63/284). Of the survey respondents, 54.0 percent (N=36) were Non-Hispanic white individuals, 19.1 percent (N=12) were Hispanic or Latino, and 20.6 percent (n=13) were Black or African American. Approximately half of respondents were male (54.0%; N=34) and 46.0 percent (N=29) were female. The mean age of all respondents was 53.2 (Median: 54; SD: 17.21) years of age . In 84.1 percent (N=53) of households, every adult has at least a high school diploma. The average years lived in households was 13.75 (SD: 14.43) and the average years lived in Somerville was 24.40 (SD:18.35) (Table 3.1).

Table 3.1 Sample Characteristics

Characteristics	N (%)
Gender	
Male	34 (54.0%)
Female	29 (46.0%)
Race	
Non-Hispanic White	36 (57.1%)
Hispanic or Latino/a	12 (19.1%
African American	13 (20.6%)
Other	2 (3.2%)
Age in Years	
Mean (SD)	53.2 (17.21)
Age in Groups	
< 35	13 (20.6%)
36 – 50	15 (23.8%)
51 – 69	21 (33.3%)
70+	14 (22.2%)
Education (HS Diploma)	
Yes	53 (84.1%)
No	9 (14.3%)
Employment (Currently Unemployed)	
Yes	14 (22.2%)
No	49 (77.8%)
Average Years in House	13.75 (14.43)
Average Years in Somerville	24.40 (18.35)

MCS (34.03; p-value <0.001) and PCS (43.10; p-value <0.001) among the overall sample, as well as among men, women, and all racial/ethnic groups were statistically significantly lower than the national mean score of 50 (Table 3.2). When stratified by gender and race, MCS and PCS were significantly different than the national mean score for all groups. For MCS, females had a mean score of 32.67 (p-value <0.001) and males had a mean score of 35.32 (p-value<0.001). Non-White females had the lowest mean score (32.32; p-value=0.001). Non-Hispanic White males had the lowest mean PCS with a value of 40.72 (p-value <0.001).

Table 3.2 One-sample *t* Test of Mean Values of Mental and Physical Composite Scores

Outcome and Group	*t* value	Mean	95%CI	p-value
Mental Composite Score	-15.11	34.03*	31.90-36.16	<0.001
Male	-10.16	35.32*	32.33-38.32	<0.001
Female	-11.35	32.67*	29.49-35.84	<0.001
Non-Hispanic White	-10.92	34.04*	31.04-37.05	<0.001
Non-White	-10.49	34.00*	30.78-37.22	<0.001
Non-Hispanic White Male	-7.24	35.10*	30.65-39.55	<0.001
Non-Hispanic White Female	-8.10	32.90*	28.30-37.51	<0.001
Non-White Male	-7.24	35.68*	31.11-40.24	0.001
Non-White Female	-7.70	32.32*	27.03-37.62	0.001
Physical Composite Score	-6.72	43.10*	41.03, 45.27	<0.001
Male	-4.91	41.16*	37.43-44.89	<0.001
Female	-6.35	45.14*	43.55-46.73	<0.001
Non-Hispanic White	-5.99	42.36*	39.74-44.98	<0.001
Non-White	-3.35	44.24*	40.58-47.86	0.004
Non-Hispanic White Male	-4.17	40.72*	35.90-45.53	<0.001
Non-Hispanic White Female	-5.82	44.13*	41.94-46.32	<0.001
Non-White Male	-2.56	41.84*	34.51-49.18	0.03
Non-White Female	-3.23	46.59*	44.16-49.03	0.01

*statistically significant (p-value<0.05)

Plotting PCS against the years respondents reported living in Somerville resulted in a weak positive linear relationship (r=0.04, p-value=0.77) (Figure 3.2). A weak negative correlation exists between MCS values and time living in Somerville (r=0.23, p-value=0.14) (Figure 3.3). Results also indicated a weak negative correlation between PCS and time living in the house (r=-0.16, p-value=0.30) (Figure 3.4). MCS plotted against time respondents reported living in Somerville resulted in a weak positive correlation (r=0.02, p-value=0.90) (Figure 3.5).

Figure 3.2 Physical Health Composite Score by Time Lived in Somerville

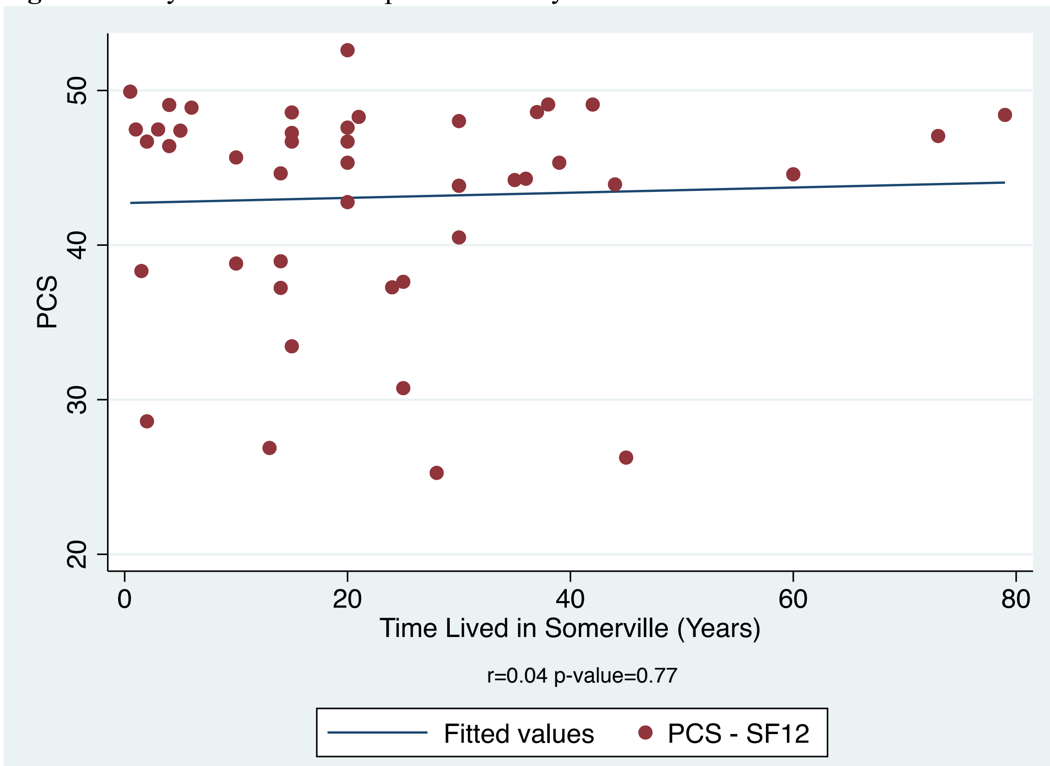


Figure 3.3 Mental Health Composite Score by Time Lived in Somerville

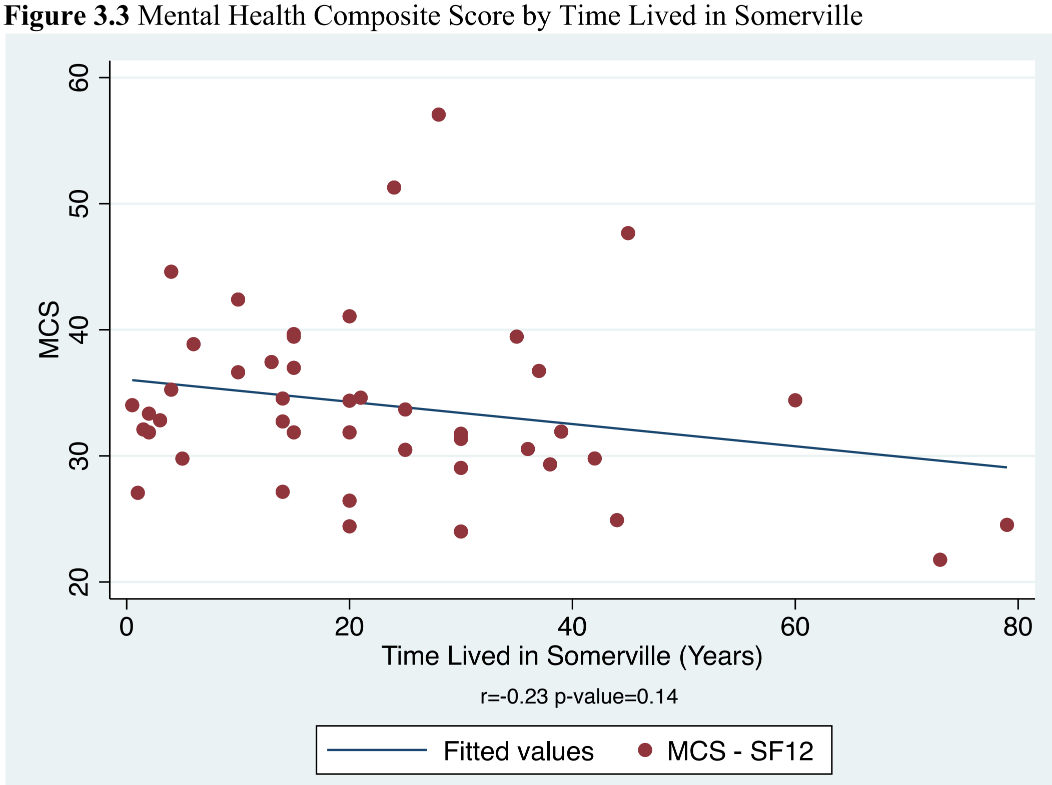


Figure 3.4 Physical Health Composite Score by Time Lived in House

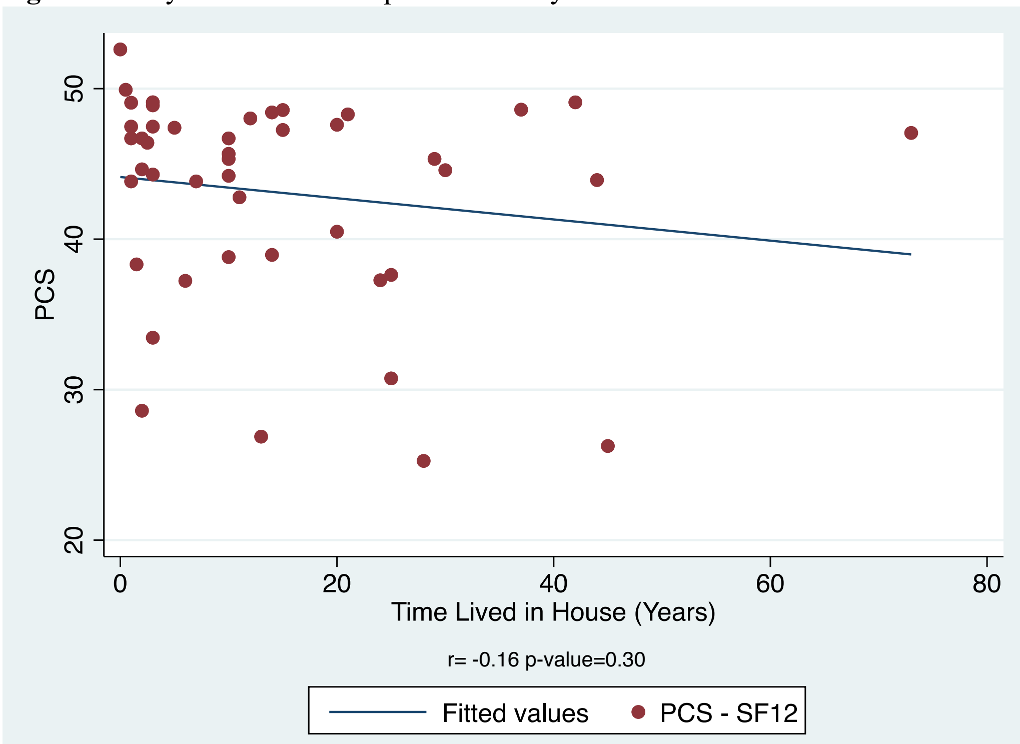


Figure 3.5 Mental Health Composite Score by Time Lived in House

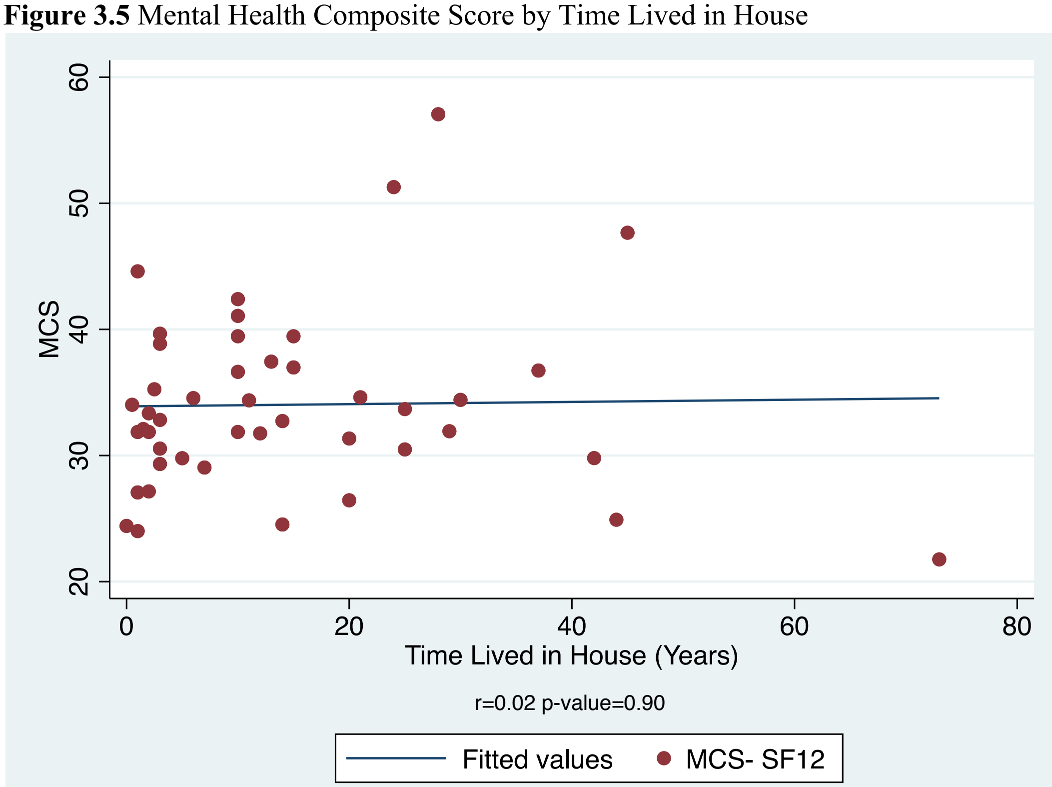


Table 3.3 shows the results of bivariate regression comparing the covariates gender, race, age, time lived in the house, and time lived in Somerville on MCS and PCS values. Age was found to be negatively associated with the physical health of study participants. A one-year increase in age was associated with an 87% reduction in PCS (Coef: = -0.13, p-value=0.04).

Table 3.3 Unadjusted associations of variables with SF-12 (MCS and PCS)

MCS	Coef	Std. Error	95% CI	p-value
Gender (Female)	-2.66	2.10	-6.89-1.58	0.21
Race (Non-White)	-0.04	2.18	-4.44-4.36	0.99
Age	0.04	0.67	-0.10-0.17	0.58
Time in House	0.01	0.07	-0.13-0.15	0.90
Time in Somerville	-0.09	0.06	-0.20-0.03	0.14
PCS	Coef	Std. Error	95% CI	p-value
Gender (Female)	3.98	1.99	-0.03-7.99	0.05
Race (Non-White)	1.86	2.10	-2.38-6.09	0.38
Age	-0.13	0.06	-0.26- -0.01	0.04*
Time in House	-0.07	0.67	-0.21-0.07	0.30
Time in Somerville	0.02	0.06	-0.10-0.13	0.77

*statistically significant (p-value<0.05)

Table 3.4 shows the final models of multiple linear regression for the outcome variables MCS and PCS and the predictor variable time lived in the house. Backward elimination resulted in gender and age being retained in the models for MCS and PCS. After adjusting for gender and age, a one-year increase in time lived in the house was associated with a decrease in both MCS (Coef:-0.01, p-value=0.95) and PCS (Coef:-0.01, p-value=0.89) (Table 3.4).

Table 3.5 shows the final models of multiple linear regression for the outcome variables MCS and PCS and the predictor variable time lived in Somerville. Backward elimination resulted in only age being retained in the model for MCS and age and gender being retained in the model for PCS. After adjusting for age, a one-year increase in time lived in Somerville was associated with a reduction in MCS (Coef: -0.13, p-value=0.05). After adjusting for gender and age, a one-year increase in time lived in Somerville was associated with an increase in PCS, (Coef:0.06, p-value=0.31). (Table 3.5).

Table 3.4 Multiple Linear Regression Model Comparing the Covariates Age, Gender, Time Lived in Household on MCS and PCS

Group	Coef	Std Err.	95% CI	p-value
MCS				
Gender (Female)	-2.60	2.17	-6.98-1.77	0.24
Age	0.04	0.08	-0.13-0.20	0.65
Time in House	-0.01	0.09	-0.18-0.17	0.95
PCS				
Gender (Female)	3.89	1.95	-0.05-7.84	0.05
Age	-0.12	0.07	-0.27-0.03	0.11
Time in House	-0.01	0.08	-0.17-0.15	0.89

*statistically significant (p-value<0.05)

Table 3.5 Multiple Linear Regression Model Comparing the Covariates Age, Gender, Time Lived in Somerville on MCS and PCS

Group	Coef	Std Err.	95% CI	p-value
MCS				
Age	0.10	0.07	-0.04-0.25	0.16
Time in Somerville	-0.13	0.06	-0.26-0.00	0.05
PCS				
Gender (Female)	3.41	1.96	-0.54-7.37	0.09
Age	-0.16	0.07	-0.29-0.02	0.02*
Time in Somerville	0.06	0.06	-0.06-0.19	0.31

*statistically significant (p-value<0.05)

3.5 Discussion

Prior research suggests that exposure to environmental hazards such as pollution, toxic waste, and industrial chemicals have negative effects on physiological and psychological well-being (Eldstein 1988; Dunn et al. 1994; Peek et al. 2009). In this cross-sectional study, we observed that Somerville residents had lower physical and mental health scores compared to the national average. Stratified by gender and race, all strata of respondents had lower values for physical and mental health when compared to the U.S. general population mean. Similar to results from other studies using the SF-12 to assess self-rated health in environmental justice communities, non-Hispanic White males had the lowest PCS scores (Sansom et al. 2018).

Behavioral health conditions affect approximately 25% of adults in the United States and are experienced at greater levels by low-income and racial/ethnic minorities (Kessler and Neighbors 1986; Somervell et al. 1989; Riolo et al. 2005). Results from this study show that MCS scores for Non-White residents of Somerville were lower than the national mean with Non-White females reporting the lowest MCS scores. Based on the data collected as a part of this study and the knowledge that differences exist in mental health diagnosis, care and help-seeking along racial and socioeconomic lines (Leaf 1987; Canino et al. 2002; Riolo et al. 2005; Chang et al. 2017), the city of Somerville should consider the development of targeted educational and outreach initiatives to focus on the mental health of residents.

Several important limitations are acknowledged in this study. The interview administered methodology used to collect responses may have led to response or social desirability bias.

However, due to the long history of legal actions and the designation of other similar creosote facilities as Superfund sites, it would be expected that residents would be generally aware of the potential impacts and unlikely under or over-report. Recall bias may have been a factor due to residents providing estimates for the length of time lived in their current home and in the city of Somerville. However, given the widespread publicity about the potential for creosote exposure to have negative health impacts, it is unlikely residents would not remember possible exposures. Several residents reported being transient and were unsure of the collective number of years spent in Somerville. To assess self-rated health, PCS and MCS were used rather than clinical assessments and physical examinations. In future research, biological samples could be collected, or medical records could be used to provide support for self-reported conditions.

This study supports prior environmental justice research studies and demonstrates that communities in proximity to environmental contamination sites have lower self-reported physical and mental health. This study also demonstrates the need for clinical studies to further assess the physiological and psychological health of residents near hazardous facilities. These types of data are likely needed to support potential buyout and relocation programs, such as those implemented in the Carver Terrace neighborhood of Texarkana, TX, that required large financial investments but are necessary in some cases to protect communities that are disproportionately affected due to unequal exposure to hazardous facilities.

Even without buyouts for residents currently impacted by this facility, data from this study can be used by local, state, and federal governmental agencies to guide decision-making related to the determination of future facility placement and location. This study establishes a baseline of self-reported mental and physical health among residents of an environmental justice community and highlights the need for longitudinal, cohort-based health studies to improve understanding of how environmental exposures and environmental racism impact the health of communities over time. Follow up studies should include collection of biological samples and well as physical examinations to assess whether medical findings support self-reported health.

4.RESIDENT PERCEPTION OF RELOCATION OR HOME BUYOUT

4.1 Introduction

Low-income and communities of color face a disproportionate burden of environmental exposure and negative health outcomes. This increased risk from differential exposure is largely due to unequal treatment and unequal environmental protection (Bullard, 1983; Bullard and Wright 1993; Bullard, 2012). Environmental justice laws, policies and regulations have not been applied equitably across all communities and populations. In the early 1990s, environmental justice activists, civil rights groups, and nonprofit organizations began to address these issues, approaching them from a civil rights and social justice lens. This activism led to changes including the development of Environmental Protection Agency's (EPA) Office of Environmental Equity and the introduction of H.R.5326 – the Environmental Justice Act of 1992 into Congress by Congressman John Lewis (Bullard, 2012). The purpose of H.R. 5326 was to establish a program to assure nondiscriminatory compliance with all environmental, health and safety laws and to assure equal protection of the public health (U.S. Congress, 1992).

In addition to the development of new policies and regulations to address environmental inequities, environmental justice communities began to receive home buyouts and offers for relocation. Home buyout programs were designed to facilitate the permanent relocation of residents out of hazard-prone communities and have been a more widely used tool for disaster mitigation (Binder et al., 2015; Binder et al., 2020).

Long term relocation is considered to be one of the most effective long-term strategies for adaptation among many coastal communities due to lack of affordability of structural protection measures and other factors (Bukvik et al., 2015). The Love Canal community near Niagara Falls, NY was the first environmental justice community to experience a relocation and resettlement in the late 1970s. Numerous buyouts and community relocation efforts have taken place since, including neighborhoods in close proximity to creosote facilities (Bullard and Wright 1993; Čapek, 1993; Collins, 2014; Karouna-Renier et al., 2007). Perception of and will to relocate or be bought out are influenced by factors such as economic concerns around property values, community attachment, home ownership or renter status, and physical and psychological well-being. While several studies have mentioned the occurrence of relocation or buyout as a solution to natural hazard exposure, to our knowledge this is the first study to assess resident perceptions of home buyout and relocation for an environmental justice community that has not received buyout or relocation offers.

4.2 Background

Environmental hazardous sites are disproportionately placed in communities populated by African American, Hispanic, Native American and low-income White individuals (Morello-Frosch and Lopez, 2006; Taylor et al., 2006; Lerner, 2010; Taylor, 2014). Existing literature has linked negative health outcomes to this disproportionate siting and racial residential segregation (Gee and Payne-Sturges, 2004; Hill, 2009; Taylor, 2014). Gee and Payne-Sturges (2004) argue that residential segregation leads to increased differences in exposure to pollutants and access to resources including time, money, and political power. Differentiations in access can also be seen in the ways laws, policies, regulations, and practices have been enforced in low-income and communities of color.

Several laws and policies were enacted to provide home buyout and relocation assistance to residents. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, was enacted by Congress on December 11, 1980 (EPA, 2018). CERCLA authorizes short-term and long-term response actions for hazardous waste sites including the use of permanent relocation (EPA, 2018). The Uniform Relocation Assistance and Real Property Acquisition Act (URA), 49 CFA Part 24, establishes the minimum standards for federally funded programs that require the acquisition of real estate or displace persons from their homes, business, or farms (HUD, 2020). URA ensures that displaced occupants are provided with reimbursement for moving expenses and payment for the cost of renting or purchasing comparable replacement housing (HUD, 2020).

The Love Canal, a predominantly White, lower-middle class neighborhood, became the first community to receive home buyout and relocation after it was discovered that a local school was sitting on a toxic waste dumping ground. In 1978, a health emergency was declared by the State of New York after extensive reports of birth defects, respiratory problems, and skin rashes (Fletcher, 2002; Schultz, 2016). A 1985 study assessing birth outcomes in children living near the Love Canal found that when controlled for other variables, birth defects were increased in exposed homeowner (OR=1.95, 95% CI:1.03-3.72) and renter (OR=2.87 95% CI:1.15-7.18) groups compared to control groups (Magnant and Highland, 1985). In 1980, President Jimmy Carter granted a state of emergency leading to the permanent relocation of all residents in a specified resettlement zone (Fletcher, 2002). Residents of the LaSalle Development, a predominately Black public housing development, were not included in the evacuation and resettlement zone

(Fletcher, 2002). Therefore, residents did not receive compensation; however, they were forced to move so their homes could be demolished.

Carver Terrace, an all-Black neighborhood in Texarkana, Texas was built in the 1964 in a 100-year flood plain on the land of a former Koppers Inc. wood treatment site (Bullard and Wright, 1993). The Koppers Inc, facility operated from 1911 to 1961 preserving, drying, and storing railroad cross-ties and switch ties (Brender et al. 2003). Due to racial segregation laws, Carver Terrace was one of two neighborhoods where middle and upper-middle class African Americans were allowed to own homes in Texarkana (Bullard and Wright 1993; Bullard, 1995). In the 1980s, residents who were concerned about the environmental and health conditions of the neighborhood began to protest and demand relocation through the development of organizations such as the Carver Terrace Community Action Group and Texarkana's Friends United for a Safe Environment (FUSE) which led to action (Čapek 1993).

A study funded by the Agency for Toxic Substances and Diseases Registry (ATSDR) and conducted by the Texas Department of Health found that living in the area of Koppers was associated with a higher prevalence of reported rashes (RR=6.80, 95% CI=2.47-18.68) and difficulties becoming pregnant (RR=2.78,95% CI=1.11-6.94) when compared to a similar neighborhood away from the site (ATSDR, 1994). Despite having only been added to the Superfund National Priorities List (NPL) in 1991, (EPA, 2020) the U.S Army Corps of Engineers began the buyout in 1992 with completion and demolition of the Carver Terrace neighborhood occurring in 1994.

Prior to this federal buyout, lawyers representing Koppers went door to door in the community asking residents not to sue them in exchange for $5,000 (Middleton, 2015).

Those who accepted the $5,000 from Koppers were ineligible to receive any of the $5 million appropriated for the buyout and relocation of Carver Terrace residents (Taylor, 2014; Chultz, 2016). Residents receiving the U.S Army Corps of Engineers offer also faced discriminatory practices. For example, unlike the buyout offer letter received by residents of the Love Canal and other White communities, Carver Terrace residents were told if negotiation failed, their payout would be based on the contaminated value of the property (Taylor, 2014).

While home buyout and relocation programs may be an effective solution to the environmental exposure issues faced by communities, for some, this solution is socially and economically disruptive (Mohai et al. 2009). Factors such as economic concerns around property values, community attachment, homeownership or renter status, and physical and psychological well-being impact peoples' perception of and will to relocate. Relocation may force families to move a significant distance from the area, leaving jobs and social networks behind (Binder et al. 2015; Seebauer and Winkler, 2020). Prior studies indicate that long-term residents have stronger attachment to their communities (Theodori, 2004; Shriver and Kennedy, 2005). Buyout and relocation programs also have an extensive history of lacking transparency, which may lead to increased public distrust of the process (Siders, 2018).

4.3 Materials and Methods

4.3.1 Study Location and Population

Somerville, TX is located in Burleson County, 80 miles north of Houston and 25 miles west of College Station.

Somerville is home to approximately 1,483 residents living in 509 households with an average household size of 2.50 and an average family size of 3.05 (U.S Census Bureau, 2019). Of the 509 households, 337 are owner-occupied housing units. Approximately 62% of Somerville residents are Non-Hispanic White, 25% are Black or African American, and 27% are Hispanic, dissimilar to the state of Texas where residents identify as 41.5% Non-Hispanic White, 12.8% Black or African American, and 39.6 % Hispanic (U.S Census Bureau, 2019). As of 2017, the median household income is relatively low at $42,617, compared to $56,235 for Burleson County, and $59,570 for the State of Texas.

Somerville was founded in 1882 when the Santa Fe Railroad Co. established a railroad tie plant and switching yard. Since 1897, several companies have run wood treatment facilities in Somerville including Burlington Northern Santa Fe Railway Co. (BNSF), one of the largest freight companies in North America.

This facility, now known as Koppers Industries Inc. is the only facility in Somerville that reports to the EPA's Toxic Release Inventory (TRI). The Koppers Industries Inc. Somerville facility currently contains four creosote treating cylinders. In 2018, the facilities TRI Facility Profile Report showed a total on-site chemical release of 7,421 pounds of creosote via fugitive or non-point air emissions, stack or point air emission, and discharges to receiving streams or water bodies (EPA, 2018).

On October 25, 2007, current and former residents of Somerville filed a lawsuit against BNSF and Koppers Industries Inc. seeking to represent "all persons who own property or lease property within 1 mile" of the facility. Residents alleged that BNSF and Koppers operated the plant in a manner that released dangerous chemicals into the environment leading to soil, ground water, and air contamination that resulted in physical injuries and property damage. Between February and August of 2008, these lawsuits were dismissed or dropped. In 2010, approximately 90 residents filed a class-action suit stating that pentachlorophenol, coal tar creosote, and other chemicals from the plant had contaminated homes, schools, and businesses, with the environmental contamination leading to increases in rates of cases of cancer and birth defects in Somerville. Although several other former wood treatment facilities in Texas have been listed as Superfund sites and have been subject to environmental investigation and remedial actions, the class-action lawsuit was dismissed in December 2010. Although we know a good deal about the health impacts of occupational creosote exposure, little is known about residential exposure. The continuation of the environmental litigation may have provided financial support for residential creosote exposure studies; their dismissal demonstrates the need for this study. These factors led to the selection of Somerville as a study location to assess the risk perceptions of residents to domestic creosote exposure.

4.3.2 Survey Sample

A power analysis was conducted to determine the sample size estimation. Further type I error rate (α) of 0.05 and a desired statistical power of 80 percent were goals to detect a change of 2.5 points from national norms. This required a sample of 126 participants to be recruited in Somerville, TX.

Figure 4.1 Sample Location with Geographic Zones

The study area was divided into nine geographic zones with zone one being the closest in proximity to the Koppers Inc. facility and zone nine being the furthest (Figure 4.1). Survey teams were comprised of student volunteers from the Texas A&M University School of Public Health's EpiAssist program who provide surge capacity for conducting public health field work. A just-in-time training was held to ensure that all volunteers were familiar with the survey and the required consent documents prior to conducting the interviews.

Interviews were conducted over four visits to Somerville between January 11 and March 1, 2020. Interview teams consisting of two or three members were sent to a specific zone to conduct interviews. Homes that were fenced off, abandoned, or deemed unsafe by the team were not approached. Teams kept a record of all completed interviews, refusals, and any language barriers encountered for the calculation of contact (the number of completed interviews divided by the total number of housing units at which contact was attempted), cooperation (the number of completed interviews divided by all eligible housing units that were contacted), and completion (the number of completed interviews divided by the goal number of completed interviews) rates.

The survey included four sections. The first section included eight demographic questions such as gender (male or female); year of birth; race (White, Black or African American, American Indian or Alaska Native; Asian, or Native Hawaiian or Pacific Islander); ethnicity (Hispanic); level of education (at least a high school diploma), employment status; length of residence in the home and length of residence in Somerville. Due to the low number of respondents, race was recoded as Non-Hispanic White or Non-White. of the survey included 12 items to assess self-rated physical and mental health. The items were adopted from the 12-Item Short-Form Health Survey (SF-12) (Ware et al., 1996). The third section of the survey contained questions to assess an individual's knowledge and perception of living near the Koppers Inc. creosote facility.

Section four of the survey included questions gauging individuals' perceptions on relocation or home buyout. Occupancy type was assessed by asking participants if they or someone else in the household owned or rented the home (I own the home; Another resident owns the home; I rent the home or share equally to pay rent; Another resident rents the home; Other). Likeliness to relocate was assessed based on occupancy type. If the respondent or another resident owned the home, they were asked how likely is it that you or the owner would move out of your residential community if given fair value of a house comparable to a similar home in a low crime area (Very likely, Likely, Unsure, Unlikely, Very Unlikely, Refused). If the respondent or another resident rented the home, they were asked how likely is it that you or the primary renter would move out of your residential community if given the financial assistance to do so (Very likely, Likely, Unsure, Unlikely, Very Unlikely, Refused). Barriers to relocation were assessed by asking respondents to indicate their level of agreement or disagreement with the following statements; moving out of the community would be difficult for me with no additional financial help (Strongly agree, Agree, Neither, Disagree, or Strongly disagree), if relocation were an option I would be concerned about leaving the community because I may lose my social ties (Strongly agree, Agree, Neither, Disagree, or Strongly disagree), and moving out of the community would be difficult for me because of my age (Strongly agree, Agree, Neither, Disagree, or Strongly disagree).

The second section of the survey included 12 items to assess self-rated physical and mental health. The items were adopted from the 12-Item Short-Form Health Survey (SF-12) (Ware et al., 1996). The third section of the survey contained questions to assess an individual's knowledge and perception of living near the Koppers Inc. creosote facility.

The survey and all accompanying materials were reviewed and approved by the Texas A&M Institutional Review Board (IRB2019-1248). A complete version of the survey questionnaire can be found in Appendix B.

4.3.3 Statistical Methods

Descriptive statistics were calculated for all variables. Logistic regression was used to evaluate associations between race, gender, and age and a resident's likeness to relocate.

Multiple logistic regression was used to estimate the adjusted relative odds of likeliness to relocate.

In order to evaluate if there was a relationship between likeliness to relocate and reasons for difficulty relocating, Pearson Chi-Square Test for Independence and Fisher's exact tests were conducted.

4.4 Results

Sixty-three surveys were completed for a cooperation rate of 58.3% (63/108) and a contact rate of 22.2% (63/284). Of the survey respondents, 54.0 percent (N=36) were Non-Hispanic white individuals, 19.1 percent (N=12) were Hispanic or Latino, and 20.6 percent (N=13) were Black or African American. Approximately half of respondents were male (54.0%; N=34) and 46.0 percent (N=29) were female. The mean age of all respondents was 53.2 (SD: 17.21) years of age.

In 84.1 percent (N=53) of households, every adult has at least a high school diploma. The average years lived in households was 13.75 (SD: 14.43) and the average years lived in Somerville was 24.40 (SD:18.35) (Table 4.1).

Table 4.1 Sample Characteristics

Characteristics	N (%)
Gender	
Male	34 (54.0%)
Female	29 (46.0%)
Race	
Non-Hispanic White	36 (57.1%)
Hispanic or Latino/a	12 (19.1%
African American	13 (20.6%)
Other	2 (3.2%)
Age in Years	
Mean (SD)	53.2 (17.21)
Age in Groups	
< 35	13 (20.6%)
36 – 50	15 (23.8%)
51 – 69	21 (33.3%)
70+	14 (22.2%)
Education (HS Diploma)	
Yes	53 (84.1%)
No	9 (14.3%)
Employment (Currently Unemployed)	
Yes	14 (22.2%)
No	49 (77.8%)
Average Years in House	13.75 (14.43)
Average Years in Somerville	24.40 (18.35)

When asked if they or someone else in their household owned or rented the home, 61.5% (N=41) owned their home, 19.1% of (N=12) rented their home and 11.1% (N=7) reported another resident owned the home (Table 4.2). Of survey respondents, 39.6% of owner-occupied householders (N=19) and 46.2% of renter householders (N=6) would be likely to very likely to move out of their current residential community for fair value or with financial assistance (Table 4.3).

Approximately 44% of owner-occupied householders (N=21) and 7.7% of renter householders (N=1) would be unlikely to very unlikely to move out of their current residential community for fair value or with financial assistance (Table 4.3).

Table 4.2 Occupancy Type

Occupancy Type	N (%)
Respondent Owns Home	41 (65.1%)
Another Resident Owns Home	7 (11.1%)
Respondent Rents Home	12 (19.1%)
Another Resident Rents Home	1 (1.6%)
Other	2 (3.2%)

Table 4.3 Likeliness to Relocate by Occupancy Type

	N (%)
Owner Occupied	
Likely/Very Likely	19 (39.6%)
Unsure	6 (12.5%)
Unlikely/Very Unlikely	21 (43.8%)
Refused	2 (4.2%)
Renter Occupied	
Likely/Very Likely	6 (46.2%)
Unsure	5 (38.5%)
Unlikely/Very Unlikely	1 (7.7%)
Refused	1 (7.7%)

Female respondents were approximately 4 times more likely to consider relocation when given fair value or financial assistance (OR=3.81; 95% CI=1.13-12.82). Though not significant, Non-Whites were 90 percent (95% CI=1.26-17.79) more likely to want to relocate if provided resources or financial support compared to Non-Hispanic Whites. When comparing Non-Hispanic White males to other gender and racial categories, Non-White females were statistically more likely to relocate (OR=8.10; 95% CI=1.23-53.2) (Table 4.4).

Table 4.4 Odds Ratios (OR) and 95% Confidence Intervals (CI) of Likeliness to Relocate

	OR	95%CI	p-Value
Likeliness to Relocate			
Race			
Non-Hispanic White	1.00	Reference	
Non-White	1.90	0.59-6.11	0.28
Gender			
Male	1.00	Reference	
Female	3.81	1.13-12.82	0.03*
Race and Gender			
Non-Hispanic White Male	1.00	Reference	
Non-Hispanic White Female	2.52	0.52-12.30	0.25
Non-White Male	1.20	0.23-6.39	0.83
Non-White Female	8.10	1.23-53.2	0.03*
Age	0.99	0.96-1.03	0.85

*statistically significant (p-value<0.05)

Table 4.5 and Table 4.6 shows the results of a multiple logistic regression estimating the relationship between likeliness to relocate and the covariates gender, age, race, time lived in household or time lived in Somerville. Likeliness to relocate when given fair value or with financial assistance was statistically significantly associated with gender. When controlling for age, race, and time lived in the house, female respondents were approximately 4 times more likely to want to relocate when compared to their male counterparts (OR=4.22; 95%CI:1.18-15.11). (Table 4.5).

When controlling for age, race, and time lived in the Somerville, female respondents were approximately 5 times more likely to want to relocate when compared to their male counterparts (OR=4.74; 95%CI:1.26-17.93) (Table 4.6). Although not statistically significant, Non-White respondents were approximately 2 times more likely to report likeliness to relocate when controlling for other covariates in both models (OR=2.19; 95%CI:0.53-9.06, OR=2.07; 95%CI:0.52-8.32).

Table 4.5 Multiple Logistic Regression for the Association between Race, Gender, Age and Time Lived in House on Likeliness to Relocate

	OR	95%CI	p-Value
Race			
Non-Hispanic White	1.00	Reference	
Non-White	2.19	0.53-9.06	0.28
Gender			
Male	1.00	Reference	
Female	4.22	1.18-15.11	0.03*
Age	1.02	0.97-1.07	0.47
Time Lived in House	0.97	0.00-1.79	0.20

*statistically significant (p-value<0.05)

Table 4.6 Multiple Logistic Regression for the Association between Race, Gender, Age and Time Lived in Somerville on Likeliness to Relocate

	OR	95%CI	p-Value
Race			
Non-Hispanic White	1.00	Reference	
Non-White	2.07	0.52-8.32	0.31
Gender			
Male	1.00	Reference	
Female	4.74	1.26-17.93	0.02*
Age	1.01	0.97-1.06	0.52
Time Lived in Somerville	0.97	0.00-2.09	0.11

*statistically significant (p-value<0.05)

When assessing level of agreement or disagreement with reasons that may cause difficulty in relocating, approximately 60 percent of respondents agreed or strongly agreed (58.1%, N=36) that lack of financial help would make relocating difficult. (Table 4.7). If relocation were an option, 27.4% (N=17) of respondents agreed or strongly agreed that they would be concerned about leaving the community because they may lose their social ties (Table 4.7). Approximately one-fifth of respondents agreed or strongly agreed (20.6%, N=13) that moving out of the community would be difficult for them because of their age (Table 4.7).

A chi-square test of independence showed that there is a significant relationship between likeliness to relocate and difficulty moving with no financial help (χ^2=5.82, p=0.02). Fisher's exact test results showed insignificant associations between likelihood to relocate and concern of losing social ties (P value = 0.17) and difficulty moving due to age (P value = 0.73).

Table 4.7 Reasons for difficulty relocating

Reason	N (%)
No Financial Assistance	
Disagree/Strongly Disagree	20 (32.2%)
Neither	2 (3.2%)
Agree/Strongly Agree	36 (58.1%)
DK/Refused	4 (6.5%)
Concerned About Losing Social Ties	
Disagree/Strongly Disagree	37 (59.7%)
Neither	3 (4.8%)
Agree/Strongly Agree	17 (27.4%)
DK/Refused	5 (8.1%)
Age	
Disagree/Strongly Disagree	43 (68.3%)
Neither	2 (3.2%)
Agree/Strongly Agree	13 (20.6%)
DK/Refused	5 (7.94%)

4.5 Discussion

Home buyout and relocation programs are increasingly used as a tool to reduce future vulnerability by permanently relocating households impacted by ongoing risks associated with exposure to disasters and environmental contaminants (Binder and Greer, 2016; Siders, 2019). However, prior research shows that differences exist in the decisions about where buyouts occur and how they are carried out (Benz TA, 2017; Durfee, 2018; Martin, 2019).

For example, Black public housing residents living near the Love Canal landfill were not included in the initial relocation or buyout efforts (Fletcher, 2002). Studies have also shown that buyout programs typically lack transparency.

A 2019 study evaluating the social justice implications of buyout programs found that while all reviewed studies provided information to the public about program criteria for determination of buyout, the criteria were extremely broad and therefore not useful or relevant (Binder and Greer, 2016).

Differences also exist in perception of, and willingness to, relocate or be bought among residents. These differences are influenced by factors such as economic concerns around property values (Shriver and Kennedy, 2005), community attachment (Theodori 2004; Shriver and Kennedy, 2005; Brehm et al., 2006; Binder et al., 2015; Seebauer and Winkler, 2020) , and home ownership or renter status (Fletcher 2002;Shriver and Kennedy 2005). Results of this study showed that there was a significant correlation between concern of difficulty moving with no financial help and willingness to relocate. However, there was no significant relationship between willingness to relocate and concern about social ties or difficulty because of age.

These findings underscore the need for home buyout and relocation programs to provide adequate funding and resources and demonstrates the need for affordable housing to all residents.

This study has several important limitations. Although power calculations based on the community's population indicated a necessary sample size of 126, only 63 surveys were completed. Survey administration was suspended early due to the global impact of COVID-19 and the inability to conduct in-person interviews as part of IRB approved research. The interview administered methodology used to collect responses may have led to response or social desirability bias. However, due to the long history of legal actions and the designation of other similar creosote facilities as Superfund sites, it would be expected that residents would be generally aware of the potential impacts and unlikely under or over-report.

Data from this study can be used to further explore the opportunities for home buyout and relocation in communities exposed to creosote and other environmental contaminants like Somerville, TX. The concern of difficulty relocating with no financial assistance also demonstrates the need for increased transparency with communities about the home buyout or relocation process and the opportunity to reframe the conversation to include residents in the decision-making process. Current policies and regulations regarding buyout and relocation are inadequate and inconsistent. Future buyout and relocation policies and programs must take into consideration rental and tenant rights as well as the implications for public housing residents and the need for increased affordable housing.

Buyout and relocation programs should be developed or adapted with a focus on the concerns and needs of vulnerable populations and consider vulnerability beyond risks associated with natural hazards. Much of the existing literature regarding home buyout or relocation is based in the area of climate disaster and not environmental exposures. This study highlights the need for further research on social vulnerabilities and buyout or relocation in environmental justice communities.

5. CONCLUSION

5.1 Summary

The purpose of this study was to investigate the impact of residential creosote exposure in Somerville, TX, home of a Koppers Inc wood treatment facility. The study focused on three main aims. First, to assess levels of concern and knowledge of risks associated with residential exposure to creosote. Second, to collect and analyze data on resident self-rated physical and mental health through use of the SF-12 survey. Third, to assess resident perception of relocation or home buyout and to understand the roles of financial assistance, social ties, and age on the relocation or home buyout decision making process.

5.1.1. Perception of Environmental Exposure

Results of this study support prior research findings that have shown females and racial and ethnic minorities are more likely to demonstrate concern of environmental pollution or contamination. Disparities in levels of concern and risk perception speak to a history of disproportionate exposure, differences in lived experiences, and false beliefs that vulnerable populations are less concerned with environmental issues. Despite a lack of resources and political power, minority communities continue to play an active role in grassroots environmentalism. Gender appeared to have been even more of a significant predictor of risk perception and environmental concern. Females were 4 times more likely than males to show high levels of environmental concern and were more likely to report air and surface water quality as poor or fair.

This is consistent with environmentalism research which has repeatedly shown that women express greater environmental concern when compared to men (Davidson and Freudenburg, 1996; Xiao and McCright, 2011). Differences in gender perception and concern are thought to be derived from historical social gender roles where women are seen as nurturing caregivers often providing empathy and compassion. When evaluating the intersection of race and gender and their association with environmental risk perception and concern, Non-White women demonstrated the highest level of concern for environmental issues and are more likely to believe their health problems are associated with exposure. One explanation for this phenomenon is the role of Black women as the head of household in low-income minority communities, which are often those burdened with increased toxic facility siting.

5.1.2 Physical and Mental Health

The hypothesis that Somerville residents would have lower levels of physical and mental health compared to the U.S general population mean held true, even after stratifying by gender, race, and the intersection of gender and race. This suggests that the environmental conditions and other social factors faced by Somerville residents are associated with poorer health-related quality of life. Mean PCS scores were highest among Non-White females, while mean MCS scores were highest among Non-White males. This could be accounted for by the increased social cohesion, social support and cultural influences often seen among Black and Hispanic communities (Johnson et al. 1990; Alegria 2007; Sansom 2020). It was our hypothesis that the longer individuals lived in Somerville the lower their MCS and PCS scores would be. Neither time lived in the house or time lived in Somerville were a significant predictor of MCS or PCS. However, results showed that when controlled for gender and time lived in Somerville, increase in age was associated with decline in physical health score. The findings of this study demonstrate the need for clinical studies to further assess the physiological and psychological impact of residing in proximity to hazardous facilities.

5.1.3 Perception of Relocation and Home Buyout

Home buyout and relocation programs have been widely used in post-disaster scenarios as well as to permanently relocate residents living in hazard prone coastal communities. The use of home buyout and relocation practices in environmental justice communities dates back to the late 1970s. However, inequality has been seen in the way policies and laws created to provide home buyout and relocation assistance are carried out. This has been seen in communities such as the Love Canal in Niagara Falls, NY and Carver Terrace in Texarkana, TX. We hypothesized that older residents and those who have lived in Somerville longer will report less interest in relocation or buyout, while female residents and individuals of a racial minority will reporter increased interest. Results showed that Non-White females were more likely to relocate if provided resources or financial support when compared to Non-Hispanic White men. This suggests that while Black and Hispanic residents in environmental justice communities have not been afforded equal opportunities for relocation or buyout it is not due to lack of interest if given the adequate resources such as affordable housing options. This study highlights the need for relocation policies to focus on the needs of vulnerable populations.

5.2 Future Direction

5.2.1 Somerville

Additional research and community resources are needed to understand the impact of residential creosote exposure on the people of Somerville. Residents of Somerville expressed concern about air and surface water quality in the community. Future studies should include environmental and biological sampling to validate the environmental risk perceptions and concerns of residents and to obtain an accurate assessment of individuals creosote exposure. Mental and physical health scores were significantly lower than the national mean. Physical and mental health screenings need to be conducted to substantiate self-reported psychological and physiological health. A policy analysis needs to be conducted to further understand the impact of home buyout and relocation laws, policies, and programs on environmental justice communities and vulnerable populations.

5.2.2 Residential Creosote Exposure

While results of this study add to the existing literature on environmental risk perception, health related quality of life, and home buyout and relocation perception, the scope is limited due to small sample size and the inability to assess a temporal relationship. Environmental risk perception and concern need to be examined in other geographical areas with residential creosote exposure. Environmental and biological sampling needed to be conducted to further validate environmental risk perceptions. To evaluate the physical and mental health impacts of residential creosote exposure, clinical examinations need to be conducted. A cohort-based longitudinal study needs to be conducted to better understand the impact of creosote exposure over time.

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APPENDIX A

TEXAS A&M UNIVERSITY HUMAN RESEARCH PROTECTION PROGRAM
INFORMATION SHEET

Title of Research Study: RESIDENTIAL CREOSOTE EXPOSURE: ASSESSMENT OF HEALTH AND ENVIRONMENTAL RISK PERCEPTIONS IN SOMERVILLE, TX

Investigator: Garett Sansom, DrPH, MPH
Funded/Supported By: This research is funded/supported by Texas A&M University.

Why are you being invited to take part in a research study?
We need information from those of at least 18 years of age to assess the health and knowledge of the community about the Creosote plant.

What should you know about a research study?

- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Who can I talk to?
If you have questions, concerns, or complaints, or think the research has hurt you, talk to the principle investigator Garett Sansom, DrPH at (979) 436-9387 or at Sansom@tamhsc.edu. This research has been reviewed and approved by the Texas A&M Institutional Review Board (IRB). You may talk to them at 1-979-458-4067, toll free at 1-855-795-8636, or by email at irb@tamu.edu.

Why is this research being done?
The survey is being conducted to assess individuals experience with the creosote plant. The goal of this project is to discover the health of the community and individuals perceptions of risks in relation to industrial disasters.

How many people will be studied?
We expect to enroll about 130 people.

What happens if I say "Yes, I want to be in this research"?
You will be asked to complete a 10 to 15 minute survey with me right now

What happens if I do not want to be in this research?
You can leave the research at any time and it will not be held against you.
What happens if I say "Yes", but I change my mind later?
You can leave the research at any time and it will not be held against you.

What happens to the information collected for the research?
Efforts will be made to limit the use and disclosure of your personal information, including research study and other records, to people who have a need to review this information. We cannot promise complete privacy. Organizations that may inspect and copy your information include the TAMU HRPP/IRB and other representatives of this institution. However, the *only identifiable information that will be collected is your zip code.*

APPENDIX B

SURVEY QUESTIONNAIRE

Thank you so much for taking time to speak with us. My name is _________________ and I am a student at Texas A&M University. We are conducting this study to gather information on the perceived health effects of the Koppers Inc. creosote facility. This survey should take less than 15 minutes.

Section 1. This section provides information on your background

Q1 Gender: What is your gender?
❍ Male
❍ Female

Q2 Age: What year were you born?

Q3 Race: Which of the following races do you most closely identify with?
❍ White
❍ Black or African-American
❍ American Indian or Alaska Native
❍ Asian
❍ Native Hawaiian or Pacific Islander

Q4 Ethnicity: Are you Hispanic or Latino/a?
❍ Yes
❍ No

Q5 Education: Does every adult who lives in this house have at least a high school diploma?
❍ Yes
❍ No
❍ Don't Know
❍ Refused

Q6 Employment: Are there any adults in this household currently unemployed?
❍ Yes
❍ No
❍ Don't Know
❍ Refused

Q7 How many years have you lived in this house?

Q8 How many years have you lived in Somerville?

Section 2: This section will ask for information on your physical and mental health.

Q9 In general, would you say your overall health is excellent, very good, good, fair, or poor?
- ❍ Excellent
- ❍ Very Good
- ❍ Good
- ❍ Fair
- ❍ Poor

Q10 How does your health now limit you in moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf? Would you say you are limited a lot, a little or not at all?
- ❍ Yes, limited a lot
- ❍ Yes, limited a little
- ❍ No, not limited at all

Q11 How about climbing several flights of stairs? Would you say your health limits you a lot, a little, or not at all?
- ❍ Yes, limited a lot
- ❍ Yes, limited a little
- ❍ No, not limited at all

Q12 Thinking about the past four weeks, have you accomplished less than you would like as a result of your physical health?
- ❍ Yes
- ❍ No

Q13 During the past four weeks, were you limited in the kind of work or other activities you could do as a result of your physical health?
- ❍ Yes
- ❍ No

Q14 During the past four weeks, how much did pain interfere with your normal work including both work outside the home and housework?

- ❍ Extremely
- ❍ Quite a bit
- ❍ Moderately
- ❍ A little bit
- ❍ Not at all

Q15 How much of the time during the past four weeks did you have a lot of energy? Would you say (read responses)?

- ❍ None of the time
- ❍ A little of the time
- ❍ Some of the time
- ❍ Good bit of the time
- ❍ Most of the time
- ❍ All of the time

Q16 In the past four weeks, did you accomplish less than you would like as a result of an emotional problem, such as feeling depressed or anxious?

- ❍ Yes
- ❍ No

Q17 During the last four weeks, did you have trouble doing work or other activities as carefully as usual as a result of an emotional problem, such as feeling depressed or anxious?

- ❍ Yes
- ❍ No

Q18 How much of the time during the past four weeks have you felt calm and peaceful? Would you say (read responses)?

- ❍ None of the time
- ❍ A little of the time
- ❍ Some of the time
- ❍ Good bit of the time
- ❍ Most of the time
- ❍ All of the time

Q19 How much of the time during the past four weeks have you felt downhearted and blue? (If necessary, read responses)

- ❍ None of the time
- ❍ A little of the time
- ❍ Some of the time
- ❍ Good bit of the time
- ❍ Most of the time
- ❍ All of the time

Q20 During the last four weeks, how much of the time has your physical health or emotional problems interfered with your social activities, like visiting with friends, relatives etc.? (If necessary, read responses)

- ❍ None of the time
- ❍ A little of the time
- ❍ Some of the time
- ❍ Good bit of the time
- ❍ Most of the time
- ❍ All of the time

Section 3: This section asks for information on your perception of living near the Koppers Inc. creosote facility.

Q21 Are you aware that the Koppers Inc. creosote facility operates in the City of Somerville? (prompt if needed corner of Texas 36 and F.M.1361)

- ❍ Yes
- ❍ No
- ❍ Don't Know
- ❍ Refused

If yes, continue to Q22. If no skip to Q23.

Q22 Have you had any personal contact with the site?

- ❍ Yes
- ❍ No
- ❍ Don't Know
- ❍ Refused

If yes, Explain:____

Q23 How would you rate the overall air quality in your city?

- ❍ Excellent
- ❍ Very Good
- ❍ Good
- ❍ Fair
- ❍ Poor

Q24 How would you rate the quality of surface water (from rivers, creeks, and water that pools after rain) in your neighborhood?

- ❍ Excellent
- ❍ Very Good
- ❍ Good
- ❍ Fair
- ❍ Poor

Q25 How concerned are you about any environmental pollution or contaminants in your community?

- ❍ Extremely
- ❍ Quite a bit
- ❍ Moderately
- ❍ A little bit
- ❍ Not at all

Q26 What is your level of agreement with the following statement: I believe that I have experienced health problems due to exposure to environmental pollution or contaminants in my residential area.

- ❍ Strongly agree
- ❍ Agree
- ❍ Neither
- ❍ Disagree
- ❍ Strongly disagree

Section 4: This section asks for information on your perception of home buyout

Q27 Do you or someone else in your household own or rent your home?

- ❍ I own the home (listed on the mortgage or deed)
- ❍ Another resident owns the home (listed on the mortgage or deed) **Skip to Q29**
- ❍ I rent the home or share equally to pay rent **Skip to Q30**
- ❍ Another resident rents the home **Skip to Q31**
- ❍ Other:____________________ **Skip to Q30**

Q28 How likely is it that you would move out of your residential community if you were given a fair value of a house comparable to a similar home in a low crime area?

- ❍ Very likely
- ❍ Likely
- ❍ Unsure
- ❍ Unlikely
- ❍ Very unlikely
- ❍ Refused

Q29 How likely is it that the owner would move out of your residential community if they were given a fair value of a house comparable to a similar home in a low crime area?

- ❍ Very likely
- ❍ Likely
- ❍ Unsure
- ❍ Unlikely
- ❍ Very unlikely
- ❍ Refused

Q30 How likely is it that you would move out of your residential community if you were given the financial assistance to do so?
- Very likely
- Likely
- Unsure
- Unlikely
- Very unlikely
- Refused

Q31 How likely is it that the primary renter would move out of your residential community if they were given the financial assistance to do so?
- Very likely
- Likely
- Unsure
- Unlikely
- Very unlikely
- Refused

Q32 For the next several statements concerning relocation, please indicate your level of agreement or disagreement.

	SD	D	N	A	SA	DK/Refused
Moving out of the community would be difficult for me with no additional financial help						
If relocation were an option I would be concerned about leaving the community because I may lose my social ties						
Moving out of the community would be difficult for me because of my age						

Thank you for your participation in this survey. Do you have any questions for me?