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County Demographic Influence on Toxic Chemical Activities of Chemical-Related Industry in Michigan

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Abstract

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MBA, Wayne State University, 1993

BS, Oakland University, 1989

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Policy and Administration

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Abstract

There are a large number of chemical facilities that emit toxic chemicals in Michigan, and there is a concern regarding toxic chemical exposure to the residents of Michigan counties. However, it is uncertain whether chemical companies that emit toxic chemicals in Michigan are influenced by county demographic factors in deciding whether to engage in voluntary pollution prevention (P2) activities and whether this decision influences U.S. Environmental Protection Agency's (U.S. EPA) Risk-Screening Environmental Indicators (RSEI) scores. Using Bullard's theory of environmental justice, the purpose of this quantitative study was to determine if there was a correlation between chemical-related industry's voluntary P2 participation, U.S. EPA's RSEI scores for chemical-related facilities, and demographic factors in Michigan counties between 2007 through 2011. A cross-sectional design using hierarchical multiple regression analysis was used to study potential environmental inequality in 20 Michigan counties. Publically available data from the U.S. Census Bureau and the U.S. EPA included demographic data, voluntary P2 participation data, and RSEI scores for 20 counties in Michigan. A statistically insignificant correlation was found between voluntary P2 participation and median annual RSEI scores of Michigan industry; while a statistically significant, inverse correlation was found between median annual RSEI scores and educational attainment. The results from this study can be used by policy makers to promote more effective voluntary P2 policy and to create county-specific public education programs promoting toxic chemical awareness that will lead to positive social change in Michigan.

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Chapter 1: Introduction to the Study

Introduction

Michigan is an important geographical region for environmental burden research because of the prevalence of chemical-related industry and toxic chemical facilities, high reported levels of toxic chemical emissions, struggling economic conditions, and ethnic diversity in metropolitan areas across the state (United States Environmental Protection Agency, 2014b; United States Census Bureau, 2013, 2014a, 2014b, 2014c). Toxic chemical data collected by the U.S. EPA are an effective means to study potential environmental burden caused by toxic chemical activity (Bryant & Mohai, 1992, 2011; Downey, 1998, 2005, 2006; Mohai, 2002; Mohai & Bryant, 1989, 1992a, 1992b, 2011; Smith, 2007). Toxic chemical exposure can compromise public health and increase environmental burden (Clapp, Jacobs, & Loechler, 2008; U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute, 2010). Bryant and Mohai (1992, 2011), Downey (1998, 2005, 2006), Mohai (2002), Mohai and Bryant (1989, 1992a, 1992b, 2011), and Smith (2007) selected the Detroit metropolitan area and other areas of Michigan for environmental burden and environmental justice research because of the prevalence of toxic chemicals and demographic diversity of residents living in the area. These researchers used environmental data from the 1990s and demographic data from 1990 and 2000. No additional environmental justice studies focusing on Michigan county environmental and demographic data after 2000 have been conducted.

The question of unequal environmental burden from toxic chemical emissions can be studied by comparing demographic and toxic chemical activity datasets across Michigan counties. For example, if industry's voluntary U.S. EPA's voluntary pollution prevention (P2) activity is higher in more affluent, higher educated counties in Michigan during 206 through 2010, further research looking into the causes of the unequal burden and the possible environmental justice involvement could be warranted. Likewise, it was not known whether Michigan counties that are less affluent, less educated, and more racially diverse reported higher RSEI scores for the toxic chemical facilities than more affluent, higher educated, and less ethnically diverse counties during that time period.

In this study, I investigated whether county demographic factors were correlated with selected toxic chemical activities reported for Michigan's chemical-related industries during the time period spanning 2007 to 2011. I used regression analysis to analyze demographic data, toxic chemical data represented by U.S. Environmental Protection Agency's (U.S. EPA) Risk-Screening Environmental Indicators (RSEI) scores, and data representing toxic chemical facility participation in the P2 program in Michigan. The intent of this study was to determine if correlations exist between median RSEI scores calculated for toxic chemical facilities in Michigan counties, voluntary P2 participation reported by the U.S. EPA for toxic chemical facilities in Michigan counties, and Michigan county demographic factors. The demographic factors of interest included the percentage of minorities or non-Whites, average income level, and average education attainment level in the Michigan counties between 2007 and 2011. In this study, I focused on the time period from 2007 through 2011 because this was the most recent time span for which the U.S. EPA and the U.S. Census Bureau archival data sets were available. This multiple year timeframe allowed for a broader analysis of the associated data and led to a more credible and robust study (Creswell, 2009; Frankfort-Nachmias & Nachmias, 2008).

This study included Michigan counties with a minimum population of 100,000 inhabitants. Counties with a minimum population of at least 100,000 were included for two reasons. First, counties with this population were selected in order to capture a higher level of diversity in the sample population. For example, populations lower than 100,000 did not report a high level of ethnic diversity (U.S. Census Bureau, 2014). Second, counties with at least 100,000 inhabitants also reported a higher number of toxic chemical facilities (U.S. Environmental Protection Agency, 2014b). Because this study concerned population exposure to toxic chemicals, more densely populated Michigan counties were selected.

I focused on the time period from 2007 through 2011. During that time, the U.S. EPA (2014b) reported high levels of toxic chemical emissions and a large number of toxic chemical facilities in Michigan counties. The high number of toxic chemical facilities and the volumes of toxic emissions lead to concerns regarding public exposure to the toxic chemicals emitted in the region. Because no environmental justice research was found that focused on Michigan counties from 2007 to 2011, it was not clear if there was a correlation between county demographics such as income, racial diversity, and education and chemical-related industry’s toxic chemical activities during that time period. For example, it was unclear if the voluntary P2 activity of chemical-related industry in Michigan counties influenced the toxic chemical health risk scores, represented by U.S. EPA RSEI scores calculated for their facilities after controlling for county demographic factors. Also, it was uncertain whether county demographic factors influenced the RSEI scores reported for the potential health risk from toxic chemical exposure in the Michigan counties. This uncertainty led to questions regarding unequal environmental burden when comparing toxic chemical data and demographic data across Michigan counties.

This study is necessary to help promote a greater understanding of the potential environmental burden from toxic chemical exposure in Michigan counties. The knowledge gained by this study can be used to help Michigan officials determine if future investigation of environmental injustice is warranted in the state. Further investigation would be necessary in order to determine potential causes and effects associated with environmental justice concerns. An environmental justice framework for this study was appropriate because industry might be less concerned about participating in voluntary P2 activities and toxic chemical reduction if located in less affluent, less educated, and more racially diverse counties where residents were less empowered to push for change. Correlative findings could present implications for positive social change to expand environmental justice and public protection within Michigan. The resulting positive social changes could include policy change to influence improvements in communication between Michigan's toxic chemical companies and Michigan counties affected by the toxic chemical exposure. The policy changes could promote enhanced public education and awareness programs of potential hazards associated with chemical exposure. Also, policy change could transform current industry's voluntary P2 disclosure guidelines into a mandated reporting system that would help to increase the transparency of U.S. EPA toxic chemical data in the public domain.

The sections of this chapter include a background, a brief summary of the literature related to the scope of the study topic, the problem statement, the purpose of this study, the research questions and hypotheses, conceptual framework, theoretical framework, the nature of the study, definitions, assumptions, scope, delimitations, study limitations, significance, and summary.

Background

Toxic chemical emissions are associated with an increased risk of cancer and increased rates of cancer in exposed populations (Clapp et al., 2008; National Cancer Institute, 2014; U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute, 2010). Michigan was ranked the 14th highest contributor of toxic chemical emissions in the United States in 2011 based on U.S. EPA statistics (United States Environmental Protection Agency, 2014b). The Michigan Department of County Health (2014) indicated that cancer was the second leading cause of death in Michigan based on 2010-2012 statistics. In 2010, Michigan reported a cancer mortality rate of 182.5 deaths per 100,000 people and 55,660 cancer diagnoses (Michigan Department of County Health, 2014). Because Michigan has a high volume of annual toxic chemical emissions, high number of toxic chemical facilities, and high incidences of health problems related to toxic chemical exposure, further research on toxic chemical exposure of populations within the state would advance the study of environmental burden in Michigan.

In the United States, toxic chemical emissions are regulated under the U.S. EPA's Toxics Release Inventory (TRI) program (United States Environmental Protection Agency, 2014b). The U.S. EPA's TRI program was created in 1986 and established guidelines for chemical-related industries to report toxic chemical production and toxic chemical release data (United States Environmental Protection Agency, 2014b). In 1990 the U.S. EPA incorporated the TRI program into the Pollution Prevention Act of 1990. The U.S. EPA established the Pollution Prevention Act of 1990 to help protect human health and the environment from toxic chemical exposure. Pollution prevention is also defined by the U.S. EPA as: "reducing or eliminating waste at the source by modifying production, the use of less-toxic substances, better conservation techniques, and re-use of materials" (United States Environmental Protection Agency, 2014e, p. 2). This definition means that pollution prevention activities may involve adjusting manufacturing processes to reduce emissions and deciding to handle and produce less-hazardous chemicals at a manufacturing site. Also, based on the U.S. EPA's definition, pollution prevention can include recycling measures and steps to reduce chemical activities in order to protect the environment.

Under the Pollution Prevention Act of 1990, chemical facilities that manufacture, store, or dispose of toxic chemicals must be registered under the U.S. EPA's TRI program. The U.S. EPA refers to chemical facilities registered under the TRI program as TRI-regulated facilities. All TRI-regulated chemical facilities are mandated to report their annual toxic chemical emissions data to the U.S. EPA under the Pollution Prevention Act of 1990.The U.S. EPA publishes data sets associated with TRI-regulated chemical facilities. One example of data that are reported by the U.S. EPA are chemical facility voluntary P2 activity data for toxic chemicals reported under the TRI program. Chemical industry's voluntary P2 activities are reported under the U.S. EPA's P2 Program. The U.S. EPA publishes annual P2 reports for each regulated toxic chemical facility on the public portion of their website.

Under the U.S. EPA's P2 program, companies have the option to voluntarily report details of their facility-specific pollution prevention activities related to toxic chemicals. These activities can include "equipment or technology modifications, process or procedure modifications, reformulation or redesign or products, substitution of raw materials and improvements in housekeeping, maintenance, training, or inventory control" (United States Environmental Protection Agency, 2014e, p. 2). The P2 activities can also involve varying levels of corporate involvement and corporate resource commitments. The U.S. EPA defines P2 information as "a tool for identifying effective environmental practices and highlighting pollution prevention successes" (United States Environmental Protection Agency, 2014m, p. 1). Voluntary P2 data provided by toxic chemical facilities can be further analyzed at a county level and were used in the current study.

In addition to voluntary P2 activity data, the U.S. EPA also calculates and reports other data sets related to toxic chemical emissions from TRI-regulated toxic chemical facilities. An example of an additional dataset that was used in this study was U.S. EPA

RSEI facility scores. The U.S. EPA developed RSEI scores for toxic chemical facilities to better evaluate and understand the potential human health hazards associated with toxic chemical releases (U.S. Environmental Protection Agency, 2014i). The RSEI scores are calculated by the U.S. EPA using a combination of scientific data, toxic chemical production data, and demographic-related information.

RSEI scores are based on a summation of health, environmental, and demographic factors gathered by the U.S. EPA. The calculations are based on factors "such as the amount of chemical releases, their degree of toxicity, and size of the exposed population" (U.S. Environmental Protection Agency, 2014j, p. 4). The U.S. EPA also uses U.S. Census data and chemical dissipation factors in air, water, and soil to come up with an overall annual RSEI score for each toxic chemical facility. These RSEI scores can help researchers analyze trends related to environmental conditions and toxic chemical exposure (U.S. Environmental Protection Agency, 2014j).

The RSEI score and annual voluntary P2 activity data are available for each TRI-regulated chemical facility in each county in the United States and are associated with toxic chemical activities. The U.S. EPA calculates a numerical RSEI score for a registered chemical facility each year and also reports a county median RSEI score based on that data. A high score indicates a greater potential risk of chronic human health effects from exposure to toxic chemical emissions of a given facility (U.S. Environmental Protection Agency, 2014j). The U.S. EPA reports voluntary P2 participation data as a spreadsheet of voluntary P2 activities associated with the toxic chemical emissions reported by each TRI-regulated chemical facility. For the purposes of this study, median county RSEI scores and voluntary P2 participation data of chemical-related facilities in Michigan counties represented the toxic chemical activity of industry in the Michigan counties. This toxic chemical activity was analyzed along with Michigan county demographic data to see if possible correlations between the median county RSEI scores and voluntary P2 activity and county demographics existed.

Brief Summary of Research Literature

Literature addressing environmental burden in Michigan is limited in number. Eleven peer-reviewed articles pertaining to environmental burden in Michigan were found (Bryant & Mohai, 1992, 2011; Downey, 1998, 2005, 2006; Mohai, 2002; Mohai & Bryant, 1989, 1992a, 1992b, 2011; Smith, 2008).

Bryant and Mohai (1992, 2011), Mohai (2002), and Mohai and Bryant (1989, 1992a, 1992b, 2011) analyzed environmental quality in relation to race, income level, and the level of public concern over pollution exposure in Detroit metropolitan area neighborhoods using datasets from the 1990 Detroit Area Study. The researchers studied the possibility of unequal environmental burden and the possibility of environmental injustice facing minorities living close to hazardous waste sites located in the study area in Michigan between 1989 and 1990. Bryant and Mohai, Mohai, and Mohai and Bryant published their findings in seven peer-reviewed articles.

Downey (1998) used 1990 U.S. Census data and U.S. EPA TRI emissions data from 1989 to study "environmental hazard distribution" (p. 776) in the Detroit metropolitan area and in other parts of the state. Downey wished to determine if there were correlations between race, income, and TRI toxic chemical emissions data in the Detroit metropolitan area and across Michigan.

Downey (2005) analyzed 1990 U.S. Census data and U.S. EPA TRI data from 1970 to 1990 to determine if "residential segregation has played a dual role in shaping environmental racial inequality" (p. 1,000). Downey studied the possible correlation between the chemical industry's TRI activity, income distribution, and housing market depression in the Detroit metropolitan area.

Downey (2006) continued research in the Detroit metropolitan area and used 2000 U.S. Census data and U.S. EPA TRI emissions data to determine a correlation between the toxic emissions, income, and race in the area.

Smith (2007) also studied correlations between toxic emissions and income in Detroit, Michigan and focused on toxic waste sites and landfills in Detroit from 1970 through 1990. Like Downey (1998, 2005, 2006), Smith found a correlation between income level and exposure to toxic chemical emissions in Detroit.

Environmental burden United States. Contemporary research involving environmental burden in the United States is discussed in detail in Chapter 2. Researchers who have studied environmental burden in the United States typically focused on specific regions with a high concentration of industry and a high population of racial minorities with low socioeconomic status. Scholars included information relevant to the current study's independent variable, industry's voluntary P2 activity and the industry's voluntary environmental program activity, the dependent variable, toxic chemical facility RSEI scores, and demographic factors.

The United Church of Christ's Commission for Racial Justice (1987, 2007) looked at populations living in close proximity to hazardous waste sites in Tennessee and other Southern U.S. states. The researchers determined that the Black populations in the study experienced environmental inequality and unequal environmental burden when compared to White populations in the geographical region included in the study.

Chakraborty, Maantay, and Brender (2011) looked at county health factors in relation to the location of toxic chemical facilities in Florida counties and used Geographic Information System (GIS) tracking of chemical emissions to illustrate chemical exposure. The researchers determined that Hispanic and minority communities were exposed to more chemical risk when compared to areas with a higher population of White residents.

Grant, Trautner, Downey, and Thiebaud, (2010) investigated environmental burden in areas with high percentages of Hispanic and Black residents and high toxic chemical emissions and across the United States. Grant et al. used U.S. EPA RSEI chemical risk scores from 2002 and demographic data to study potential environmental burden affecting Hispanic and Black populations in the United States.

Shapiro (2005) analyzed environmental burden across the United States and used demographic data and U.S. EPA TRI chemical emissions data from 1988 to 1996. Shapiro suggested that U.S. EPA RSEI scores along with the U.S. EPA TRI data should be used as indicators of environmental burden in research (p. 393).

Cong and Freedman (2011) investigated the possible correlation between corporate governance and corporate environmental performance and disclosure activities of chemical companies. Cong and Freedman used RSEI data from 2003 through 2005 as an indicator for environmental performance and found it to be a better indicator of performance than U.S. EPA TRI data.

Konisky and Schario (2010) used U.S. Census Bureau data on income and minority status and government enforcement data pertaining to environmental protection under the U.S. EPA's Clean Water Act to study environmental justice in the United States. Konisky and Schario wished to determine if government enforcement of environmental protection was different in less affluent areas and in areas with a higher percentage of minorities.

Godsil (2004) reviewed environmental inequality cases in Black and Hispanic communities in the United States in order to determine if environmental injustice based on race and income was a factor. Godsil discussed how environmental inequity is market driven and not race driven.

Sicotte and Swanson (2007) used U.S. EPA RSEI data and 2000 U.S. Census demographic data on ethnicity and income to analyze environmental justice in Philadelphia. Sicotte and Swanson selected Philadelphia because of the number of hazardous facilities and economic and racial diversity.

Lyon and Maxwell (2007) studied data on U.S. voluntary environmental programs related to pollution protection in order to determine if program results were linked to corporate environmental performance and corporate behavior.

Sam (2010) looked at corporate participation in the U.S. EPA sponsored voluntary P2 program activities and focused on violation rates and enforcement rates of various industries in relation to toxic emission reporting. Sam determined that P2 program participation did not always equate to improvement in environmental protection or a reduction in pollution.

Carrion-Flores, Innes, and Sam (2006) evaluated the efficiency of the voluntary U.S. EPA environmental program for pollution reduction, the 33/50 program, and compared program participation with U.S. EPA TRI data from toxic chemical companies. Carrion-Flores et al. wanted to learn if the reduction of emissions led to long term environmental protection innovation in the chemical companies included in the study.

Delmas and Blass (2010) evaluated possible correlation between U.S. EPA TRI data, U.S. EPA RSEI data, U.S. EPA environmental compliance data, and environmental reporting at 15 chemical companies in the United States. Delmas and Blass used U.S. EPA RSEI scores and U.S. EPA TRI data for the period spanning 2000 through 2005 in order to analyze trends in the data.

Delmas and Keller (2005) studied the voluntary U.S. EPA environmental program, WasteWise, in order to see if the program promoted positive environmental change and increased corporate participation.

Khanna and Damon (1999) studied the voluntary U.S. EPA's environmental program known as 33/50, which focused on the voluntary reduction of industrial chemical emissions, and looked at U.S. chemical industry data from 1991 to 1993. Khanna and Damon wanted to see if program participation influenced corporate economic performance.

King and Lenox (2000) used U.S. EPA TRI data from 1987 through 1996 and statistical modeling to investigate the possible correlation between toxic chemical company environmental performance and participation in the voluntary environmental program, Responsible Care.

Rivera, de Leon, and Koerber (2006) analyzed data from the voluntary U.S. EPA's environmental program, Sustainable Slopes Program, to access the effectiveness of the program. Rivera et al. compared U.S. EPA data before and after program implementation to see if changes could be detected.

Videras and Alberini (2000) studied chemical industry's participation in U.S. EPA voluntary environmental programs from 1993 through 1998 to see whether companies with worse environmental performance were more apt to participate in the voluntary programs than companies with higher environmental performance.

Vidovic and Khanna (2012) analyzed the effectiveness of industry's voluntary environmental program participation by using U.S. EPA TRI data from 1991 to 1995 and data from industry participation in the voluntary U.S. EPA environmental program, 33/50. Vidovic and Khanna found that program participation did not always lead to a decline in chemical emission volumes at the toxic chemical facilities used in the study.

This section included brief summaries of selected studies pertaining to environmental burden research in Michigan and in other parts of the United States. These studies will be discussed in further detail in Chapter 2.

Gaps in Literature

This study contributes to the literature and body of knowledge related to environmental burden research in Michigan. Bryant and Mohai (1989, 1992, 2011), Mohai (2002), and Mohai and Bryant (1989, 1992a, 1992b) looked at correlation between race and income and toxic chemical exposure based on proximity to hazardous waste sites in the Detroit metropolitan area. In this research, I studied the possible correlation between toxic chemical industry's voluntary P2 participation and U.S. EPA RSEI scores in Michigan counties after controlling for county demographics. Shapiro (2005) theorized that RSEI scores should be used in research to help promote a more robust study of environmental burden. No other study was found on the influence of toxic chemical industry's voluntary P2 participation on toxic chemical RSEI scores in Michigan counties during 2007 through 2011. Also, no other researcher used Michigan demographic factors as control variables to study the possible influence of Michigan demographics factors on toxic chemical RSEI scores during this time period.

While research on environmental burden and chemical exposure exists at national, state, and local levels exists, there are only 11 studies on environmental burden in Michigan. In seven of these studies, scholars focused on the same set of data from the 1990 Detroit Area study (Bryant & Mohai, 1989, 1992, 2011; Mohai, 2002, Mohai & Bryant, 1989, 1992a, 1992b). Downey (1998, 2005, 2006) and Smith (2007) also focused on Detroit and the Detroit metropolitan area. However, these researchers used demographic data and toxic chemical emissions data from time periods prior to the timeframe of the current study. Noted limitations from these studies included a focus on a single time period of 1989 through 1990, focus on hazard waste sites rather than a broader focus on all registered toxic chemical facilities in the area, and a limited regional focus within Michigan. Because of these limitations, the results of the 11 prior Michigan studies cannot be used to generalize correlation of Michigan county demographics to industry's toxic chemical activities during the timeframe for the current study. Therefore, the need to conduct the current study was warranted.

Problem Statement

There are a large number of chemical facilities that emit toxic chemicals in Michigan, and there is a concern regarding toxic chemical exposure to the residents of Michigan counties (United States Environmental Protection Agency, 2014c). The U.S. EPA reported 61,287 registered chemical facilities in Michigan in 2012 (United States Environmental Protection Agency, 2014c). Many of those facilities produced and emitted toxic chemicals and were registered under the U.S. EPA's TRI program (United States Environmental Protection Agency, 2014c). In 2011, Michigan was ranked number 14 on the list of states with the highest volume of toxic chemical releases (United States Environmental Protection Agency, 2014b). Michigan counties are exposed to high levels of chemical pollution and may experience health risks and environmental burden associated with toxic chemical emissions. There were no recent studies on whether toxic chemical facilities in Michigan counties practice different voluntary P2 activity and produce more potentially hazardous toxic chemicals in counties that are less affluent, have less education attainment, and are more ethnically diverse. In this study, I wished to determine if there was a possible correlation between the chemical industry's participation in voluntary P2 activities, median county RSEI scores, and county demographics in Michigan. Under the theoretical framework of environmental justice, I found that chemical-related industry in Michigan had lower RSEI scores and reported lower voluntary P2 programs in counties that were less educated. The study expanded the body of knowledge surrounding toxic chemical activity and environmental burden in Michigan counties during the time period of 2007 through 2011.

Purpose of the Study

The purpose of this study was to investigate whether toxic chemical facilities in Michigan counties practice different voluntary P2 participation and produce more potentially hazardous toxic chemicals, as seen through median RSEI scores, in counties that are less affluent, have lower education attainment, and greater racial diversity. I determined if there was a correlation between chemical-related industry's participation in voluntary P2 activities, RSEI scores calculated by the U.S. EPA for toxic chemical facilities, and demographic factors in Michigan counties from 2007 to 2011. County findings were then compared. Voluntary P2 activities and median RSEI scores are associated with the chemical-related industry's toxic chemical activity (United States Environmental Protection Agency, 2014e; United States Environmental Protection Agency, 2014i). Within the scope of this study, county demographics included the percent of non-White or minorities in the Michigan counties, the median annual household income, and the percent of educational attainment of at least a high school degree in the county for the time period of 2007 through 2011. Correlative findings and comparison of county data could be used to indicate unequal environmental burden within the state, which could justify the need for further investigation of environmental justice conditions. The results could be used to promote change in Michigan's state and local environmental protection policies and in public education programs involving toxic chemical activity awareness.

Research Questions

The research question associated with this study was as follows:

1. Does the voluntary P2 activity of chemical-related industry in Michigan counties influence toxic chemical health risk scores, represented by U.S. EPA's RSEI scores, after controlling for county demographic factors?

The null hypothesis and alternative hypothesis associated with this study are defined as follows:

H_0: There is no influence of voluntary P2 activity on the toxic chemical health risk scores, represented by U.S. EPA's RSEI scores of chemical-related industry in Michigan counties, after controlling for county demographic factors.

H_1: There is influence of voluntary P2 activity on the toxic chemical health risk scores, represented by U.S. EPA's RSEI scores of chemical-related industry in Michigan counties, after controlling for county demographic factors.

Conceptual Framework

The conceptual framework for this study involved the assumption that corporate voluntary environmental program participation is representative of corporate social responsibility. Company participation in voluntary environmental programs, such as P2, is assumed to be a positive attribute and illustrates positive corporate social responsibility (Pava, 2008; Rahman & Post, 2012). Shum and Yam (2011) and Wirth, Chi, and Young (2010) used the term voluntary environmental responsibility to describe nonmandated chemical industry environmental sustainability activities such as voluntary P2 program participation. Pava and Rahman and Post described voluntary corporate actions as forms of corporate social responsibility. Pava stressed the importance of corporate social responsibility initiatives for corporate and societal sustainability. Rahman and Post defined corporate social responsibility as sustainability involving economic, environmental, and social factors. This framework can be used in environmental burden research to study possible correlations between pollution prevention and county demographic factors.

A review of relevant studies pertaining to corporate voluntary environmental programs is included in Chapter 2. The studies included provide background for corporate social responsibility and corporate voluntary environmental responsibility. Brouhl, Griffiths, and Wolverton (2009); Alberini and Segerson (2002); Carmin et al. (2003); Dawson and Segerson (2008); Glachant (2007); Lyon and Maxwell (2007); Reich (2007); Schlosberg (2004); and Tashman and Rivera (2010) addressed this conceptual framework. This information will be discussed in more detail in Chapter 2.

Theoretical Framework

The theoretical framework for this study included environmental justice theory proposed by Bullard (1996). Bullard defined environmental justice as "the principle that all people and communities are entitled to equal protection of environmental and public health laws and regulations” (p. 493). Bullard also defined environmental justice as a movement that “emerged as a response to industry and government practices, policies, and conditions that many people judged to be unjust, unfair, and illegal” (p. 493). Populations are entitled to equal treatment when it pertains to environmental rights and public health associated with environmental exposure.

Within the scope of the current study, Bullard’s (1996) environmental justice theory was used to explain and understand the relationship between Michigan industry’s participation in voluntary pollution prevention, toxic chemical exposure, and population demographics of Michigan counties. The framework provided by Bullard’s environmental justice theory helped me to explain the phenomenon of why chemical-related companies may or may not participate in voluntary environmental protection activities. The framework also helped me to explain why research questions such as determining correlation between the variables industry’s RSEI health risk scores and county demographic factors were being asked. In the study’s research questions, I also challenged the assumptions found in Bullard’s environmental justice theory. Bullard theorized that the definition of environmental justice becomes misdirected when researchers make erroneous assumptions, try to generalize findings, and fail to address the influence of outside social factors on environmental justice. As a result, researchers could miss details that influence study results. Bullard’s theory helped me to focus on my research and to not assume the results could be used to explain conditions in geographical areas outside the scope of my study

Nature of the Study

The nature of this study was quantitative and included a cross-sectional analysis of data from Michigan counties. A quasi-experimental approach using regression models was used (Campbell & Stanley, 1963; Tuckman, 1999). I also incorporated a correlational and ex post facto design (Campbell & Stanley, 1963). Archival government data spanning 2007 through 2011 were used. The study included Michigan counties with a population of at least 100,000 inhabitants. This study was limited to counties over 100,000 inhabitants because those counties are areas where Michigan's population is centered and where toxic chemical facilities are located. Based on U.S. Census data, 20 Michigan counties met that criterion (United States Census Bureau, 2013, 2014c). Regression analysis was performed on the variables included in the study. The intent of this study was to find a possible correlation between the dependent variable, independent variable, and control variables through multiple regression analysis of the data from all 20 counties included in the study.

One dependent variable, one independent variable, and three control variables were included in this study. The dependent variable was the median county RSEI score for the toxic chemical facilities located in the Michigan counties from 2007 through 2011. The independent variable in this study was the average percentage of Michigan county TRI-regulated facilities reporting voluntary P2 participation between 2007 and 2011. This study also included three control variables.

The control variables in this study were represented by demographic data from the U.S. Census Bureau data for the time period of 2007 through 2011 (United States Census

Bureau 2013, 2014a, 2014b, 2014c). The variables were the percent of non-Whites or minorities in the Michigan county for the period spanning 2007 through 2011, the median household income for the period spanning 2007 to 2011 in the Michigan county, and the percent of educational attainment of at least a high school degree in the Michigan county for the time period of 2007 through 2011. I looked at the possible correlation of the independent variable, voluntary P2 participation, with median annual county RSEI scores after controlling for the demographic variables mentioned.

Methodology Summary

Secondary government data were used in this quantitative study. The secondary data represented chemical industry participation in the U.S. EPA's voluntary P2 program and were used to calculate the percentage of Michigan toxic chemical facilities participating in the U.S. EPA's voluntary P2 program during the period of 2007 through 2011 and the median county U.S. EPA RSEI scores for chemical-related facilities in Michigan counties from 2007 to 2011. Archival data reported by the U.S. Census Bureau were used to represent demographic factors in the Michigan counties (United States Census Bureau, 2013, 2014a, 2014b, 2014c). I sought to determine if correlations existed between industry's participation in the U.S. EPA's P2 program, Michigan county median U.S. EPA RSEI scores, and county demographics in Michigan. The variables used in this study will be defined in further detail in Chapter 3.

Definitions

Key words associated with this study include the following:

Corporate environmental responsibility: An indication of a company's commitment toward promoting positive and ethical activities that benefit the local community outside of the organization (Rahman & Post, 2012).

EJView: The U.S. EPA environmental justice database that provides geographic mapping of communities based on U.S. EPA environmental data and demographic data from the U.S. Census Bureau (United States Environmental Protection Agency, 2014a).

Environmental corporate social responsibility (ECSR): "Potentially useful framework for developing and guiding a better corporate response to the questions raised by environmental justice" (Monsma, 2006, p. 497).

Environmental discrimination: Unequal treatment and exposure to environmental protection activity and the unjust treatment of members of one population over another (Bullard, 1996, p. 497).

Environmental justice: "A social justice issue and civil rights concern with the potentially discriminatory application of environmental laws" (Monsma, 2006, p. 445). The U.S. EPA definition of environmental justice was indicated as the "fair treatment and meaningful involvement of all people regardless of race, color national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulation, and polices" (United States Environmental Protection Agency, 2014a, p. 1). Environmental justice research typically involves studying population statistics in conjunction with environmental burden.

Environmental justice theory: Is defined by Bullard (1996) as "the principle that all people and communities are entitled to equal protection of environmental and public health laws and regulations" (p. 494).

Risk-screening environmental indicator: A tool used by the U.S. EPA to assess the level of risk to human health associated toxic chemical releases. This indicator is abbreviated as RSEI (United States Environmental Protection Agency, 2014b). The RSEI score is a calculation that includes chemical toxicity, environmental, and population datasets to determine the human health hazards of toxic chemicals present at a given toxic chemical facility (Sicotte & Swanson, 2007, p. 516). An average RSEI score for a county and state can also be calculated.

Social responsibility: A part of social and organizational theory and is used to define industry's ethical actions toward county and environmental sustainability (Melville 2010).

Toxics release inventory (TRI): Mandated reporting of toxic chemical releases and toxic chemical activity to the environment by toxic chemical facilities under the U.S. EPA's Pollution Prevention Act of 1990 (United States Environmental Protection Agency, 2014b).

TRI-regulated facility: A chemical-related company or site that is registered and regulated under the U.S. EPA TRI program (United States Environmental Protection Agency, 2014b).

Voluntary environmental programs: Self-directed or sponsor-directed nonmandated participation in programs such as pollution prevention that are directed toward corporations to promote corporate environmental responsibility (Carmin et al., 2003; Darnall & Sides, 2008; United States Environmental Protection Agency, 2014b).

Voluntary pollution prevention (P2) program: A voluntary preventative and corrective action program sponsored by the U.S. EPA to help chemical companies reduce chemical releases to the environment and is abbreviated as voluntary P2. Corporate program participation involves progress reporting of facility-specific voluntary P2 activities to the U.S. EPA (United States Environmental Protection Agency, 2014b).

Assumptions

It was assumed that the U.S. EPA conducted validity and reliability checks of its databases housing the secondary environmental data that were used in this study. It was also assumed that the U.S. EPA data and U.S. Census data are reliable, validated, and credible because the data were obtained and managed by the U.S. government. Further information regarding the validity of the study will appear in Chapter 3.

Scope and Delimitations

The scope of this study included demographic factors and data pertaining to toxic chemical activity in Michigan counties during the period of 2007 through 2011. The population selected for this study included Michigan counties reporting a total population of 100,000 or greater based on data from the 2010 U.S. Census. Twenty Michigan counties met this selection criterion (U.S. Census Bureau, 2013, 2014c). Because I was concerned about population exposure to toxic chemicals, counties with higher populations and higher racial and economic diversity were selected. According to published government statistics, sparsely populated Michigan counties did no show significant levels of demographic diversity (U.S. Census Bureau, 2014c). Sparsely populated Michigan counties also reported a lower number of chemical-related facilities than counties with populations greater than 100,000 inhabitants (U.S. Census Bureau, 2014c; United States Environmental Protection Agency, 2014b).

Variables pertaining to industry's toxic chemical activity and county demographic factors were included in the study. The variables related to toxic chemical activity that were included within the scope of this research were chemical-related industry's voluntary P2 participation and median annual RSEI scores of Michigan chemical facilities registered under the U.S. EPA's TRI program in Michigan counties with populations greater than 100,000 inhabitants. Secondary data were obtained from the U.S. EPA TRI Explorer database (United States Environmental Protection Agency, 2014b). These data were reported at the county level. The control variables in this study were the following county demographic factors: percentage of minorities or non-Whites, median annual household income, and educational attainment of a high school degree. Comparisons were across the counties included in the sample population.

Limitations

There were several limitations noted in the study. Limitations included the inability to generalize results, variable selection and the possibility of intervening variables affecting study results, and secondary data availability. One limitation in the current study included the inability to use the study results to generalize relationships and conditions in industries, geographic areas, and periods of time outside the scope of this study. The study findings were also geographically limited with focus only on Michigan communities and associated Michigan chemical-related industry. These findings cannot be generalized to explain voluntary P2 activities of companies that are not registered in the U.S. EPA's TRI program. The study findings also cannot be generalized to represent P2 participation and RSEI scores in areas outside the state of Michigan. Because I also focused on a specific period of time, results outside of the period from 2007 through 2011 cannot be generalized. Another limitation included the selection of control variables in the current study.

The selection of control variables for this study was a potential limitation. There was the possibility that additional demographic and social factors and historical bias may influence study results and study validity. Demographic variables not included in the study could function as intervening variables and influence the outcome of the study. As a result, the possible effects associated with demographic variables and data not selected and included in the study cannot be assumed or dismissed. Also, historical bias resulting from the selection of the timeframe spanning 2007 to 2011 may play a role in the validity of this study (Campbell & Stanley, 1963). Another limitation in the current study corresponded to secondary data availability and accessibility.

Data availability is an additional limiting factor in this study. U.S. Census data used in this study were collected from the U.S. Census Bureau's American Community Survey in the years between the decennial U.S. Census (United States Census Bureau, 2014a). The American Community Survey randomly surveys U.S. citizens during the period between each census and includes estimates for total population statistics.

Demographic data are reported in yearly estimates and in 3 and 5-year ranges as averages and median values in a variety of tables available in the U.S. Census Bureau's American Factfinder database.

Significance

The focus of this study included an analysis of correlation of county demographics with toxic chemical facilities' voluntary P2 activity and with U.S. EPA RSEI scores for toxic chemical facilities in Michigan counties during the time period of 2007 through 2011. I did not find significant correlation between P2 activity and median county U.S. EPA RSEI scores. However, I found correlation between median county RSEI scores and the demographic factor, educational attainment, in these counties. Further research on environmental inequality in the region would be warranted.

There are several positive outcomes that can occur as a result of this research. This research can lead to improvements in the transparency, accessibility, and dissemination of information on toxic chemical activity and exposure within Michigan. This research can also be used to elevate public understanding and awareness of the hazards associated with toxic emissions. The research revealed inconsistencies in voluntary P2 practices and RSEI scores across Michigan. A correlation between median RSEI scores and educational attainment in Michigan counties was seen. Further investigation by the U.S. EPA, the U.S. Justice Department, and the Michigan Department of Environmental Quality may be warranted. The outcome of this study may help to promote social change in Michigan by illustrating the need for government regulation of industry's voluntary P2 activities and enhanced pollution prevention measures for chemical-related industry. My research may also lead to improved public education programs on toxic chemical activity. These changes would be made in response to further investigation confirming environmental justice issues in Michigan.

Summary

This chapter contained background and introductory information regarding research investigating the potential influence of county demographic factors on chemical-related industry's toxic chemical activities in Michigan. I defined the purpose of this study which was to investigate whether toxic chemical facilities in Michigan counties practice different voluntary P2 participation and produce more potentially hazardous toxic chemicals, as seen through RSEI scores, in counties with specific demographic factors. I determined whether a correlation existed between corporate voluntary P2 participation, median annual RSEI scores, and county demographics in Michigan. The environmental justice theory by Bullard (1996) was used as framework in this quantitative study. The study's research questions were used to test this environmental justice theory. The study helps to promote the understanding of the relationship between Michigan county demographics and chemical-related industry's voluntary P2 activities and RSEI scores associated with industry's toxic chemical activity during the time period of 2007 through 2011. This research also helps to promote awareness of industry's toxic chemical activity and the potential environmental burden from toxic chemical exposure in Michigan counties.

Chapter 2 begins with an introduction, a discussion of the literature search strategy, and a presentation of the theoretical foundation and conceptual framework of the study. The chapter continues with a review of the literature associated with environmental burden and environmental justice studies in the United States, a discussion of gaps in the literature, and limitations found in the reviewed literature. The chapter closes with summary and conclusions sections.

Chapter 2: Literature Review

Introduction

In the United States, toxic chemicals are regulated by the U.S. EPA under the Pollution Prevention Act of 1990. Industry's toxic chemical activities are associated with toxic emissions, production, storage, and disposal of toxic chemicals. These toxic chemical activities involve mandatory pollution protection reporting and voluntary P2 program participation by toxic chemical companies (United States Environmental Protection Agency, 2014b). The P2 program is an example of a voluntary environmental program that is supported and sponsored by government agencies, such as the U.S. EPA, and also by industry groups (Darnall & Sides, 2008; Carmin, Darnall, & Mil-Homens, 2003). The U.S. EPA's RSEI scores are an example of mandatory reporting and disclosure of toxic chemical information by the government agency. The RSEI scores are calculated by the U.S. EPA as a tool to help assess toxic chemical pollution protection under the Pollution Prevention Act of 1990. Voluntary P2 activities and U.S. EPA RSEI scores can be used to study environmental burden and environmental justice on a regional level. In this study, I focused on toxic chemical activities involving RSEI scores and industry's voluntary P2 program participation in Michigan counties.

Michigan counties are involved with chemical industry activity. There are many toxic chemical facilities, high levels of toxic chemical emissions, and a high frequency of health issues such as cancer and asthma based on data reported by the U.S. government (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014i; U.S. Department of Health and Human Services, National

Institutes of Health, National Cancer Institute, 2010). Downey (1998, 2005, 2006), Bryant and Mohai (1992, 2011), Mohai (2002), and Mohai and Bryant (1989, 1992a, 1992b) used data from 1990 and concluded disproportional environmental burden existed in select Michigan communities. Less researched aspects of Michigan industry's toxic chemical activity involve investigation and comparison of industry's participation in the voluntary U.S. EPA's P2 program and toxic chemical activity using toxic chemical facility U.S. EPA RSEI scores across Michigan counties. Researchers have not investigated whether toxic chemical facilities in Michigan counties practice different voluntary P2 activity and produce more potentially hazardous toxic chemicals in counties that are less affluent, have less education attainment, and are more ethnically diverse.

The purpose of this study was to investigate whether toxic chemical facilities in Michigan counties practice different voluntary P2 participation and produce more potentially hazardous toxic chemicals, as seen through RSEI scores, in counties that are poorer, less educated, and report higher racial diversity. I determined if there was a correlation between chemical-related industry's participation in voluntary P2 activities, RSEI scores calculated for toxic chemical companies, and demographics in Michigan counties from 2007 to 2011. The current study will broaden public knowledge of the environmental quality and potential environmental burden in Michigan counties.

In Chapter 2, the literature search strategy of this study will be discussed. Then, the theoretical foundation and framework will be presented and analyzed. The theoretical framework used was the environmental justice theory as defined by Bullard (1996). Next, the conceptual framework of the study will be presented and discussed. The conceptual framework included corporate social responsibility and environmental responsibility in association to environmental burden. Chapter 2 then continues with a literature review related to the background and history of pollution prevention and environmental justice studies in Michigan and in other parts of the United States. I will then discuss literature that incorporates the key variables and concepts that will be addressed in the current study. Next, limitations in existing literature are addressed. Finally, a summary of the chapter and conclusions will be presented.

Literature Search Strategy

The literature search and literature review used for this paper involved several research databases accessed through the Walden University library. The databases used included the following: ProQuest Central, Academic Search Complete, Thoreau, Business Source Complete, Google Scholar and LexisNexis. Ulrich's Periodicals Directory was also used to obtain and verify peer-reviewed articles. Various search terms were also used in the literature search. These terms included *environmental justice, environmental injustice, environmental racism, environmental burden, corporate environmental responsibility, corporate social responsibility, voluntary environmental programs, voluntary disclosure theory, corporate environmental disclosure theory,* and *Michigan environmental justice*.

The focus of peer-reviewed literature for this study primarily included the years 2005 to 2013. However, relevant literature from earlier periods was also used in the literature review. This prior research included research by Adeola (1994); Alberini and Segerson (2002); Bowen and Wells (2002); Delmas and Keller (2005); Godsil (1991);

Hall and Kerr (1991); Khanna and Damon (1999); King and Lenox (2000); King, Lenox, and Terlaak (2005); Maantay (2002); Mohai and Bryant (1992a, 1992b); United Church of Christ's Commission for Racial Justice (1987, 2007); and Videras and Alberini (2000). Studies by Brouhl et al. (2009); Alberini and Segerson (2002); Carmin et al. (2003); Dawson and Segerson (2008); Glachant (2007); Khanna, Deltas, and Harrington (2009); Lyon and Maxwell (2007); Pava (2008); Reich (2007); Schlosberg (2004); and Tashman and Rivera (2010) were used to discuss the conceptual framework in the study. Bullard's (1996) environmental justice theory represented the study's theoretical framework. Research by Callewaert (2002), Ewall (2012), Schweitzer and Stephenson (2007), and Taylor (2000) were used to provide background information regarding environmental justice. The following sources included a discussion of environmental justice research in Michigan: Downey (1998, 2005, 2006), Mohai and Saha (2006), Godsil (1991), Bryant and Mohai (1992, 2011), Mohai (2002), Mohai and Bryant (1989, 1992a, 1992b), and Smith (2007). The following sources included environmental justice research in other parts of the United States: Adeola (1994); Baden, Noonan, and Turaga (2007); Basu, Devaraj, and Ganesh-Babu (2009); Blodgett (2006); Bowen, Salling, Haynes, and Cryan (1995); Bowen and Wells (2002); Brulle and Pellow (2006); Bullard (1996), Bullard and Johnson (2000); Campbell, Peck, and Tschudi (2010); Chakraborty et al. (2011); Cutter (1995); Denq and Joung (2000); Grineski (2006); Gouldson (2006); Grecyn (2009); Hall and Kerr (1991); Hite (2000); Jones and Raney (2006); Latta (2007); Maatay (2002); Mohai and Saha (2006); Norton, Wing, Lipscomb, Kaufman, Marshall, and Cravey (2007); Rivera, Oetezel, de Leon, and Starik (2009); Pastor, Morello-Frosch, and Sadd

(2006); Pastor, Sadd, and Hipp, (2001); Sicotte (2010); The United Church of Christ's Commission for Racial Justice's Commission for Racial Justice (1987, 2007); and Whittaker, Segura, and Bowler (2005). The following sources included discussions related to the dependent variable and independent variable in the current study: Cong and Freedman (2011); Konisky and Schario (2010); Godsil (2004); Grant, Trautner, Downey, and Thiebaud; (2010); Shapiro (2005); Sicotte and Swanson (2007); Lyon and Maxwell (2007); and Sam (2010). Further background regarding the independent variables was included in research by Carrion-Flores, Innes, and Sam (2006); Delmas and Blass (2010); Delmas and Keller (2005); Khanna and Damon (1999); King and Lenox (2000); Rivera, de Leon, and Koerber (2006); Videras and Alberini (2000); and Vidovic and Khanna (2012).

Bullard's Environmental Justice Theory

The theoretical framework for this study was based on the social theory provided by Bullard (1996). According to the environmental justice theory, poor populations and minorities are not always victims of environmental justice discrimination (Bullard, 1996). Bullard hypothesized that environmental justice researchers often make generalizations that environmental justice principles only apply to poor minorities and not to White populations (p. 497). On the contrary, Bullard contended that environmental justice principles apply to everyone in the population. Bullard also stated that people at all economic levels and ethnicities may experience environmental inequality and are affected by environmental justice. Broad generalizations and assumptions in environmental justice research should be avoided. One generalization that causes problems in environmental justice research is the use of varying the spatial unit used to compare populations in environmental justice research (Bullard, 1996).

Bullard (1996) used the environmental justice theory as a tool to analyze prior environmental justice research. Bullard indicated that environmental justice researchers often make erroneous assumptions when trying to generalize exposure risk across various regions and areas. Exposure risk from toxic chemicals involves a mix of variables and should not be generalized. For instance, toxic chemical areas such as landfills have varying hazards and levels of associated risk and should not be evaluated equally (Bullard, 1996, p. 496). The areas and toxic facilities should be differentiated appropriately. Generalization errors also occur when researchers try to compare different spatial units such as zip code and census tract data across regions (Bullard, 1996).

Environmental justice research incorporates the use of spatial units to help identify which members of the population to study. Bullard (1996) stressed that the varying units should not be compared equally because they are not the same. For example, studies incorporating a specific spatial unit should not be used to generalize results of studies using alternative units (Bullard, 1996, p. 495). Under this logic, it is not safe to assume results from an individual census block represent results seen across other blocks or across census tracts. These results cannot be compared on a one-to-one basis. Bullard’s definition of environmental justice also included several factors that play a role in environmental justice research.

Bullard (1996) also presented other details in environmental justice theory. Bullard indicated that social factors and historical factors contribute to environmental justice findings. Both sets of factors must be considered before reaching environmental justice conclusions. Bullard also contended that communities and areas that are typically included in environmental justice studies are not “homogeneous” (p. 496) and consist of a mix of cultures and varying economic and social influences. Early environmental justice research overlooked these influences and the association to environmental inequalities (Bullard, 1996). Bullard’s environmental justice framework was applied to various environmental justice studies addressed in this dissertation. Bullard’s framework can be seen in research by Downey (2005).

Downey (2005) studied environmental inequality in Detroit, Michigan and incorporated several demographic and economic factors to help describe the unequal environmental burden experienced in Black neighborhoods. These factors included economic indicators such as income levels and housing statistics and also demographic factors such as the number of Black and White residents living in close proximity to industrial hazards in Detroit. U.S. Census data and environmental data from 1970 to 1990 were incorporated in Downey’s study.

Downey (2005) looked at the distribution of Black and White residents around the hazardous chemical sites. Downey concluded that the residential segregation was based on the housing market in Detroit. A depressed housing market led to unequal population distribution in the city. As a result, Downey determined that environmental racism was not a result of chemical industry activity but was a result of declining economic conditions. Downey concluded that differences in income and housing markets in the areas where Black and White populations lived accounted for the unequal distribution of these groups. Downey's research follows the theoretical framework provided by Bullard (1996). Downey found that the historical factors, regional economic conditions and struggling housing market contributed to the environmental inequality seen in the study population. Downey's research also supported the concept of the reduced significance of race as a factor of environmental inequality (Downey, 2005, p. 973).

Downey's (2005) findings were consistent with the results and analysis made by Kain (1968) regarding population inequality in Detroit and Chicago 40 years ago. Downey and Kain expanded their focus of environmental justice by broadening their research to include factors other than race. This approach supports Bullard's (1996) ideas that environmental justice researchers should look at the influence of social and historically motivated causes of the inequality. Bullard described the need for researchers to be cognizant of the effects of historical events such as economic recession and social environment rather than race when applying environmental justice theory to research. Bullard's theory on environmental justice provided framework to help answer the research question and hypothesis of the current study of Michigan counties.

Conceptual Framework

Corporate Environmental and Social Responsibility and Environmental Burden and Justice

For the scope of this study, it is conceptualized that indicators of corporate environmental and corporate social responsibility can be seen in when looking at the extent of environmental burden in communities. RSEI toxic chemical risk scores of facilities and facility-level voluntary P2 activity represented indicators of environmental quality and indicators of potential environmental burden in Michigan counties included in this study. Lower RSEI scores indicate a lower hazard risk associated with the chemicals produced at the toxic chemical facility (United States Environmental Protection Agency, 2014c). It is conceptualized that lower RSEI scores indicate positive steps toward voluntary corporate environmental and social responsibility. It is also conceptualized that the lower risk scores represent a positive contribution to environmental responsibility and a positive step toward voluntary pollution prevention (P2) activities. The ideas of positive corporate voluntary environmental and social responsibility have been addressed in literature. I used these concepts as conceptual framework for this study.

Corporate Social Responsibility and Voluntary Environmental Responsibility.

In this study, I applied corporate social and voluntary environmental responsibility as conceptual framework in order to help me analyze, understand, and explain the study results. I found prior research that discussed the importance of corporate social responsibility. Pava (2008) stressed the importance of corporate social responsibility and indicated corporate social responsibility enhanced the transparency of information, promoted ethical practices, created positive relationships, and ultimately increased the economic stability of companies. Positive benefits such better relations with government stakeholders and improved stakeholder perception of corporate social responsibility were seen when corporations worked with government agencies to solve problems and implemented improvements (Pava, 2008). In terms of this study, cooperative relationships with the toxic chemical facilities and the U.S. EPA and with state and local officials regarding pollution prevention activity would be considered benefits of practicing environmental and social responsibility. Voluntary environmental responsibility was also discussed in research by Carmin et al. (2003).

Carmin et al. (2003) focused on the definition of voluntary environmental programs. The researchers defined voluntary environmental programs as programs that included environmental activities that were separate from the regulatory compliance mandated through government regulations. These voluntary environmental programs were typically sponsored by government, trade association groups, and industry stakeholders who worked together to design and shape the voluntary environmental programs (Carmin et al., 2003). Carmin et al. noted that the U.S. EPA's support and sponsorship of voluntary environmental programs such as P2 initiatives helped to promote responsible actions and positive environmental benefit. The concept has relevance to this study because U.S. EPA data related to companies' voluntary P2 programs were used. The theme of voluntary environmental program research was also seen in research by Brouhl et al. (2009), Alberini and Segerson (2002), Khanna et al. (2009) and Tashman and Rivera (2010).

Research by Brouhl et al. (2009), Alberini and Segerson (2002), Khanna et al. (2009), and Tashman and Rivera (2010) illustrated the use of politics as a motive for participation in corporate voluntary environmental programs. Brouhl et al. suggested politics were a motivational force behind corporate disclosure of environmental information. Brouhl et al. indicated voluntary programs such as the U.S. EPA sponsored Strategic Goals Programs were used as tools to promote policy and were used by regulators when a specific government mandated policy did not exist. Brouhl et al. also noted that the pending threat of regulatory action if chemical emission reduction was not achieved motivated corporate environmental program participation to do a better job in promoting positive program activity. The threat of government mandates and increased political pressure was also discussed by Alberini and Segerson.

Alberini and Segerson (2002) determined that pressure from lobbyists and organizations influenced corporate participation in voluntary environmental programs. The threat of government mandates if improvement and progress were not achieved helped drive company participation in the programs (Alberini & Segerson, 2002). It was also found that voluntary programs helped participants implement programs that were perceived to benefit the corporation and produce positive returns (Alberini & Segerson, 2002). The threat of regulatory pressure and mandates were also subjects of research by Khanna et al. (2009) and Tashman and Rivera (2010).

Khanna et al. (2009) looked at factors that influenced corporate involvement in voluntary implement pollution prevention activities from 1994 to 1996. The researchers initially wanted to see if program participation influenced corporate economic performance and found that regulatory pressure and the threat of policy enactment were an influencing factor in promoting corporate voluntary environmental activity (Khanna et al., 2009). Khanna et al. studied the voluntary environmental program, Total Quality Environmental Management. Khanna et al. determined the program helped to influence pollution prevention activity by helping to change processes and operations affecting the environment. Tashman and Rivera (2010) researched the effectiveness of voluntary environmental protection programs in association with corporate social performance.

Tashman and Rivera (2010) looked at 14 dimensions of corporate social performance from a 5-year span of time and used social network theory as framework to explain why companies practice corporate social responsibility. Tashman and Rivera determined that internal networks helped to promote communication and helped to promote a positive corporate image. Dawson and Segerson (2008) and Lyon and Maxwell (2007) also used this conceptual framework in their studies.

Dawson and Segerson (2008) looked at voluntary environmental agreements directed at industries. The researchers determined that voluntary programs were typically the precursor to mandatory environmental policy implementation. Program ineffectiveness of and lack of corporate participation in the voluntary initiates were seen as incentives for the government sponsors to convert voluntary environmental programs to government mandated programs (Dawson & Segerson, 2008). Dawson and Segerson indicated that companies benefited from all levels of voluntary environmental program participation. The companies maintained a positive corporate image from the participation and often avoided new restrictions such as emissions taxation for pollution as a result of the positive voluntary environmental activity (Dawson & Segerson, 2008). Additional researchers looked at motivational factors for corporate voluntary program participation.

Lyon and Maxwell (2007) studied factors that influenced voluntary program participation. The researchers indicated that governmental and non-governmental stakeholder pressure was a motivating factor for corporate voluntary environmental program participation and defined as the threat of legislative action. Lyon and Maxwell indicated that conventional indicators of voluntary program success did not give a realistic picture of environmental improvement and led to questionable conclusions. Lyon and Maxwell also found that the information exchange between participating companies and the government led to dissemination of information to companies that did not participate in the programs and often promoted policy changes.

When reviewing the scope of literature related to the current study's conceptual framework, I noted that researcher opinions on the effectiveness of corporate voluntary environmental programs and corporate social responsibility motivators were not alike. Conflicting opinions can be seen in literature by Glachant (2007) and Reich (2007). Glachant addressed corporate voluntary environmental programs while Reich discussed corporate social responsibility.

Glachant (2007) stated that voluntary environmental programs were not binding or enforceable which meant the government did not have authority to require reporting compliance. Glachant wanted to see if the threat of government regulation influenced companies to participate in voluntary environmental programs and developed various models to better understand the relationship between corporate voluntary environmental program participant and government voluntary program sponsorship. Glachant found that voluntary environmental agreements did not have the same level of effectiveness across all industries and long-term voluntary program strategy was said to be used to prevent or delay possible enforcement action if initiatives were not met (Glachant, 2007). A contracting opinion was expressed by Reich (2007).

Reich (2007) analyzed corporate social responsibility in terms of its economic benefits. From a profitability standpoint, the researcher indicated corporate social responsibility activities could be a cost detriment and counterproductive to the corporate bottom line (Reich, 2007). Furthermore, corporate voluntary activities were not considered to be forms of social responsibility but were viewed as positive management decisions only when profits and other corporate economic factors were positively influenced (Reich, 2007).

Literature Review

Background Environmental Justice Research

The terms environmental burden research and environmental justice research were used interchangeably in studies. The U.S. EPA defines environmental justice as the "fair treatment and meaningful involvement of all people regardless of race, color national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulation, and polices" (United States Environmental Protection Agency, 2014a, p. 1). When looking at environmental justice, literature various definitions are found. For example, Dotson and Wyte (2013) stated, "Environmental justice seeks fairness in how environmental burdens and risks are visited on poor people, women, communities of color, indigenous peoples, minorities, and citizens of developing countries" (p. 1085). Taylor (2000) indicated that the "analysis of the principles of environmental justice will show a well-developed environmental ideological framework that explicitly links ecological concerns with labor and social justice concerns" (p. 538). Taylor referred to environmental justice as a system that is comprised of various "frames" that bridge or link environment activities together (p. 566). Schlosberg (2004) suggested the definitions and theories used to describe environmental justice over the years were lacking and used Rawls' (1971) liberal justice theory as an example of such a theory.

Schlosberg (2004) hypothesized that the ideas of cultural recognition and respect of cultural history should be included in the definition of environmental justice. Schlosberg indicated that prior justice theory by Rawls (1971) was limited in focus and criticized the theory's idea that there was equal benefit to all individual from "the distribution of economic and social inequality in a society" (p. 518). Schlosberg indicated that history and cultural factors were associated with variations of experiences seen in the field. This interpretation corresponds with the environmental justice theory presented by Bullard (1996). Schlosberg's idea of social and historical influence on environmental justice research is consistent with Bullard's ideas of environmental justice theory and builds upon the theoretical framework of the current study.

When approaching environmental justice, Schlosberg (2004) also indicated that because of cultural differences, the use of one theory or plan to identify and analyze a situation does not work. Consideration and inclusion of a broader focus on environmental justice would be a better practice when studying this issue. This idea is consistent with the environmental justice framework presented by Bullard (1996). Bullard also theorized that environmental justice is subject to multiple definitions and was a complex field. Bullard's theory can also be applied to a study by Godsil (2004).

Godsil (2004) discussed how environmental inequity is not driven by race but is influenced by economic factors. The researcher stated that "market adherents suggest redistributing environmental burdens from areas currently comprised by people of color is both morally and ethically unnecessary because the current distribution does not necessarily reflect racism, but simply the distributional effects of our economy" (Godsil, 2004, p. 1111). Bullard's (1996) environmental justice theory also included the idea that environmental justice reflects other areas besides racial factors. Bullard did not define a scope of economic indicators in his analysis of environmental justice. However, Bullard's framework included a broad network of factors that often contribute to environmental inequality. Bullard's ideas of the importance of factors such as history and culture in environmental justice research were also seen in a study by Schweitzer and Stephenson (2007).

Schweitzer and Stephenson (2007) reviewed environmental justice literature and noted many discrepancies in the studies. For example, the researchers determined that many prior studies included too broad of a focus and did not address "historical, economic, and cultural differences that exist among regions" (Schweitzer & Stephenson, 2007, p. 321). The researchers also noted that the environmental justice studies presented in 2000 seemed to address more localized areas that included metropolitan areas. Schweitzer and Stephenson covered a "longitudinal review of existing literature" because there was an extensive amount written on the subject of environmental justice

(Schweitzer & Stephenson, 2007, p. 320). Research by Callewaert (2002) also stressed the importance of social and historical factors in environmental justice research.

Callewaert (2002) looked at several communities that filed environmental inequity claims. Callewaert described environmental justice as a “socio-historical process” that demanded attention to the compliance history of the manufacturing facility and the history of the county (Callewaert, 2002, p. 264). Furthermore, the researcher indicated that history should be used in environmental injustice claims in order for communities to support their case and gain policy change (Callewaert, 2002, p. 266). Callewaert’s description of environmental justice is consistent with the framework presented by Bullard (1996). Bullard viewed historical influence as a strong factor in environmental justice theory and included the influence as a potential cause for some of the environmental inequality noted in research. The complexity of data interpretation and environmental justice studies was also addressed in research by Ewall (2012).

Ewall (2012) reviewed past research initiatives on environmental justice and found varying conclusions. For example, the researcher discovered that income level of Black populations and race were primary contributors in environmental discrimination claims Social class played less of a contributing role in environmental injustice. It was also indicated that “intentional discrimination is very hard to prove” in environmental injustice claims (Ewall, 2012, p. 4). Ewall also hypothesized that “‘environmental justice’ policies have actually been ‘equity’ policies weakly designed to redistribute harms” (Ewall, 2012, p. 12). The researcher also mentioned that the U.S. EPA’s Office of Environmental Justice was first called Office of Environmental Equity until it was decided the term "equity" was misleading and was not always as associated with environmental justice (Ewall, 2012, p. 4). Ewall concluded that policy changes were needed to solve the problems associated with environmental justice in the United States.

Environmental Burden in Michigan

Prior research on environmental justice in Michigan is limited in number. Research by Downey (1998, 2005, 2006), Mohai and Saha (2006), Godsil (1991), Bryant and Mohai (1992, 2011), Mohai (2002), Mohai and Bryant (1989, 1992a, 1992b, 1998), and Smith (2007) addressed chemical exposure from hazardous waste sites and the relation to demographic factors of race and income in the Detroit, Michigan metropolitan area in the early 1990's. These researchers used environmental justice studies by the United Church of Christ's Commission for Racial Justice (1987, 2007) as framework in the Detroit studies. Environmental justice studies that focused on Michigan are addressed in the following paragraphs and provide background and framework for this study.

Downey (1998, 2005, 2006) focused on the Detroit metropolitan area in several studies during various time periods. Downey (1998) used U.S. EPA data on TRI emissions from 1989 and 1990 U.S. Census data for the Detroit metropolitan area to see if there was a correlation between race, income, and the level of TRI chemical releases in those communities. Downey found inconsistent results when trying to compare the three variables. When Downey included data for other Michigan urban areas in the study, a correlation between county race and emission levels during 1989 and 1990 was noted. The researcher could not determine which demographic factor was the most influential and concluded that further study addressing environmental justice was necessary.

Downey (2005, 2006) then looked at conditions during other time periods. This information will be examined in the next paragraphs.

Downey (2005) looked at race in regard to potential environmental inequality in Detroit and used spatial mismatch theory to help describe environmental inequality. The income levels and number of Black and White residents in close proximity to industrial hazards in Detroit were analyzed using census data and environmental data from 1970 to 1990 (Downey, 2005). The researcher looked at the distribution of Black and White residents around these sites and found residential segregation was based on differences in the housing market between these groups. Downey determined the perceived environmental racism was not seen to be a result of industry, but was the result of housing market issues Differences in income accounted for the unequal distribution of these groups. Downey (2005) indicated that in 1990, succession and spatial residential segregation reduced the options for Blacks living in the city and “played a dual role in shaping environmental racial inequality” (Downey, 2005, p. 1000). Downey’s results demonstrated how history played a role in the actual inequality seen in Detroit and support Bullard’s (1996) definition of environmental justice theory.

Downey (2005) was unable to conclude racial environmental injustice. Black and White populations lived in areas affected by toxic chemicals in the Detroit metropolitan area during the time period from 1970 through 1990. White populations lived around industrial facilities in Detroit suburbs while Black populations lived near in industry in the city (Downey, 2005). White and Black populations were both exposed to toxic chemical activities. Based on these findings, environmental racial inequality could not be determined in the neighborhoods studied because both populations experienced toxic chemical exposure.

Downey (2006) also looked at race in regard to potential environmental inequality in the Detroit metropolitan area using 2000 U.S. Census data and TRI emissions data from facilities in that area. These data represented a different data set than Downey's earlier research. Downey (2006) discussed the limitations of using Census data and various tract units within environmental justice research and noted the use led to insistent interpretations across the discipline. Downey (2006) also indicated that Detroit was selected for the research because it was "one of the nation's most important rust belt cities and because TRI emissions and waste transfers in Wayne County, Detroit's host county, are among the worst in the nation" (p. 781). Downey (2006) used hazard proximity indicators and a distance decay model to show how far chemical hazards traveled to estimate hazard proximity of communities. Black communities were seen to be exposed to more environmental hazard by TRI facilities in the Detroit area in 2000 than other populations. Black populations were "disportionately burdened by TRI facility activity in 2000" (Downey, 2006, p.786). Downey concluded that environmental racial inequality existed based on significance of the correlation between proximity hazard indicator and the percentage of Blacks in the population in the study area. Correlation was also found with income, race, and hazard indicators (Downey, 2006, p.783).These conclusions were different than Downey's (2005) conclusions based on datasets from 1970 through 1990. Additional environmental justice research on Michigan was performed by Bryant and Mohai (1992, 2011), Mohai and Bryant (1989, 1992a, 1992b, 1998), and Mohai (2002).

Bryant and Mohai (1992, 2011), Mohai and Bryant (1989, 1992a, 1992b, 1998), and Mohai (2002) discussed environmental racism and injustice in relation to their research sponsored the University of Michigan's 1990 Detroit Area Study project. Mohai was a primary investigator in the 1990 Detroit Area Study. The 1990 Detroit Area Study looked at environmental conditions and county perceptions of environmental conditions and possible injustice in the Michigan counties of Wayne, Oakland, and Macomb (Bryant & Mohai, 1992, 2011; Mohai & Bryant, 1989, 1992a, 1992b, 1998; Mohai, 2002). The researchers noted that Detroit contained more than half of the hazardous waste sites in Michigan during the study timeframe and had the highest percentages of Blacks than in other areas of Michigan (Bryant & Mohai, 1992, 2011). The Detroit Area Study used resident interview data to assess perceptions of environmental conditions and environmental treatment in their neighborhoods (Bryant & Mohai, 1992, 2011; Mohai, 1989, Mohai & Bryant, 1992a, 1992b, 1998). Study findings indicated high levels of environmental awareness in both Black and White populations. Black residents indicated their environmental quality of life and environmental justice perceptions were worse than White respondents and had little power to influence environmental change in their communities (Bryant & Mohai, 1992, 2011; Mohai, 1989; Mohai & Bryant, 1992a, 1992b, 1998). The researchers also found that responses concerning environmental quality perceptions were different when responses from lower income and higher income Black respondents were studied. Affluent Black populations in the Detroit Area Study indicated they were happy with their level of environmental quality (Bryant & Mohai, 1992, 2011; Mohai, 1989). Bryant and Mohai, Mohai, and Mohai and Bryant concluded that low-income, Black populations in the Detroit area experienced environmental racism in based on the 1990 data

Bullard (1996) was critical of the conclusions based on the Detroit Area Study and specifically cited the environmental justice assumptions of Bryan and Mohai (1992) were flawed. Bullard criticized Bryan and Mohai and other researchers by saying their environmental justice studies “fail to provide an accurate sociohistorical context of their reexamination (Bullard, 1996, p. 493). Bullard also identified the prior studies to be limited and indicated the studies did not consider all of the possible influences.

In studies by Mohai and Bryant (1992a) and Godsil (1991), the 1990 Detroit Area Study data were used to analyze environmental injustice and disparity between Black and White populations in the Detroit metropolitan area. Mohai and Bryant found that poor Blacks were four times more likely to live close to hazardous waste landfills than White residents in the (Mohai & Bryant 1992a). In terms of environmental justice, the researchers concluded racial bias appeared to be more prevalent that class bias in Detroit and more disparity was seen between Black and White populations in the geographical area (Mohai & Bryant, 1992a). Godsil also mentioned the Detroit Area Study in a legal review on environmental racism noted some evidence leading to environmental injustice against Black residents based the results of the 1990 Detroit Area Study.

Bullard’s (1996) environmental justice framework can be used to analyze the conclusions made by Mohai and Bryant (1992a) and Godsil (1992). Inconsistencies in the interpretation of environmental justice can be seen. For instance, neither Mohai and Bryant nor Godsil included investigation of the influence from historical events or regional economic conditions in their research. Bullard indicated the factors should be considered before researchers make conclusions of environmental racism and environmental inequality. Smith (2007) incorporated elements of Bullard's environmental justice theory in another environmental inequality research on Detroit.

Smith (2007) studied environmental inequality within the Detroit metropolitan area using data from the time period 1970 to 1990. The researcher focused on areas near landfills and toxic chemical sites identified as hazardous sites under the U.S. EPA's Superfund program (United States Environmental Protection Agency, 2014k). The author used spatial tracking and data in order to analyze conditions in the geographical area Smith determined there was a correlation between economic factors and the location of the landfill and Superfund sites. Smith found that there was a high probability that "economically deprived" (p. 40) individuals lived near landfills and did not find a correlation between race and site location. It was also indicated that those individuals did not have the financial means to move to environmentally safer areas. Smith also concluded that "economically deprived neighborhoods are less able to mount resistance to unwanted facilities" than more affluent neighborhoods (Smith, 2007, p. 40). This rationale follows the Bullard's environmental justice theory by suggesting possible environmental justice factors besides race. Bullard's environmental justice framework can also be seen in research by Mohai and Saha (2006).

In another study, Mohai and Saha (2006) used environmental justice theory as theoretical framework to reexamine racial and socioeconomic data from populations living near environmental hazardous sites in Michigan in the early 1990's. Mohai and Saha concluded that past literature on environmental justice reported mixed conclusions that could not be used to generalize environmental justice situations in other communities. This conclusion supports Bullard's (1996) definition and theory of environmental justice by stressing the difficulty in trying to generalize results of this type. Mohai and Saha also suggested that a geographical "distance-based approach" to data gathering and analysis could better address environmental injustice questions (Mohai & Saha 2006, p. 396). Based on this information, the researchers concluded the mixed conclusions seen in environmental justice research resulted from inconsistencies in the scope and scales in environmental justice studies. Bullard (1996) also discussed the issue of scale and scope misalignment seen in prior environmental justice studies. Research by Baden, Noonan, and Turaga (2007) also noted this limitation when analyzing prior environmental justice studies.

Baden et al. (2007) reviewed existing environmental justice studies and noted inconsistency in the scopes and scales of the studies. The inconsistencies made it difficult for the researchers to compare study findings. In order to test this hypothesis, the researchers conducted a study testing combinations of scales and scopes to prove the point. Baden et al. determined the study results were influence by the the geographical scope of the study and the type of spatial scale used to define the study population. For example, the spatial scale could include the unit of study area or areal such as census tract while the scope would define a study area in terms of a regional, local, or national level (Baden et al., 2007, p. 170). Bullard (1996) supported the idea that census tracts were not homogeneous and results gathered from different spatial scales were difficult to compare because of their differences. Bullard concluded that researchers of environmental justice and environmental burden in different geographical areas did not always come to the same conclusions.

Environmental Justice Research across the United States

Influence of Demographic Factors: In order to better understand the current environmental burden environment in Michigan, a review of studies analyzing regional and national data on environmental burden environmental justice was necessary. Early research showed mixed or inconclusive results which concur with the ideas of Baden et al. (2007), Bullard (1996), and Mohai and Saha (2006) stated in the previous section. For instance, it was noted by researchers Church of Christ's Commission for Racial Justice (1987, 2007) looked at populations living in close proximity to hazardous waste sites in Tennessee and other southern states. These researchers determined that the Black populations in the study communities experienced environmental inequality and burden when compared to White populations in the regions. United Church of Christ's Commission for Racial Justice's Commission for Racial Justice conducted research that included environmental mapping of hazardous waste sites throughout the United States. The researchers found that many of the hazardous waste sites were in close proximity to Black populations in the Southern United States communities targeted in the study (United Church of Christ's Commission for Racial Justice, 1987). This study was cited as a paramount study that resulted in policy change for hazardous waste site management and helped promote interest in further environmental justice research.

Twenty years later, United Church of Christ's Commission for Racial Justice (2007) sponsored a follow-up study to their 1987 review of the toxic hazardous waste site locations in the United States in relation to neighborhood ethnicity. The researchers revisited the regional and demographic data associated with toxic waste sites and neighborhood racial makeup and utilized digital mapping to plot chemical facility locations, U.S. EPA data, and U.S. Census data in their research (United Church of Christ's Commission for Racial Justice, 2007). The researchers indicated that race and income disparities existed in communities in close proximity to hazardous waste sites. Also, the researchers determined that the racial mix of communities was a contributing factor in predicting where toxic facilities were located (United Church of Christ's Commission for Racial Justice, 2007). The United Church of Christ's Commission for Racial Justice (1987, 2007) studies were cited in environmental justice research by Mohai and Saha (2006), Mohai and Bryant (1989, 1992a, 1992b, 1998), Grant et al. (2010), and Hite (2000).

In order to capture applicable viewpoints, environmental justice research from additional geographical regions in the United States will be discussed in the following paragraphs. These studies include works by Grineski (2006), Gouldson (2006), Chakraborty et al. (2011), Blodgett (2006), Latta (2007), Brulle and Pellow (2006), Maatay (2002), Cutter (1995), Denq and Joung (2000), Hite (2000), Grecyn (2009), Rivera et al. (2009), Campbell et al. (2010), Adeola (1994), Hall and Kerr (1991), Jones and Raney (2006), Whittaker et al.(2005), Pastor, Sadd, et al. (2001), Pastor, Morello-Frosch et al. (2006), Bowen et al. (1995), Bowen and Wells (2002), Bullard and Johnson (2000), Sicotte (2010), Norton et al. (2007), and Basu et al. (2009) that focus on specific geographical areas facing environmental burden in the United States.

Grineski (2006) looked at environmental justice in Phoenix, AZ. The researcher interviewed study participants using specific questions regarding environmental quality in the community and also performed air monitoring. The area was known for a high level of industry and industry related health issues in the county due to dust exposure (Grineski, 2006, p. 44). The communities were primarily Latino and considered low-income. As a result of these findings, individuals from academia and the government then went to Phoenix to educate the public how to better protect them from the exposure to dust in their area. These stakeholders also worked with local policy makers to change ordinances in the area. Grineski indicated: “Knowledge, no matter how powerful, is irrelevant without a legal framework that facilitates environmental change. Power attached to knowledge in an EJ struggle is part of a larger framework of environmental policy” (Grineski, 2006, p. 45). The researcher also discussed the positive steps various stakeholders took to improve the environmental justice situation in one particular geographical region of the study. These findings illustrate the importance of positive social change. Next, regional environmental justice research by Gouldson (2006) that focused on chemical pollution created by oil refineries will be addressed.

Gouldson (2006) looked at environmental justice conditions in areas associated with oil refineries in the United States and Europe from 2002 to 2005. Corporate policies and chemical emissions data were reviewed to determine variations in "corporate environmental performance" (Gouldson, 2006, p. 408). The researcher determined that correlations existed between level of pollution and factors that included population density, county income, and county employment. Lower income communities were seen to have higher levels of chemical releases than more affluent areas. Gouldson concluded that variations in local enforcement of pollution protection can result from factors related to social change, economic development, the local housing and employment conditions (p.409). These points mimic the environmental justice framework of Bullard (1996) that stated a multitude of societal factors played a role in environmental justice research and must be considered to fully evaluate environmental inequality associated with environmental justice. Gouldson found a correlation between the factors and concluded that environmental justice was associated with corporate social responsibility initiatives. However, further investigation was needed to determine causality. Next, environmental justice research by Chakraborty et al., (2011) and Grant et al. (2010) will be addressed.

Chakraborty et al., (2011) and Grant et al. (2010) used U.S. EPA chemical risk data and toxic chemical emissions data to analyze environmental justice conditions in different parts of the United States. Chakraborty et al. looked at county health risk factors associated with proximity to chemical plants in Florida. Chakraborty et al. used chemical proximity data, and chemical risk data from Florida communities to show minorities in the area experienced more chemical exposure risk. The researchers determined that Hispanic and minority communities were exposed to more chemical risk when compared to communities that were White. Limitations in the study by Chakraborty et al. included a study focus limited to conditions in certain areas of Florida. This logic was also presented by Bullard (1996) who indicated a limited study focus could lead to the inability to use these data to generalize conditions in other parts of the country. Chakraborty et al. did not include analysis of the significance of social and historical factors in the study as suggested by Bullard. Grant et al. also included chemical health risk data and government emissions data similar to the data used by Chakraborty et al. and expanded the study to cover multiple states.

Grant et al. (2010) studied toxic chemical emissions data and chemical risk data for communities surrounding the 10 highest corporate polluters in the country to show Blacks and Hispanics were subjected to more environmental injustices than White populations in those areas. Both of these studies looked at correlations between minority status and exposure to chemical or environmental risk. This methodology is similar to the present study because ethnicity data and chemical risk data were compared. However, chemical risk data for the current study were derived from U.S. EPA RSEI data as opposed to public health statistics. Also, Grant et al. (2010) illustrated limited focus by including a small subset of chemical facilities in the research while Chakraborty et al. (2011) focused only on a limited geographical area within Florida. It is uncertain if the results of those studies are indicative of correlation between demographics and factors representing environmental burden or risk in Michigan. Similar study variables were also used by Blodgett (2006) to analyze populations in Louisiana.

Blodgett (2006) studied the possible correlation between demographic factors and environmental quality based on pollution exposure in St. James Parish, Louisiana. The demographic factors included race, income, education, and occupation. The geographical area was selected by the researcher because of the presence of heavy chemical pollution. Blodgett used geographical information system mapping of hazardous chemical locations in the study area and U.S. Census Bureau census tract data from 2000 to create maps to study environmental justice in the area. The researcher found that polluting facilities were located in areas with lower income levels, lower education levels, and a higher percentage of Blacks. Blodgett concluded the results represented environmental inequality and unequal environmental burden in St. James Parish.

Blodgett's (2006) study included variables that were consistent with the current study. However, Blodgett did not focus on risk data such as U.S.EPA RSEI data and relied on geographical mapping of sites for proximity indication. One limitation of Blodgett's study was the absence of statistical test results. Other limitations included a narrow geographical focus and timeframe. Bullard (1996) also indicated limitations can cause "erroneous assumptions and false generalizations" (p. 493). Further environmental justice research will be addressed in the next paragraphs.

Literature by Latta (2007) and Brulle and Pellow (2006) addressed environmental justice by looking at county chemical exposure statistics involving chemical manufacturing and disposal sites. Latta saw importance in environmental justice and citizenship and expressed the need for environmental justice to include democratic policy and environmental policy considerations. Latta stressed the importance of enforcing democratic participation in issues involving environmental and social justice concerns. Brulle and Pellow described environmental injustice in terms of unequal exposure to chemical pollution from a public health perspective. Brulle and Pellow separated the concepts of environmental justice and environmental inequality by stating that environmental inequality included environmental racism which involved unequal environmental treatment of populations based on ethnicity. The researchers indicated that social change was necessary in order to promote environmental justice and to correct environmental inequality (Brulle & Pellow, 2006). Environmental justice was also studied by Maantay (2002).

Maantay (2002) used geographic plotting to map areas of environmental hazard to study environmental justice in terms of chemical risk and demographic factors. Maantay analyzed literature from 1993 to 1999 and determined that race and income factors were associated with environmental justice situations. Other factors, such as historical factors or social and cultural factors as suggested by Bullard (1996) in environmental justice theory were not included in the study. It was also stated that low income and minority status of county members appeared to create "disproportionate environmental burden" on those populations (Maantay, 2002, p. 170). Maantay concluded that spatial studies involving geographic information systems could increase understanding of environmental injustice and improved modeling tools were needed to accurately predict county risk.

In another study involving environmental justice, Cutter (1995) discussed U.S. EPA policy leading up to the 1992 Environmental Justice Act. It was noted that the 1992 Environmental Justice Act was renamed to include the more positive name, environmental justice. Cutter also referred to the 1994 executive order involving environmental equity as an illustration of the U.S. EPA's commitment toward protecting underprivileged populations. The definition of an underprivileged population in this case was based on race and class of the communities. Cutter described environmental equity to represent the even distribution of environmental burden across populations. Cutter concluded that environmental justice research prior to 1995 illustrated indecisive results regarding environmental racism and injustice. This conclusion was consistent with Bullard's (1996) environmental justice framework and supports the theoretical framework of the current study. Denq and Joung (2000) used an alternate framework in their environmental justice research that incorporated elements found in Bullard's theory.

Denq and Joung (2000) looked at environmental justice conditions in Texas and Louisiana. The researchers used a multi-dimensional, conceptual framework that referred to power, status, and class as dimensions illustrating "social inequality (Denq & Joung, 2000, p. 95). Denq and Joung concluded that "environmental classism" (p. 95) was a better way to explain environmental justice than environmental discrimination. The study looked at communities near hazardous waste sites and found correlations between income and the percent of college graduates. Denq and Joung used income and housing values to represent class, college graduation attainment data as measurements for power, and percent of minorities as a measurement for status (Denq & Joung, 2000, p. 86). These economic and socially driven variables support Bullard's environmental justice framework. Correlations were found between income, employment in manufacturing sector, graduation level, and location of hazardous waste sites. The researchers found no correlation between race or percentage of minorities and location of hazardous waste sites.

Bullard (1996) suggested importance of a broader view of chemical facilities beyond the level of the hazardous waste sites and would most likely be critical of that aspect in the study of Denq and Joung (2000) study. Denq and Joung defined the populations near hazardous waste sites as “working class communities” (p. 97). In the current study, I followed Bullard’s suggestions to incorporate a broad focus and used a cross-sectional view to better understand relationships between toxic chemical activity and demographics in Michigan. Support of Bullard’s environmental justice framework was also seen in an environmental justice study by Hite (2000).

Hite (2000) used the random utility model to discuss environmental justice in association with housing selection utility. Hite wanted to see if elements of environmental discrimination were seen in housing selection near landfills in Ohio and used 1990 data. The researcher indicated that prior research illustrated relationships between “socioeconomic or racial characteristics and toxic exposures” (Hite, 2000, p. 40). Housing value, property characteristics, and demographic factors such as race and social class were included as study variables. Hite determined that social class was not seen as a barrier for either environmental quality or associated utility and consumption of the housing variables in the study. However, Black populations were found to be located closer to the hazardous sites than other ethnicities in the area. Hite indicated the Black populations in this study were seen to have limited choice “in the consumption of environmental quality” and could possibly experience housing discrimination in that region (p. 55).

Hite's (2000) ideas of the influence of socioeconomic factors in environmental justice research support the environmental justice theory defined by Bullard (1996). Bullard's ideas stressed the importance in considering the history and culture of the study population and area. The factors should be used before making a determination of environmental injustice based on race alone (Bullard, 1996). Bullard also indicated that factors in addition to race and socioeconomics also influence environmental justice conclusions and should not be overlooked (Bullard, 1996). Grecyn (2009) also addressed the proximity of Black populations to toxic chemical sites in the United States in an environmental justice study.

Grecyn (2009) studied the influence of U.S. EPA TRI-regulated toxic chemical facilities on populations in West Virginia, Louisiana, and Baltimore, Maryland. The areas were selected by the researcher because they contained large numbers of toxic chemical facilities. Geographic Information System (GIS) analysis and 1990 U.S. Census Bureau data were also used. Grecyn noted that the TRI facilities were often located by rivers and other waterways and found that Black populations lived closer to TRI facilities than White populations at these locations. The researcher also noted that the populations at lower poverty levels lived closer to TRI facilities (Grecyn, 2009, p. 43). Next, research by Rivera et al. (2009) and Gamper-Rabindran (2006) will be discussed.

Studies by Rivera et al. (2009) and Gamper-Rabindran (2006) addressed the role of county income in relation to corporate environmental activities. Rivera et al. used neo-institutional theory as framework to analyze the relationship between corporate activity involving social and environmental protection policy and various factors that included national income, regulatory approach, level of democracy, and interest in the program. The approach of incorporating socioeconomic factors and factors related to environmental justice studies supports Bullard's (1996) environmental justice framework. Inclusion of historical factors such as the influence of government policy, and political design also supports theory suggested by Bullard. Rivera et al., (2009) determined the relationship between business and the environmental protection policy process was less positive in countries with less democracy, lower per-capita income, less cooperative regulatory procedures, and more rigid policy processes (Rivera, et al., 2009). Next, environmental justice research by Gamper-Rabindran (2006) will be discussed.

Gamper-Rabindran (2006) used U.S. EPA TRI data on chemical emissions of companies participating in the 30-50 Program, a voluntary environmental program sponsored by the U.S. EPA, between 1991 and 1996 to determine if the program was effective in influencing environmental protection. The study focused on emissions reduction data, toxicity level, health risk of the chemicals reported, and data on the political activity of the neighborhood (Gamper-Rabindran, 2006). Gamper-Rabindran determined voter participation was a significant influence on chemical emission rates with areas of lower voter participation rates reporting higher emissions than areas with higher voter participation. However, county education, income, and minority status were found to have little influence on participation in the voluntary environmental program, the 30-50 Program (Gamper-Rabindran, 2006). More importantly, Gamper-Rabindran also found that industries transferred reportable chemicals to off sight locations such as recycling locations and really did not reduce risk, but instead, relocated risky products.

These researchers focused on a broader range of variables than discussed in previous sections of this literature review. These variables involved different social factors and economic factors that can be used to help to create more robust environmental justice research (Bullard, 1996). Drawbacks of the study by Gamper-Rabindran included the inability to use the data to generalize results for the current study because a different voluntary environmental program, different geographical focus, and different time period are associated with the current study. Next, the work of Campbell et al. (2010) will be discussed.

Campbell et al., (2010) also studied environmental justice and focused specifically on Maricopa County, Arizona over a 3-year period. These periods included U.S. Census Bureau data and TRI facility plant start-up dates up to 2003. Campbell et al. looked at the number of new TRI facility locations in association with county ethnicity, income, and legal costs associated with fines, during that period. Campbell et al. found inequality based on race and determined that environmental injustice took place during the time of location selection for new plants. The researchers noted that the areas mentioned contain a higher population of Asian citizens. Campbell et al. were unable to determine "whether discrimination is explicitly intended" (p. 21). Noted limitations in this study included limited geographical focus and restrictions toward generalization of information to other regions. Environmental justice studies by Adeola (1994), Hall and Kerr (1991), Jones and Raney (2006), and Cutter (1995) will now be discussed.

Studies by Adeola (1994), Hall and Kerr (1991), and Jones and Raney (2006) focused on populations within communities in the southern United States while Cutter

(1995) looked at the relationship between air quality and hazardous waste and toxic chemical releases in specified U.S. states and geographical regions in the United States. Adeola found significance linking race and location near waste facilities in Baton Rouge, Louisiana. Adeola's (results illustrated environmental inequality toward Black populations living near the Baton Rouge industrial waste facilities. One downside to the study by Adeola was the study timeframe and regionalized focus. Because the researcher did not look at populations in Michigan and was performed approximately 30 years ago, it is difficult to use these data to generalize the recent environmental justice situation in Michigan. Hall and Kerr (1991) focused their research in an alternate geographical area. The researchers looked at environmental burden in the southern region of the United States. Study variables included social class, income, and proximity to chemical exposure.

Hall and Kerr (1991) determined that poor communities were more likely to experience worse environmental conditions than higher income communities and concluded that more research surrounding environmental equity was needed. Limitations noted in the Hall and Kerr study were similar to that of the Adeola (1994) study and include limited geographical focus, limited focus on timeframe, and inability to generalize results to other regions of the state or country. Jones and Raney (2006) performed further research concerning race and chemical exposure in Tennessee. Their study will be described in the next paragraph.

Jones and Raney (2006) looked at Tennessee communities and used survey data to determine if a correlation existed between the attitudes of Black populations toward environmental issues and the level of pollution in their neighborhoods. Jones and Raney determined that Black residents were aware of environmental quality issues in their neighborhoods, believed they were exposed to environmental injustices, and believed they were treated unjustly by regulators. Survey results indicated that Black populations in the study communities believed they were exposed to worse environmental conditions than other races (Jones & Raney, 2006). These findings were similar to findings by Mohai and Bryant (1989, 1992a, 1992b) regarding environmental justice conditions in Michigan in 1990. Bias in the test results presented by Jones and Raney may be a potential concern. The concern is based on the fact that only selected southern populations were targeted in the Jones and Raney study. Environmental justice research focusing on California communities will be discussed in the next two paragraphs.

Studies by Whittaker et al., (2005), and Pastor et al., (2001) focused on environmental justice concerns in minority communities in California. Whittaker et al. used California Field Poll data from 1980 to 2000 to look at the perception of minorities regarding environmental pollution and problems in their communities. Whittaker et al. indicated the Latino population in the study appeared to have increased awareness of environmental issues throughout the years indicated in the poll. Whittaker et al. noted that minimal information pertaining to Latino population perception of environmental issues was available prior to their study. Pastor et al. used geographical track mapping to analyze environmentally hazardous storage and disposal facilities in Los Angeles County, California. The researchers were looking for an association of facility location and minority residential areas to environmental justice theory. The researchers found that areas where hazardous storage and disposal facilities were located where low income and minorities resided. Pastor et al. could not definitively prove that race alone played a role in the selection of hazardous storage and disposal facility locations.

Pastor, Morello-Frosch et al. (2006) studied environmental justice related to student exposure to toxic chemical emissions in California schools. The researchers reviewed air monitoring data and chemical emissions data from various U.S. EPA data bases and also used income level, ethnicity, percentage of homeownership, and educational attainment as variables. One difference between this study and prior studies noted in the literature review was the use of student achievement scores as a variable. Pastor, Morello-Frosch et al. determined students in poorer communities were exposed to higher levels of air pollution and higher "respiratory risk" (p.355). These communities had lower test scores, lower income levels, a higher population of minorities, and higher risk to children's health. The approach of looking at economic, social, and cultural factors when examining environmental justice was consistent with the theoretical framework of Bullard (1996). Noted limitations of the study by Pastor, Morello-Frosch et al. included a limited geographical focus and time period. These limitations do not allow for the generalization of results to other areas and time periods, such as those addressed in the current study. Additional environmental justice research by Bowen and Wells (2002), Bullard and Johnson (2000), Sicotte (2010), Norton et al. (2007), and Basu et al. (2009) will be discussed in the remainder of this section.

Bowen and Wells (2002) reviewed environmental justice articles from 1980 to 1998 that compared race, income, and other demographic factors of people living near toxic hazards to the level of toxic chemicals in the United States. The researchers found that the majority of research was not conducted empirically and exhibited inconclusive results (Bowen & Wells, 2002). It was also suggested that inconsistency of data measurements led to difficulties in comparing and generalizing results from the environmental justice studies. Bullard (1996) commented on that issue when defining environmental justice theory. Bowen and Wells also noted that further research using stronger data gathering techniques was needed in order to more accurately analyze environmental justice. Bullard and Johnson (2000) also reviewed prior environmental justice studies and found several common themes.

Bullard and Johnson (2000) studied prior environmental justice research in order to gain a better understanding the environmental justice field in the United States. The researchers determined that prior environmental justice studies often came to the conclusion that Black, low-income communities experienced more exposure to hazardous chemicals than other demographics. Bullard and Johnson also noted that environmental activist initiatives and grass roots activities helped promote environmental justice awareness.

Sicotte (2010) looked at the environmental justice situation of communities in the Philadelphia metropolitan area to see if certain demographics were exposed to higher risk from environmental hazard exposure than others. Limitations from prior studies included a narrow focus only on hazardous waste sites and mandatory reporting of TRI emissions. Sicotte looked at chemical hazard by using a system known as the Faber and Krieg Environmental Hazard Point System to determine the risk burden of communities associated with various types of hazardous chemical sites (Sicotte, 2010, p. 763). Communities were seen to have unequal distribution of environmental hazards. Study findings also indicated that areas with larger minority populations, less education, and lower economic conditions experienced higher environmental burden that communities with higher economic status and less minorities. Because Sicotte did not use the same data for chemical risk as the current study, Bullard (1996) would caution against using the data to generalize conditions and results associated with the current study. The next paragraph includes an environmental justice study by Norton et al. (2007) that addresses the unequal distribution of environmental hazards in North Carolina communities between 1990 and 2003.

Norton et al. (2007) studied environmental justice in North Carolina and looked at communities near solid waste facilities that were in operation between 1990 and 2003. U.S. Census Bureau data was also used and cross-sectional and longitudinal analyses were performed. Norton et al. found that there was a higher population density of Blacks living near the facilities than Whites. Lower housing values were noted in the Black communities near landfills. Norton et al. also found that the new landfills approved during the study timeframe were located in predominantly Black neighborhoods. The researchers also stated that landfills were found in areas with " the potential for disparate impacts on public health" (Norton et al., 2007, p. 1349). Norton et al found increased environmental burden affecting Black populations in the study. The findings were consistent with results indicated in prior studies that focused on the Detroit metropolitan area (Mohai and Bryant, 1989, 1992a, 1992b; Downey, 1998, 2005, 2006; Smith, 2007).

When applying the theoretical framework of Bullard (1996) to the study by Norton et al. (2007), a point of criticism would be the limited consideration of the influence of historical and social factors. Bullard indicated that environmental justice conclusions based primarily on racial considerations should consider the influence of historical and socioeconomic factors as well as demographic factors. Basu et al. (2009) also studied environmental justice with focus on a regional level.

Basu et al. (2009) studied environmental justice by looking at the spatial distribution of chemical emissions, county income related statistics, and race statistics within census tracts located in Indiana. U.S. Census data from 2000 and U.S. EPA TRI data from 2001 to 2007 were used in the study. Basu et al. also focused on the possible influence of race, income, education level, homeownership, and the levels of chemical emissions. I also considered the influence of demographic variables on industry's toxic chemical activity. However, I included a broader, risk-based focus using RSEI scores instead of spatial distribution analysis. Basu et al. found a correlation between the locations with higher toxic chemical emissions and a high percent of Black communities. A negative correlation was seen when comparing income and housing value to the amount of chemical emissions (Basu et al., 2009, p. 77). However, Basu et al. (2009) was not able to find an influence directly related to education attainment and toxic chemical emission levels and could not be conclude that environmental injustice occurred in the region.

Basu et al. (2009) attempted to broaden the study's focus by including economic factors in addition to racial factors to evaluate environmental justice conditions. This expanded view of possible variables that influence environmental justice was consistent with Bullard's (1996) environmental justice theory that suggested social and economic variables should be included in environmental justice studies. However, Basu et al. provided no evidence that historical factors and other social factors associated with the study population were considered in the study. Bullard suggested that a small sample size and a reliance on a variety of census tract information limited the ability for researchers to generalize conditions in other areas. Because Basu et al. focused only on specific areas of Indiana, it is uncertain whether the conclusions made by the researchers related to conditions seen throughout the entire state. These limitations are consistent with the limitations seen in other environmental justice studies discussed in this literature review.

Further Background: Environmental justice research using TRI data

Mandatory corporate environmental performance disclosure is associated with compliance of U.S. EPA mandated reporting guidelines such as the TRI program (United States Environmental Protection Agency, 2014b). My review of environmental justice literature revealed that TRI statistics have been used in a large number of environmental burden and corporate environmental responsibility studies. In terms of corporate social responsibility, companies are required by law to report their toxic emissions and are punished for non-compliance and breaking the regulations under this mandatory disclosure provision. For example, Delmas and Blass (2010), Grant et al. (2010), and King, Lenox, et al. (2005) included U.S. EPA TRI data in their respective studies as a measure of corporate environmental responsibility. Bowen et al. (1995) used U.S. EPA

TRI data to study environmental justice in Ohio. Grant et al. also used U.S. EPA RSEI scores to study environmental justice. Delmas and Blass used the U.S. EPA data to better understand how investors determined if a company followed environmental responsibility measures.

Delmas and Blass (2010) and Bowen et al. (1995) used toxic chemical activity data and economic performance data in their environmental justice research. Delmas and Blass found mixed results that varied depending on the specific indicators used in the study. The researchers saw that companies with poor environmental performance disclosed more environmental information and small environmental successes in annual reports than companies with strong, more favorable environmental program progress. Delmas and Blass, concluded that the poor performers used the annual reports as a way to draw attention to the fact they were environmentally proactive and divert attention away from the actual poor performance results (Delmas & Blass, 2010). Bowen et al. found a relationship between income and TRI activity. However, the data was regionally focused and was from a narrow time period. King, Lenox, et al. (2005) also analyzed U.S. EPA TRI data in their environmental justice research.

King, Lenox, et al. (2005) used U.S. EPA TRI data on toxic chemical emissions and corporate economic data to look at the value of voluntary environmental program implementation by companies. The researchers found that strategic decisions influenced adoption of voluntary environmental programs and standards by companies. Corporate leaders and stakeholders viewed the environmental certification programs as a way to build a positive corporate image and enhance the corporate communication process (King, Lenox, et al., 2005).

Literature Related to Current Study's Dependent Variable

Research Incorporating U.S. EPA RSEI Scores. Grant et al. (2010) cited studies that looked at race and income factors within the scope of environmental justice. Grant et al. used RSEI scores from 2002 and found there was a relationship between county demographic factors and toxic chemical facilities' RSEI scores. Grant et al. stated that U.S. EPA RSEI data "incorporates detailed data on the amounts of chemicals released by individual facility, the toxicity of the chemicals, their environmental concentrations, and the people who are exposed to them" (p. 487). Grant et al. found past studies did not address chemical risk and county toxic chemical exposure appropriately. One noted limitation of this study was that it incorporated data from only one year, 2002, and included a national view of areas with high RSEI scores. Areas with low RSEI scores were not included. Because Grant et al. did not focus on Michigan counties and used data sets that predate the timeframe of the current study, the study results cannot be used to generalize results expected within the scope of the current study. Sicotte and Swanson (2007) also used RSEI data in environmental justice research. The study will be discussed in the following paragraph.

Sicotte and Swanson (2007) used U.S. EPA RSEI scores to analyze environmental justice based on county ethnicity and class demographics in Philadelphia, Pennsylvania. The researchers selected Philadelphia was selected because of the number of hazardous facilities located in the city. U.S. Census data from 2000 was also used in that study. Sicotte and Swanson indicated that low income, minority, manufacturing workers living in close proximity to chemical facilities were exposed to higher chemical hazard risk that other demographics living in the city and experienced environmental inequality. Sicotte and Swanson associated the high RSEI scores with higher health risks for the low income populations. Black populations were found to live near high and low hazard level facilities. The researchers' findings are of relevance to the current study. I also included RSEI scores in the study and evaluated them as the dependent variable in my research.

Sicotte and Swanson (2007) indicated their study was limited because it only looked at one period of time and could not be considered a "historical study" (p. 529). An additional limitation of this study not mentioned by Sicotte and Swanson was the narrow focus on select populations in close proximity to the chemical facilities rather than a broader focus that included populations further away from the chemical hazards. Bullard (1996) indicated that environmental justice was "more than waste facility siting" (p. 493) and included many other factors contribute to unequal burden and should be considered. Exclusion of certain populations from Sicotte and Swanson's study could lead to incorrect conclusions. This idea is consistent with the environmental justice theoretical framework proposed by Bullard (1996). Cong and Freedman (2011) and Shapiro (2005) also used U.S. EPA data to study environmental justice in the United States and also align with Bullard's definition of environmental justice theory (Bullard, 1996).

Cong and Freedman (2011) and Shapiro (2005) used U.S. EPA TRI data and also used U.S. EPA RSEI data to better understand the effects of corporate environmental responsibility practices on communities. Cong and Freedman looked at environmental performance data for companies that reported toxic emissions as a mandatory requirement. The researchers used data from 2003 to 2005 in order to determine if there was a correlation between corporate governance and corporate environmental performance and disclosure. No significant relationship between corporate governance and environmental performance was found. However, a correlation was found between good corporate governance practices and disclosure of environmental information (Cong & Freedman 2011). Cong and Freedman indicated that RSEI data were better measures for environmental performance than TRI data because RSEI calculations considered a combination of factors rather than a single measurement as predominantly seen in TRI data. The use and importance of RSEI data in environmental justice research were relevant to my study as well.

The use of an extended focus on environmental factors such as RSEI scores is consistent with Bullard's (1996) theory and the theoretical framework of my study. Bullard stressed the importance of a broader focus to ensure inclusion of appropriate factors influencing environmental justice. Noted limitations in the Cong and Freedman (2011) study included a focus on a timeframe and region outside the scope of the current study. Next, environmental justice research by Shapiro (2005) will be discussed.

Shapiro (2005) used U.S. EPA TRI data, U.S. EPA RSEI data, industry data, and county demographics data to show environmental inequality existed in communities with Black populations in the United States. The Black communities in the study were shown to be in closer proximity to chemical hazards than White communities and were found to have higher exposure to chemical risk over the period of study (Shapiro, 2005). One limitation of Shapiro's study was the fact that the data focused on the time period from 1988 to 1996 and may not be indicative of current conditions in the United State and specifically, in Michigan. Shapiro's study was relevant to my study because I also used U.S. EPA RSEI data to analyze environmental justice conditions facing communities. Downey and Hawkins (2008) also incorporated U.S. EPA RSEI data in their environmental justice research.

Downey and Hawkins (2008) used RSEI data from 2000 and 2000 U.S. Census Bureau data to study environmental justice in relation to county chemical risk hazard and race and income. The researchers focused on locations throughout the United States. Downey and Hawkins studied socioeconomic factors in addition to the racial profile of the study population and found that income rather race played a role in determining unequal environmental burden. White and Black populations earning the same income experienced the same pollution and experienced environmental burden. Race should not contribute to this effect (Downey & Hawkins, 2008, p.762). Downey and Hawkins noted regional variation in environmental burden and justice conditions and stated the regional variations could be a limiting factor when trying to make conclusions in environmental justice research. This point was consistent with Bullard's (1996) environmental justice theory that indicated "sociohistorical context" played a role in the analysis of unequal environmental burden and could be used to help explain environmental justice findings (Bullard, 1996, p. 493).

Corporate Voluntary Pollution Prevention (P2) Program Activity. The independent variable that was used in this study was corporate voluntary participation in the U.S. EPA's environmental program known as the P2 program. My literature review did not find any environmental justice studies that incorporated chemical-related industry participation in the voluntary P2 program as a study variable. However, studies that analyzed the effectiveness of the U.S.EPA's P2 program by Lyon, and Maxwell, (2007) and Sam (2010) were found and will be discussed in the following paragraphs.

Lyon and Maxwell (2007) looked at data from various U.S. EPA voluntary environmental programs such as P2 and found that the results indicated the programs did not influence corporation's environmental performance and corporate behavior. Lyon and Maxwell indicated it was difficult to judge the degree of progress in voluntary programs because there were no defined benchmarks for success. The researchers also determined there was a need to develop a new assessment approach because it was difficult to evaluate progress and differences between companies working with these programs (Lyon & Maxwell, 2007). I used the conclusions of Lyon and Maxwell to help me interpret the results of my study. Sam (2010) also incorporated the variable, corporate voluntary P2 participation, in environmental justice research and discussed P2 activities in terms of corporate environmental performance and behavior.

Sam (2010) looked at corporate participation U.S. EPA sponsored P2 program from 1991 to 2004 and focused on the pollution violation rates and enforcement rates of various industries in relation to P2 program participation. Sam determined that corporate P2 practices showed varying levels of effectiveness in promoting improvement in environmental protection (Sam, 2010). For example, companies using internal inspections and internal process control improvement as part of their P2 programs received less violations for pollution activities that companies that did not implement these measures (Sam, 2010). Sam also found that companies implementing large-scale change such as manufacturing modifications to reduce chemical emissions seemed to have a better working relationship with the U.S. EPA. Sam's study provided insight into chemical industry P2 activity. There were several limitations noted in Sam's research. These limitations will be discussed in the following paragraph.

The limitations found in Sam's (2010) research were similar to those mentioned in the reviews of previous studies. Sam addressed a narrow period of time that was outside the scope of my study. The researcher also did not address voluntary P2 activity at a state level and did not address voluntary P2 activity in Michigan. As suggested by Bullard (1996), it is difficult to generalize environmental justice conditions in regions other than those included in the environmental research because of regional differences involving social and historical factors. Thus, Sam's conclusions regarding voluntary P2 activity cannot be used to generalize conditions expected for the current study of Michigan counties.

Additional Voluntary Environmental Program Studies. I identified several environmental burden studies that used voluntary environmental program data other than corporate voluntary P2 activity as variables. Even though these studies did not specifically address the voluntary P2 program, the prior research findings helped me to interpret and explain my results. Studies by Videras and Alberini (2000), Khanna and

Damon (1999), King and Lenox (2000), Rivera et al. (2006), Delmas and Keller (2005), Carrion-Flores et al. (2006), and Vidovic and Khanna (2012) analyzed government sponsored voluntary pollution prevention programs.

Videras and Alberini (2000) and Khanna and Damon (1999) included voluntary environmental programs in their research. Videras and Alberini looked at data from participation in three U.S. EPA voluntary environmental programs during the time period from 1993 to 1998. The researchers determined that corporations participated in voluntary environmental programs when visible benefits were expected from the participation efforts (Videras & Alberini, 2000). Videras and Alberini determined corporations participated in the voluntary environmental programs for a variety of reasons such as self-promotion and reducing the probability of regulation and restriction by cooperating in the program. Khanna and Damon studied a voluntary U.S. EPA environmental program known as 33/50 that involved chemical emissions reductions and looked at U.S. chemical industry data from 1991 to 1993 and found findings similar to those described by Videras and Alberini.

Khanna and Damon (1999) determined that voluntary environmental programs promoted improved corporate public image, helped enhanced corporate environmental management practices, and helped improve long-term economic performance. The researchers discovered that program implementation had a short-term negative effect on return on investment and a positive impact on long term profitability. Voluntary environmental program participation and pollution prevention improved when there was fear of future penalty by regulators (Khanna & Damon, 1999). Even though the program included in the research by Khanna and Damon was not the P2 program, I applied the understanding behind the motives of participation of the chemical companies in the discussion of my study results. Research by King and Lenox (2000) also focused on corporate voluntary environmental program participation.

King and Lenox (2000) and Rivera et al. (2006) focused on a chemical industry's voluntary environmental program activity. King and Lenox focused on the voluntary environmental program, Responsible Care® and studied the effectiveness of the program. The researchers referred to voluntary programs such as "industry self-regulation" and as voluntary initiatives sponsored by industry (King & Lenox, 2000). King and Lenox determined that participating chemical companies used program membership as a "symbolic adoption" to hide problems (King & Lenox, 2000, p. 702). King and Lenox then used U.S. EPA TRI data and statistical modeling to look at environmental performance and participation in the voluntary environmental program Responsible Care®. King and Lenox concluded that voluntary environmental programs participation did not always correlate with favorable environmental performance and was associated at times with poor performers and "opportunism" (p. 713). The researchers determined that the voluntary environmental programs were implemented by some companies for reasons other than environmental protection. This point was relevance to my study because I was uncertain if study results involving voluntary P2 participation were influenced by opportunistic motives. Even though I did not investigate motivations for activity within the scope of my study, it is a point of consideration for further research. Rivera et al. also studied voluntary environmental program effectiveness and noted opportunistic motives. Their research is discussed in the next paragraph

Rivera et al. (2006) studied the corporate voluntary environmental program known as the Sustainable Slopes Program over a 5-year period. The researchers saw improvement only in conservation performance and saw no improvement in selected environmental performance indicators when comparing prior data prior to data after implementation (Rivera et al., 2006). As a result, Rivera et al. concluded that voluntary programs alone were not effective in substantially improving environmental conditions. This idea was consistent with the finding of King and Lenox (2000). Rivera et al. also determined that participation in the voluntary environmental program was influenced and improved when there were state and federal government pressures for corporate participation and performance in environmental programs. Delmas and Keller (2005) analyzed implementation data for the voluntary environmental program, WasteWise.

In another study, Delmas and Keller (2005) looked at the U.S. EPA voluntary environmental program, WasteWise, in order to determine if the program promoted the level of environmental change and corporate participation that was expected by government sponsors. The researchers noted that this program was established in 1994 and focused on the reduction of solid waste by public and private companies that decided to partner with the U.S. EPA by committing to the program (Delmas & Keller, 2005). Delmas and Keller determined that program participation in voluntary environmental initiatives helped organizations communicate their environmental activities through U.S. EPA sponsored media and helped promote public awareness (Delmas & Keller, 2005).

Study limitations were consistent to those I discussed for research by King and Lenox (2000) and Rivera et al. (2006) were also noted.

Delmas and Keller (2005) presented study limitations in their publication. The researchers acknowledged limitations to include the facts that company actions were not mandated and measured by regulators and that any reporting of progress was voluntary. These limitations made it difficult for Delmas and Keller to prove the participation was effective in promoting environmental change. Delmas and Keller also noted it was possible to register for program participation and advertise commitment in the program but not participate in activities that promote noted environmental change. That idea is consistent with the conclusions of opportunism found by King and Lenox (2000). The researchers described this activity free riding in their environmental justice research (Delmas & Keller, 2005; King & Lenox, 2000). The idea of free riding was counter intuitive to Bullard's interpretation of environmental justice and ethical decision that influence the individual and society. Further studies on voluntary environmental programs were performed by Carrion-Flores et al. (2006) and Vidovic and Khanna (2012). I used the studies as framework to better understand the voluntary P2 finding in my study.

Carrion-Flores et al. (2006) and Vidovic and Khanna (2012) evaluated the efficiency of the U.S. EPA 33/50 program, a voluntary pollution reduction program focusing on voluntary, corporate emission reduction. Carrion-Flores et al. wanted to see if the reduction of emissions led to environmental protection innovation such as new patents and research and development activity related to the environment (Carrion-Flores et al., 2006). The researchers looked at industry specific chemical release data available from the U.S. EPA and found that corporate focus on voluntary environmental programs may detract focus away from long-term and more costly environmental projects (Carrion-Flores et al., 2006). Vidovic and Khanna also studied corporate participation in the U.S. EPA's voluntary pollution reduction program, the 33/50 program, and found that program participation did not result in a decrease in corporate toxic chemical releases. These findings were consistent with the prior studies by Delmas & Keller (2005), Rivera et al. (2006), King and Lenox (2000), Videras and Alberini (2000), and Khanna and Damon (1999) that were referenced earlier in this section. Factors associated with positive performance and program success included recycling initiatives (Vidovic & Khanna, 2012).

Limitations in Reviewed Literature

Limitations were noted in the prior literature addressing environmental burden and environmental justice in the United States and specifically in Michigan. For example, Godsil (2004) indicated that "most studies fail to measure the cumulative effect of polluting facilities and lack of municipal services faced by many poor, urban areas (p. 1121). Konisky and Schario (2010) discussed limitation to using spatial units and locations near chemical emission sources to measure environmental burden and used federal and state environmental enforcement data and U.S. Census tract data in their research. These limitations included the assumption that the entire population in a selected geographical area was exposed to equal amounts of exposure risk, when in reality, there is unequal distribution of exposure to communities depending on plant proximity and wind direction (Konisky & Schario, 2010, p. 838). Cong and Freedman (2011) found limitations in environmental justice research related to interpretation of hazard and exposure risk.

Cong and Freedman (2011) also referred to limitations in studies that used TRI volume to measure chemical exposure. The researchers indicated that data on TRI volumes alone were not good indicators of the associated risk related to exposure proximity considerations and the types of health effects (Cong and Freedman, 2011). Cong and Freedman concluded that RSEI scores for the chemical risk associated with a particular chemical facility were better measures of chemical hazard and potential environmental burden because the scores also included TRI data (United States Environmental Protection Agency, 2014i). Researchers used TRI data in environmental justice research because the RSEI scores were not initially published by the U.S. EPA. As a result, the older environmental justice studies are limited. I selected median annual RSEI score as the dependent variable for my study instead of TRI data because of the conclusions from Cong and Freedman and other researchers previously noted.

I noted limitations in the prior work by researchers that used data from the 1990 Detroit Area Study. The researchers only included populations near hazardous waste sites and did not look at emissions data or actual health studies (Bryant & Mohai, 1992, 2011; Mohai & Bryant, 1992a, 1992b, 2006). These studies appeared to be biased by focusing only on statistics of Black and White populations in designated communities and did not considering impact from other ethnic groups. As a result, potentially valuable data on other ethnicities in at region was not considered. The Detroit research discussed earlier in this chapter also appeared biased in the selections of a sample population. The communities selected contained high populations of Black residents at the time of data collection and may not represent conditions seen in the rest of Michigan (Bryant & Mohai, 1992, 2011; Mohai, 1989; Mohai & Bryant, 1992a, 1992b, 2006). Other limitations in the demographic factors selected in these studies were also noted and will be discussed in the next paragraph.

As mentioned throughout the literature review, environmental justice research typically included multiple demographic factors in the analysis. However, when focusing on the Detroit Area study research, Bryant and Mohai (1992, 2011), Mohai (1989), and Mohai and Bryant (1992a, 1992b, 2006) only selected the variables ethnicity and income level. The addition of other minority groups and county demographics, such as education and homeownership, would have broadened the scope of these studies. In order to gain stronger statistical significance and to capture the true demographic composition of the state, a statewide focus on communities should have been included in the studies by Bryant and Mohai, Mohai, and Mohai and Bryant.

Another limiting factor seen in environmental justice literature for Michigan included the limited type of pollution activity used by researchers to define environmental burden. Pollution activity pertaining only to toxic waste sites was addressed in the Detroit Study (Bryant & Mohai, 1992, 2011; Mohai, 1989; Mohai & Bryant, 1992a, 1992b, 2006). Other measures of pollution activity such as toxic chemical emissions data, county chemical health risk data, and toxic chemical disposal data for Michigan could be investigated.

Study age and limited, historical timeframe were additional limiting factor that I noted in the review of environmental justice research involving Michigan (Bryant & Mohai, 1992, 2011; Mohai, 1989; Mohai & Bryant, 1992a, 1992b, 2006). The Detroit Area study utilized data from 1989 and 1990. Because the data was 24 years old and utilized only 1 year of data, historical bias may have influenced the research results. I eliminated bias by focusing on contemporary, multi-year data that was more relevant to the current time period. I noted similar limitations in another Detroit Area study by Downey (1998, 2005, 2006). These limitations can be seen in the following paragraph.

Several limitations were apparent in the environmental justice research performed by Downey (1998, 2005, 2006). One limitation was that the author did not clearly define the rationale behind selecting only a single urban area, the Detroit metropolitan area, for the research. Downey mentioned Detroit was the largest city in Michigan during the study time period but did not include any additional rationale behind that selection decision. Bullard (1996) concluded that a limited geographical focus led to the inability to accurately generalize study findings. Based on that framework, Downey could not use the study results to explain conditions in other parts of Michigan. Bullard identified the inability to use prior studies to generalize results in other areas as a critical flaw in environmental justice research. In order to produce a more robust study, I designed my research to focus on a broader, statewide analysis of the environmental justice in Michigan.

Several researchers discussed in this literature review looked at selected population exposure to chemical emissions and limited their focus to certain communities perceived as environmentally burdened. For example, in the study by Jones and Raney (2006), the population selection only involved selected areas of Tennessee. Because of the limited geographical scope, it was unlikely the study results could be used to generalize conditions in a broader population of Black communities across the United States (Bullard, 1996). As mentioned previously, United Church of Christ's Commission for Racial Justice (1987, 2007) included data from Black populations in select U.S. southern states in two research studies. However, it was noted that these researchers did not capture a statistically relevant population sampling at the regional and national level. This type of limitation was also seen in research by Adeola (1994) and Hall and Kerr (1991) with their narrow focus only on U.S. southern states. Limitations could include the potential for social and historical biases in these studies (Bullard, 1996). Chakraborty et al. (2011) illustrated environmental injustice of minorities in Florida communities to show minorities experienced more exposure risk. Studies by Pastor et al. (2001) and Whittaker et al. (2005) appeared to include bias in their studies by only including sample populations from California and focused specifically on ethnicity instead of addressing a broader range of County demographics. These limitations were also seen in regional-level studies.

Several regional levels studies addressing environmental burden also contained noted limitations (Grant et al., 2010; Shapiro, 2005). For instance, Grant et al. looked at the highest chemical polluting manufactures in the United States and determined that Black and Latino populations were victims of environmental injustice based on ethnicity. The study contained several apparent biases that included limited regional focus, focus on only the highest polluting companies, and the use of data from only 1 year, 2002 (Grant et al., 2010). Shapiro used a national sampling of data from 1988 to 1996 that included U.S. EPA TRI data and U.S. EPA chemical release and exposure risk information. The time period analyzed and the focus on U.S. EPA TRI data, as opposed to risk based U.S. EPA data, were noted limitations in Shapiro's study. Geographical-based bias and limited geographical focus prevented the researchers from using the data to generalize environmental burden and justice results across other communities and parts of the country (Bullard, 1996). Variability in scope and scale, regional biases, possible historical and cultural influences, inability to generalize study results, and inconclusive findings represented the primary limitations seen in prior environmental justice research. These studies were captured and discussed throughout this chapter.

Summary and Conclusions

Chemical-related industry must comply with pollution prevention laws. Toxic chemical facilities registered with the U.S. EPA as TRI facilities must comply with mandatory reporting of toxic chemical pollution. However, it was noted that these facilities have some flexibility in their level of participation in voluntary environmental programs, such as the voluntary (P2) participation, that are sponsored by government agencies. Companies are required by law to comply with the mandatory pollution prevention requirements such as toxic chemical emission reporting. However, companies are free to select the level of voluntary P2 program implementation. That level has the potential to vary and may be influenced by multiple factors. Support of such programs can be viewed as a positive reflection of corporate environmental and social responsibility. Other positive environmental effects include higher environmental quality and environmental sustainability in counties that actively participate. Limited voluntary P2 activity and high chemical risk, as seen through RSEI scores, could reflect unequal environmental quality and unequal environmental burden facing some Michigan counties. This inequality could justify the need for further investigation of environmental justice issues in the region.

Environmental disparity can occur when chemical-related companies do not comply with mandatory environmental protection requirements and do not fully implement and participate in voluntary P2 programs that protect county residents. Limited participation in these programs has several outcomes. One outcome can be perceived environmental inequality and environmental injustice. Environmental injustice toward county members can occur when certain populations experience unequal environmental treatment such as increased exposure to toxic chemical pollution when compared to other populations (Bullard, 1996).

When looking at prior literature addressing corporate environmental responsibility and voluntary environmental program participation, environmental justice theory appears as the dominant theoretical framework. The environmental justice theory used in many of the prior environmental justice studies discussed was consistent with the theory and ideas presented by Bullard (1996). I also tailored the theoretical framework of my study around Bullard’s theory. Bullard’s environmental justice theory stressed the importance of including social, cultural, and historical factors specific to the populations and regions included in environmental justice research. Bullard indicated that a broad matrix of factors contribute to environmental inequality and must be included when analyzing environmental justice situations. Erroneous results and incomplete analyzes occur when these factors are overlooked or over-generalized in research (Bullard, 1996).

Aspects of Bullard's theory were seen as intertwining framework in prior environmental justice studies. Studies involving the rationale and motivation behind voluntary environmental program participation seen through such corporate actions as voluntary corporate environmental disclosure were discussed. Studies illustrating the effects of voluntary program participation on corporate economics, corporate image, and county health were also noted. Other studies illustrating environmental injustice directed toward certain populations of a certain race, income, and voter activity were presented. I identified existing environmental justice studies written prior to 2005 that focused on specific states and regions. Many studies included data and demographic findings for a select geographical region in the United States and did not focus on Michigan counties during the 2007 to 2011.

I investigated whether voluntary P2 activities of toxic chemical companies in the counties in Michigan with populations over 100,000 individuals were related to the U.S. EPA RSEI scores during the time period of 2007 through 2011. Demographic factors were used as control variables. This allowed for additional analysis of the influence of demographic factors on the dependent variable, Michigan county median annual RSEI scores. Noted differences in these data indicated environmental inequality in some counties. Such findings require further research to study possible environmental justice issues in Michigan.

Prior researchers discussed the demographic influence and environmental injustice in selected parts of Michigan but did not include the entire state in the research. Data from an earlier time periods, with primary focus on data from 1990, were used in these studies. I focused on a larger region of Michigan and also incorporated a more diverse population of Michigan chemical-related industry and Michigan residents. My study also included contemporary data that was more reflective of current conditions seen in Michigan. The goal of the current study was to determine if Michigan counties that were less affluent, less educated, and had more ethnic diversity had higher RSEI scores and less corporate voluntary P2 participation reported for their toxic chemical facilities than other counties. Higher RSEI scores and less voluntary P2 participation potentially equated to higher environmental burden from toxic chemical in that area. I incorporated publically available, U.S. EPA secondary data for toxic chemical risk as seen in U.S. EPA RSEI scores and also incorporated corporate voluntary P2 activity data. My quantitative analysis also included U.S. Census Bureau data for Michigan counties. Further investigation is necessary because I found a statistically significant influence of education attainment on the toxic chemical activities of chemical-related industry in Michigan. Further investigation could result in possible social and environmental policy change in Michigan and in a broader context, across the United States.

Chapter 3: Research Method

Introduction

The purpose of this study was to investigate whether toxic chemical facilities in Michigan counties practice different voluntary P2 participation and produce more potentially hazardous toxic chemicals, as seen through RSEI scores, in counties that are less affluent, have lower educational attainment, and greater racial diversity. In this study, I determined whether toxic chemical industry's voluntary P2 activity had an impact on the RSEI scores reported for facilities in Michigan counties with populations greater than 100,000 inhabitants. Demographic variables were used as control variables in this study. The demographic factors were the percentage of minorities or non-Whites in Michigan counties, median annual household income, and percentage of educational attainment of a high school degree for the years of 2007 through 2011. I also determined if these demographic control variables were correlated with chemical-related industry's RSEI scores in Michigan counties.

This chapter begins with a discussion of the research and design of the study and the rationale behind these selections. Next, the methodology of the study in terms of the study population and sampling is defined. Data gathering will then be discussed. I then address the data analysis and plan for the study. Research questions and research hypotheses from Chapter 1 are then restated. Study validity and ethical considerations will be addressed. Finally, the chapter concludes with a summary of the research methodology that will be used in this study.

Research Design and Rationale

This study involved a quantitative research approach. Because possible a correlation between toxic chemical facility voluntary P2 activity, RSEI scores, and demographic factors for each county were analyzed, a correlational-based design for the study was appropriate (Campbell & Stanley, 1963, p. 63). A descriptive design known as a cross-sectional design using regression analysis was used for this quantitative study. Frankfort-Nachmias and Nachmias (2008) indicated that a cross-sectional design is used to determine an association between variables and does not establish causality. A cross-sectional design is also used when independent variables cannot be manipulated or compared via "before-and-after comparisons" (Frankfort-Nachmias and Nachmias, 2008, p. 116). The data for the independent variable, Michigan county toxic chemical facility voluntary P2 activity, were recorded initially as a single value per toxic facility per year, and then were used to calculate an average annual percentage of facility voluntary P2 participation for the county. The dependent variable, Michigan county toxic chemical facility median annual RSEI scores, was recorded as a median annual value for each county for the study time frame. Five year averages per county were also calculated. This study fit the criteria for a cross-sectional design because the intent was to establish if a correlation exists within a designated period of time; a pre/post treatment situation or a cause and effect scenario was not applicable (Frankfort-Nachmias and Nachmias, 2008).

I used archival data representing Michigan county toxic chemical facility voluntary P2 activity, toxic chemical facility RSEI scores, and Michigan county demographic factors, gathered, recorded, and maintained by the U.S. government. The data were electronically accessible by computer from the U.S. EPA's website and U.S. Census Bureau's website. I incorporated government data spanning over a 5-year time period, from 2007 through 2011. The government data included toxic chemical facility information for each Michigan county included in the study and related county demographic information. One independent, one dependent variable, and three control variables were used in this study.

This study included one independent variable, one dependent variable, and three control variables. The independent variable was the annual, average percentage of Michigan county toxic chemical facilities that participated in the U.S. EPA's voluntary P2 program during the time period from 2007 through 2011. The voluntary P2 program involves company pollution prevention and corrective action implantation aimed at improving environmental conditions (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014d; United States Environmental Protection Agency, 2014f). The dependent variable was the median annual county U.S. EPA RSEI score for the toxic chemical facilities in the Michigan counties for the years of 2007 through 2011. The time period from 2007 through 2011 represented the most recent 5-year span of RSEI score data reported by the U.S. EPA (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014h; Environmental Protection Agency, 2014i). The demographic factors were included as control variables.

The control variables in the study were the demographic factors in the Michigan counties in the study. These values included the percentage of minorities in the county based on 2007 through 2011 U.S. Census Bureau data, median household income for the years of 2007 through 2011, and percentage of educational attainment of a high school degree for the years of 2007 to 2011. These data were available from the U.S. Census Bureau through the American Community Survey program (United States Census Bureau, 2014a).

Because one independent variable, one dependent variable, and three control variables were included in this study, a hierarchical multiple regression analysis was performed. Analysis was performed using one dependent variable and all three independent variables per regression analysis. These regression analyses helped me to determine whether or not there was a correlation between the dependent and independent variable. The multiple regression analysis also helped me to identify if interactions exist between the variables (Field, 2009).

Methodology

Population

The population selection for this study included Michigan counties with a total population greater than 100,000 inhabitants. The selection of counties was based on 2010 U.S. Census Bureau data for Michigan. Michigan counties and their related toxic chemical activity were selected for this study based on the public accessibility of U.S. EPA secondary data. Michigan ranks in the top 20 states within the country with the highest toxic chemical releases and toxic chemical disposal volumes based on U.S. EPA statistics (United States Environmental Protection Agency, 2014b). An arbitrary value of greater than 100,000 inhabitants per county was introduced as a selection criterion for this study. This value was selected in order to include populated areas with a greater probability of demographic diversity and a greater number of toxic chemical companies in the counties. According to 2010 U.S. Census data, there were 20 geographically dispersed Michigan counties out of a total number of 83 counties that met the population selection criterion (United States Census Bureau, 2014). A list of the counties in Michigan with a total population over 100,000 inhabitants based on data from the 2010 U.S. Census is included below in Table 1.

Table 1

Michigan Counties with a Population greater than 100,000 Inhabitants

Michigan County	Population
Allegan	111,408
Bay	107,771
Berrien	156,813
Calhoun	136,146
Eaton	107,759
Genesee	435,790
Ingham	280,895
Jackson	160,248
Kalamazoo	250,331
Kent	602,622
Livingston	180,967
Macomb	840,978
Monroe	152,021
Muskegon	172,188
Ottawa	263,801
Saginaw	200,169
Saint Clair	163,040
Washtenaw	344,791
Wayne	1,820,584

Note. United States Census Bureau. (2013). State and county quickfacts. Retrieved from http://www.census.gov/

Sampling and Sample Procedures

Convenience sampling, also known as nonprobability sampling, was used to select the sample population in this study (Creswell, 2009, p. 148). This type of sampling promoted a focus on a subset of the population that best represented the scope of chemical-related facilities for this research (Frankfort-Nachmias & Nachmias 2008). A random sampling of data was not used for two reasons. First, I used a selection criterion that focused specifically on counties with a population of greater than 100,000 inhabitants. Second, I used selection criterion that included the toxic chemical facility data from facilities registered with the U.S. EPA in the counties (United States Environmental Protection Agency, 2014b, United States Environmental Protection Agency, 2014c; United States Environmental Protection Agency, 2014l). The sample population for this study included Michigan counties with greater than 100,000 inhabitants.

Another selection criterion for the sample population in Michigan counties was the inclusion of toxic chemical facilities registered under the U.S. EPA's TRI program. The sampling of chemical-related facilities within these Michigan counties was based on U.S. EPA data for toxic chemical facilities registered under the U.S. EPA TRI program, a mandatory U.S. EPA pollution control program under the Pollution Prevention Act of 1990(United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014c). G*Power analysis was performed in order to calculate sample size for this study.

G*Power analysis was performed to calculate sample size using a program by Faul and Erdfelder (n.d.). Trochim (2006) indicated that sample size calculations typically include a power of 0.8, an alpha value of .05, and also a medium effect size. Trochim's criterion was used to calculate the sample size for this study. Based on the G*Power analysis, I determined the minimal sample size for a multiple regression analysis incorporating one dependent variable and four independent variables to be 85 (Faul & Erdfelder, n.d.). Field (2009) indicated the minimum sample size suggested for four predictor variables is 82 (p. 222). The overall population of U.S. EPA TRI-regulated facilities registered in the 20 Michigan counties included in this study was 1717 facilities

(United States Environmental Protect Agency, 2014l). A sample size of 1717 represented the number of U.S. EPA TRI-regulated facilities reported for Michigan counties with populations greater than 100,000 inhabitants. This value represented the sample population in this study. Table 2 contains the number of U.S. EPA TRI-regulated facilities reported by the U.S. EPA for each Michigan county included in the study.

Table 2

Number of TRI-regulated facilities per Michigan County included in Study

Michigan County	Total Number of TRI- Facilities[a]
Allegan	42
Bay	21
Berrien	67
Calhoun	53
Eaton	20
Genesee	42
Ingham	45
Jackson	36
Kalamazoo	67
Kent	208
Livingston	45
Macomb	153
Monroe	32
Muskegon	70
Oakland	193
Ottawa	107
Saginaw	27
Saint Clair	53
Washtenaw	54
Wayne	382

Note. [a]United States Environmental Protection Agency. (2014l). TRI explorer. Retrieved from http://iaspub.epa.gov/triexplorer/tri_factsheet_search.searchfactsheet

Based on the U.S.EPA TRI facility data indicated in Table 2, the sample population of toxic chemical facilities exceeded suggested sample size minimums found in the literature and calculated using G*Power. The annual percentage of Michigan county TRI facilities participating in voluntary U.S. EPA P2 participation was calculated and reported separately per Michigan county for each year from 2007 through 2011. The median annual RSEI score for each Michigan county in the study was reported separately for each year from 2007 through 2011. Because 5-years of toxic chemical facility data and demographic data were gathered and analyzed for each of the twenty Michigan counties included in the study, the regression analysis included an overall sample size of 100 county entries. Each county had five data sets that were used in the regression analysis. The county designations were indicated by a number from 1 to 20, followed by the study year. For example, data for county 1 was defined as 12006, through 12010 in the analysis. The anticipated sample size of toxic chemical facilities included in this study, and the overall sample size of the county data were much higher than the minimum sample sizes indicated by Field (2009) and Faul and Erdfelder (n.d.) and satisfied sampling requirements.

Data Collection

Data for this study were retrieved from publically accessible U.S. government websites. The archival data sets were not published instruments; they were continuous and reported at the interval level. Data for this study were gathered from databases located on the U.S. Census Bureau website and the U.S. EPA websites. The data obtained from these databases was maintained by the United States government. Access to the census data and U.S. EPA data did not require permission and was publically available information. The government databases were populated with data gathered by the U.S. government and entered into the database by U.S. government employees (United States

Census Bureau, 2014a; United States Census Bureau, 2014d; United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014g).

U.S. EPA's voluntary P2 participation data and U.S. EPA's RSEI scores for the toxic chemical facilities in each county were accessed from the U.S. EPA TRI Explorer database and U.S. EPA Envirofacts database (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014f; United States Environmental Protection Agency, 2014h). The voluntary P2 participation data was available in tabular format for each toxic chemical facility in the Michigan counties. Each table containing the toxic facility's P2 data was printed from the U.S. EPA's website. The average percentage of toxic chemical facilities participating in the voluntary P2 program for each Michigan county in the study was then be calculated for each year during the time period of 2007 through 2011 and recorded. The median annual RSEI scores were available on the U.S. EPA's website as an annual score per county. The tables incorporating these data were printed from the U.S. EPA's databases. The data were entered into Excel spreadsheets. Demographic data access will be discussed in the next paragraph.

The annual Michigan county demographic data were accessed from the American FactFinder database maintained by the U.S. Census Bureau (United States Census Bureau, 2014a; United States Census Bureau, 2014d). The tables containing the demographic data were accessed and printed for the year of 2007 through 2011 for each county included in the study. Screen shots of the data collected from the government databases were printed at the time of data collection. The copies were filed per county. Electronic versions of the data were also stored on the laptop computer.

Further information regarding the specific variables in the study will be included in the next section.

Archival Data

As mentioned, U.S. government archival data were used in this study. One independent variable, one dependent variable, and three control variables were included. These variables will be discussed in the following paragraphs.

The independent variable was the percentage of the toxic chemical facilities in Michigan counties participating in the U.S. EPA's voluntary P2 program during the time period from 2007 through 2011. The toxic chemical facilities were located in Michigan counties with a total population greater than 100,000 individuals. The annual percentages of chemical-related industry's voluntary P2 participation in the Michigan counties between 2007 and 2011 in the counties were calculated from archival data retrieved from the U.S. EPA TRI Explorer database and were recorded in spreadsheets. This variable was reported and measured at the interval level and was continuous. Next, the dependent variable will be discussed.

The dependent variable that was used in this study was the median annual U.S. EPA RSEI score for the toxic chemical facilities in Michigan counties with a total population greater than 100,000 during the time period of 2007 through 2011 (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014h; United States Environmental Protection Agency, 2014i). This variable was an interval level variable and was also continuous. The median annual RSEI scores calculated by the U.S. EPA for each Michigan county were obtained from the U.S. EPA TRI database located in the Envirofacts portion of the agency's website. This five-year period represented the most recent RSEI score data reported by the U.S. EPA. The U.S. EPA reported the scores as an annual, numeric score for a chemical facility, a median score for a county, a state median score, and also as a median score for the entire country. The median, annual RSEI score for each county for 2007 through 2011 were recorded in an Excel spreadsheet. A higher RSEI score represented higher potential hazards to humans when exposed to the toxic chemicals found at the chemical facilities. (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014i). Next, the control variables will be discussed.

The control variables for this study were three demographic variables for Michigan counties. Data for the three control variables in this study were gathered from U.S. Census Bureau archival data. The U.S. Census Bureau data were obtained from the American Community Survey database, the American Factfinder (United States Census Bureau, 2014a; United States Census Bureau, 2014d). Another possible source for the U.S. Census Bureau data was the U.S. EPA EJView database. U.S. EPA EJView database incorporated U.S Census Bureau data but did not include the voluntary P2 data found on the alternate U.S. EPA website. My initial plan was to compare the data found on the U.S. Census Bureau site, the U.S. EPA Envirofacts site, and U.S. EPA EJView site. However, I found that all of the information needed was not on the U.S. EPA EJView site. Therefore, I did not use the site.

The first control variable in this study was the percentage of minorities or non-Whites in Michigan counties with populations over 100,000. The data were reported annually for the years of 2007 through 2011. These data were calculated from estimated population totals per county in the U.S. Census Bureau's American Community Survey. This demographic variable was derived by subtracting the total county population from the population indicated as "White alone" for each year included in the study (United States Census Bureau, 2014a; United States Census Bureau, 2014d). The percentage of non-Whites or minorities was recorded in an Excel spreadsheet at an interval level and was continuous. The second control variable that was considered in this study was median annual household income.

The second control variable in this study was the median household income in Michigan counties during the time period of 2007 through 2011. This value was calculated by the U.S. Census Bureau and was reported on the annual American Community Survey as an estimated value per county for each year. This information was retrieved from the U.S. Census Bureau's American Factfinder database (United States Census Bureau, 2014a; United States Census Bureau, 2014d). This variable was reported at the interval level and was continuous. The third control variable that was included in this study was the percentage of educational attainment in Michigan counties.

The third control variable was the average percentage of educational attainment of a high school degree in Michigan counties from 2007 to 2011. Data was accessed from the U.S. Census Bureau American Factfinder database (United States Census Bureau, 2014a). This value represented the percentage of educational attainment of a high school degree for county residents over 25 years old. This percentage was reported as a single percentage for a given year by the U.S. Census Bureau as part of the annual American Community Survey. This control variable was reported at the interval level and was continuous. Five year averages for all three demographic control variables were also calculated for each county in the study and recorded in individual county spreadsheets and in one spreadsheet that included the data for all 20 counties in the study.

Intervention Studies or Manipulation of an Independent Variable

This study was not considered an intervention study. The independent variables were not be manipulated.

Data Analysis and Plan

Data were stored on a laptop computer in spreadsheet format using Microsoft Excel software. Data were initially gathered per county and were recorded on individual spreadsheets. In order to capture the voluntary P2 data, each row of the initial county spreadsheets represented data for a toxic chemical facility registered under the U.S. EPA's TRI program in the county. Five columns were used to represent each of the 5 years included in the study. The toxic chemical facility's voluntary P2 participation for each year was then recorded. The P2 participation for each county facility was recorded as either 0, indicating no reported voluntary P2 participation that year, or 1, representing one year of reported P2 participation during that year. The sum of these values was calculated, and the percentage of TRI-regulated facilities reporting voluntary P2 activity in the county for each year between 2007 through 2011 was calculated and reported on the spreadsheet. The U.S. EPA's median annual RSEI score for each county was recorded for each year during the period of 2007 through 2011. Because the median annual RSEI score for each county was reported by the U.S. EPA on their website, there was no need for further calculations to generate RSEI data needed for this study. Finally, one new spreadsheet was created to incorporate the data for the county median annual RSEI score, the percentage of annual voluntary P2 participation, and the median annual or average demographic variable value for all 20 counties included in the study. Each row of the new spreadsheet represented county data for each year of the study. There were 100 rows of data. Data from each spreadsheet were uploaded into SPSS for quantitative analysis of the data. SPSS software was obtained from Walden University and downloaded on to the laptop computer. Spreadsheets containing 5-year averages of the county data were created and used to graphically represent study results

Data in this study were analyzed using hierarchical multiple regression analysis. The regression analysis was performed on the average annual voluntary P2 participation and median annual RSEI score for all of the counties in the study over the 5-year time period from 2007 through 2011. Descriptive statistics were also used to analyze the data (Field, 2009). The regression analysis was then used to determine if there were relationships between the independent variable, dependent variable, and control variables. The goal was to answer the research questions and also to determine if the null hypothesis was valid.

Research Questions

The research question associated with this study was as follows:

1. Does the voluntary pollution prevention (P2) activity of chemical-related industry in Michigan counties influence toxic chemical health risk scores, represented by U.S. EPA's Risk-Screening Environmental Indicators (RSEI) scores, after controlling for county demographic factors?

The null hypothesis and alternative hypothesis associated with this study were defined as follows:

H_0: There is no influence of voluntary pollution prevention (P2) activity on the toxic chemical health risk scores, represented by U.S. EPA's Risk Screening Environmental Indicators (RSEI) scores of chemical-related industry in Michigan counties, after controlling for county demographic factors.

H_1: There is influence of voluntary pollution prevention (P2) activity on the toxic chemical health risk scores, represented by U.S. EPA's Risk-Screening Environmental Indicators (RSEI) scores of chemical-related industry in Michigan counties, after controlling for county demographic factors.

Threats to Validity

The U.S. EPA requires toxic chemical companies to report their emissions to the agency. Data are reported to the U.S. EPA by the toxic chemical facilities and are entered into government databases by the agency. The U.S. EPA is responsible for the validation of the data entered into their databases (United States Environmental Protection Agency, 2014b; United States Environmental Protection Agency, 2014i). Because the secondary data were owned and maintained by the government, the data used in this study were considered to be from a reliable source (Creswell, 2009).

One possible threat to the internal validity of this study was historical bias. Because archival data were used, there was the threat that historical events at the time the data were generated and reported influenced the data reported by industry (Creswell, 2009, p. 163). In order to try to eliminate some of the historical bias, a five-year span of time was selected to capture more years of data and to address potential variability of results associated with annual historical events.

Another threat to the validity of this study was observer or researcher reliability. Care was taken to ensure there was consistency in data collection, data recording, data calculations, the data coding process, and data analysis (Creswell, 2009). Collected data were reviewed for transcription accuracy by comparing the recorded data points in the spreadsheets with the data printed from the government tables. The mathematical calculations used to create the variables, the average percent of toxic chemical facilities in each county reporting voluntary P2 activity, the percent minority or non-Whites in the counties during 2007 through 2011, and the five-year county averages for all of the variables, were reviewed and confirmed.

Content validity was another potential threat to this study. It was important to make sure the data gathered were appropriate for the study. It was also important that the research analyzed and reported what was intended to be measured. Lastly, in order to answer the research question, it was necessary to select the appropriate variables for the study.

External validity was an additional threat to this study. It was important that the population selected and sampled for this study were both appropriate (Creswell, 2009). For this study, the Michigan counties selected included an adequate number of toxic chemical facilities and an adequate number of inhabitants to allow for diversity. The sample population included areas that were geographically dispersed across the state in order to capture a more representative view of the conditions throughout Michigan. All attempts were made to eliminate sampling bias by focusing on counties dispersed throughout Michigan instead of limiting study focus to a small geographical sector of the state. The intent of this study was to conduct statistically relevant research that incorporated a suitable sample size and population.

Ethical Procedures

Ethical concerns pertaining to study participants were not an issue because I used publically available, archival data that were gathered and maintained by the United States government. There was no threat of a confidentiality breach by using publically available data. No interviews or surveys were performed for this study. The issue of researcher bias was a potential ethical concern. However, the particular workplace and county of concern was not included in the study because the company resided in a county with a population less 100,000 inhabitants. Based on this fact, the potential researcher bias was eliminated. This exclusion reduced the overall threats to study validity, bias, and the threat of ethical misconduct in the study.

Summary

The plan of study was to create a robust, quantitative analysis looking at toxic chemical activity and demographic factors in Michigan communities. The cross-sectional design involved one independent variable, one dependent variable, and three control variables. Methodology included the use of nonprobability sampling of various counties in Michigan. SPSS statistical software was used to perform hierarchical multiple regression analysis of the data. Evaluation of the collected data involved a review of the validity and reliability of the data. Threats to validity were noted and addressed. Ethical considerations were also discussed in this chapter. Due to the nature of this study and the use of pre-existing, publically available government data, ethical issues involving sample populations were not expected. Likewise, researcher bias and potential researcher conflict of interest were eliminated because the place of employment and subsequent Michigan county were not included in the current study.

Chapter 4: Results

Introduction

The purpose of this study was to learn if there was a relationship between chemical company participation in voluntary P2 activities, their production of potentially hazardous toxic chemicals, and the demographics of the Michigan counties in which they were located. The chemical-related companies studied were registered in the U.S. EPA's TRI program. Median RSEI scores were the basis for determining the level of potential hazard associated with toxic chemicals stored and manufactured by these companies. Conclusions about the demographics of the counties studied were based on affluence, educational attainment, and racial diversity. The research question was whether the voluntary P2 activity of chemical related industries influences toxic chemical health risk scores as represented by RSEI scores after controlling for county demographic factors. The research question was answered in hierarchical multiple regression with two models: (a) the demographic control variables influence on the median annual RSEI scores for the counties and (b) the chemical industry's participation in voluntary P2 activities and median annual RSEI scores while controlling for demographic factors in Michigan counties. The study period from 2007 through 2011 was selected because it represented the most current, publically available data reported for all five variables included in this research. The statistical assumptions of this study and statistical analysis will be discussed in further detail in this chapter.

Chapter 4 includes information about the data collection and the statistical analysis of the results. The data collection section includes details explaining the study timeframe and the data gathering process used in this research. Because I used nonprobability sampling, the external validity of the research will be discussed later in this chapter. The results section of this chapter includes extensive statistical analysis of the research data. Descriptive statistics and an assessment of the statistical assumptions are also included. Graphical depictions of study results follow the statistical analysis. The chapter ends with the summary that addresses the research questions and hypotheses.

Research Questions

This study included one research question, one null hypothesis, and one alternative hypothesis. The research question was the following: Does the voluntary pollution prevention activity influence toxic chemical health risk scores after controlling for county demographic factors in Michigan counties? A hierarchical multiple regression model was used with the following variables: an independent variable of voluntary pollution prevention activity; a dependent variable of toxic chemical health risk scores; and three control variables of demographic factors of affluence, educational level, and race.

The null hypothesis and alternative hypothesis were as follows:

H_0: There is no influence of voluntary pollution prevention activity on the toxic chemical health risk scores after controlling for county demographic factors.

H_1: There is influence of voluntary pollution prevention activity on the toxic chemical health risk scores after controlling for county demographic factors.

Timeframe for Data Collection

Data collection for this study commenced on December 19, 2014 immediately after Walden University's Institutional Review Board (IRB) approved the study proposal. Data were accessed from the U.S. EPA website and the U.S. Census Bureau website. Data collection for this study ended on February 1, 2015. The U.S. EPA data and U.S. Census Bureau data were captured in Excel spreadsheets and reviewed and validated during the time period spanning February 1, 2015 through February 10, 2015. Data sets captured in the spreadsheets were compared to data tables printed directly from the government websites in order to eliminate any transcription errors in data collection. Calculations were also reviewed and validated.

Discrepancies from Collection Plan

Data collection was performed electronically as specified in Chapter 3. Data were collected per Michigan county for the years spanning from 2007 through 2011. Demographic data were gathered from the U.S. Census Bureau website and were reported by the U.S. government as single, annual average or median value per year for each Michigan county. Toxic chemical data as represented by the study's dependent variable, county median annual RSEI scores, were gathered from the U.S. EPA website. The U.S. EPA reported the RSEI scores as a single, annual median value for each Michigan county. The U.S. EPA reported voluntary P2 participation data, the study's independent variable, as annual participation for the individual TRI-regulated facility and included examples of the participation activity. The annual, total number of TRI facilities reporting voluntary P2 activity in the county was then recorded for each year of the study. Finally, the annual number of facilities reporting voluntary P2 activity was divided by the total number of TRI-regulated facilities registered in the county and converted into a percentage. This value represented the average annual county voluntary P2 participation for each year included in the study. This value was defined as the annual percentage of TRI-regulated facilities reporting voluntary P2 activity in each Michigan county included in the study from 2007 through 2011. Data for all study variables were captured in Excel spreadsheets.

All U.S. Census Bureau data and U.S. EPA toxic chemical data required for the study were gathered directly from either the U.S Census Bureau website or the U.S. EPA's TRI database and Envirofacts database, located on the U.S. EPA's website, as initially planned. There was no need to gather U.S. Census data or environmental data from additional sources, such as the U.S. EPA's EJView database as originally proposed. A visual comparison of the demographic data gathered from the U.S. Census Bureau American Community Survey tables and demographic data reported for Michigan counties in the EJView database confirmed the demographic data from both sources were the same. Also, data for voluntary P2 participation and median annual RSEI scores, the study's independent and dependent variables, could not be retrieved from the EJView. For these reasons, there was no need to use the EJView database to gather additional data for this study. All intended data were successfully gathered from the intended public areas of the U.S. EPA and U.S. Census Bureau websites.

Data Collection and Sample Demographic

The sample population for this study included Michigan counties with greater than 100,000 inhabitants based on U.S. Census Bureau data. This value was selected in order to include populated areas in Michigan with a greater probability for demographic diversity. This selection also allowed for a more diverse number of small and large toxic chemical facilities to be included in the research. Twenty Michigan counties met that criteria and were included in the study.

The U.S. Census Bureau data were gathered from the annual U.S. Census Bureau American Community Survey for the time period from 2007 through 2011. Data for the first demographic control variable, race or percentage of non-White or minority population, were calculated from U.S. Census Bureau data reported as the annual percentage of White people in the Michigan county. These data were obtained from the American Community Survey1-year estimates, Table CP05. Data for demographic control variable, educational attainment, were obtained from the American Community Survey1-year estimates, Table DP02. Data for the third demographic variable, annual median household income for the Michigan county, were obtained from the American Community Survey1-year estimates, Table DP03. The U.S. Census Bureau survey captures a random sampling of inhabitants in each county and is a validated and reliable source for U.S. demographic data (United States Census Bureau, 2014a). The U.S. Census Bureau includes information on their data validation process on their website. The U.S. Census Bureau also uses the extensive data from the 10-year U.S. Census to validate the annual American Community Survey data. The highest populated counties in

Michigan were included in this study in order to capture more demographic and industrial diversity. Based on this rationale, the sample population was a good representation of Michigan population and toxic chemical facility demographics.

U.S. EPA data for this study were gathered from the U.S. EPA's website (United States Environmental Protection Agency, 2014b). The U.S. EPA includes information on their data validation process on their website. The validation process is part of the U.S. EPA's quality assurance program for data integrity and quality (United States Environmental Protection Agency, 2014g). The agency's home page contained many sublayers of information. The U.S. EPA Envirofacts database was one sublayer of the website. The Envirofacts database was accessed to locate the TRI database. Then, a TRI data search was performed to obtain the data for RSEI scores and voluntary P2 participation used in the current study. Data were accessed by entering the name of the county and state. This search brought up a table of TRI-regulated facilities located in the Michigan county (United States Environmental Protection Agency, 2014n). Several columns of information in the table were available for each regulated chemical facility. The columns labeled Risk Screening and P2 Report contained hyperlinks to the RSEI scores and P2 data. County median annual RSEI scores and voluntary P2 participation data were obtained from the hyperlinks (United States Environmental Protection Agency, 2014h; United States Environmental Protection Agency, 2014d; United States Environmental Protection Agency, 2014f). The sample population selected represented the best attempt to reduce any threat to the external validity. This selection also increased the likelihood that the data and results could be used to generalize study results to other Michigan counties during the same time period.

Results

SPSS 21 software was used to analyze the data gathered for this study. Hierarchical multiple regression analysis was performed. Three control variables, racial diversity, affluence, and educational attainment were added to the regression model to better understand the possible relationship of voluntary P2 participation on RSEI scores when the demographic factors were considered. The demographic control variables were entered into the first block or step of the regression model. The control variables were the demographic variables identified as percentage non-White or minority population, annual median household income, and average percentage of educational attainment of a high school level education. The independent or predictor variable, the percentage of average annual county voluntary P2 participation, was entered in the second block or step of the regression model. The rationale for adding the independent variable second, after the control variables, was to see if voluntary P2 participation predicted the dependent variable, median annual RSEI scores, better than what was seen when only the control variables and the dependent variable were considered in the regression model. In this way, demographic factors were said to be controlled. The following statistical output in Table 3 represents the study's descriptive statistics:

Table 3

Descriptive Statistics

Variables	*M*	*SD*	*N*
Median annual RSEI score	33.99	60.17	100
Race: % non-White or minority	16.30	9.94	100
Median annual household income ($)	48,274.70	8,167.19	100
Educational attainment of high school level (%)	89.26	2.78	100
Average annual county P2 participation (% facilities participating)	6.78	3.44	100

The sample size was represented by *N* = 100. For the five-year period from 2007 through 2011, the percentage of non-White or minority population can be represented by (*M* = 16.30, *SD* = 9.94). During the period 2007 through 2011, the median annual RSEI score for Michigan counties was (*M* = 33.99, *SD* = 60.17). The percentage of average annual county voluntary P2 participation during 2007 through 2011 was (*M* = 6.78, *SD* = 3.44). The annual median household income was represented by (*M* = 48,274.70, *SD* = 8,167.19). Lastly, the descriptive statistics for educational attainment for the period were (*M* = 89.26, *SD* = 2.78).

Statistical Assumptions

Statistical analysis performed on the independent variable, three control variables, and the dependent variable in this study indicated the variables met the assumptions for multiple regression analysis. Voluntary P2 participation, the independent variable in this study, was continuous, quantitative, and measured at the interval level. The same was true for the three demographic control variables. Annual median county RSEI scores, the dependent variable, were also quantitative, continuous, and were also measured at the interval level. The dependent variable and the control variables also met the assumption of non-zero variance because all had variances that differed from 0. Multicollinearity was not seen in the independent and control variables. This point was represented by the statistic, *VIF* value when the statistic is close to a value of 1 and when the collinearity tolerance is greater than 0.02 for each control variable and the independent variable (Field, 2009). The *VIF* values and collinearity tolerances can be found in Appendix B, Table B1.

The next assumption that will be discussed is the assumption of independent errors. The assumption of independent errors is met when where residuals are uncorrelated and is illustrated when the Durbin-Watson statistic falls between 1 and 3 (Field, 2009). The Durbin-Watson statistic for the model controlling for the demographic variables was calculated using SPSS. The output is seen in Table 4.

Table 4

Model Summary

Source	*df1*	*df2*	*R*	R^2	R^{2c}	SE	ΔR^2	ΔF	*p*	*Durbin-Watson*
Model 1	3	96	.356[a]	.127	.099	57.10	.13	4.64	.004	
Model 2	1	95	.364[b]	.133	.096	57.20	.006	.67	.42	1.15

Note. Dependent Variable: Annual median county RSEI score.
[a]Predictors: (Constant), educational attainment of high school level (%), race: % non-White or minority, median annual household income ($),
[b]Predictors: (Constant), educational attainment of high school level (%), race: % non-White or minority, median annual household income ($), average annual county voluntary P2 participation (% facilities participating)
[c]Adjusted R^2

The Durbin-Watson value for the model should be between 1 and 3 in order to meet the assumption that there is independence of errors in the regression (Field, 2009). Because the Durbin-Watson value was greater than 1 for this model, the assumption of independence of errors was met. The next assumption that will be discussed is the assumption of normality.

The assumption of normally distributed errors was also met in this analysis. Normality can be seen when there is random, normal distribution of the residuals. The plots of the residuals generated by SPSS software are located in Appendix B. Normal distribution was seen in the histogram plot of the standardized residuals in Figure B1. Normal distribution was seen in the normal P-P plot of the standardized residuals in Figure B2.

Scatter plots of the regression standardized residuals and the residuals of the dependent variable and independent variable and control variables were used to illustrate homogeneity of variance and linearity between the dependent and independent variable and the dependent variable and each control variable. In looking at the scatter plot of the regression standardized residual versus the regression standardized predicted value in Figure B3, no real pattern in the plot was seen. The data also appeared to be spread out in the plot. This means that the assumptions of homogeneity of variance and linearity were met (Field, 2009). Also, no heteroscedasticity of the standardized residuals was seen. When looking at the scatter plots of the residuals of the dependent variable and each predictor variable as seen in Appendix B, Figure B4, Figure B5, and Figure B6, no patterns in the plots were seen. Thus, it was concluded that the assumptions of homogeneity and linearity were met. If the assumptions for multiple regression analysis are met, there is the likelihood that the model can be used to make generalizations beyond the sample population (Field, 2009).

Statistical Analysis

Statistical analysis was performed using a hierarchical multiple regression model created using SPSS 21 software. In this section, statistical results are illustrated in various output tables generated from SPSS. The first table that will be discussed is Table 5 addressing correlations between the study variables. Pearson's coefficients can be used to represent effect size in multiple regression and to show the strength of the relationship between two variables (Field, 2009). Effect size can also be explained using the multiple correlation indices, part and partial correlations in multiple regression analysis (Green & Salkind, 2011). For this study, the level of significance for a 1-tailed analysis was calculated. The Pearson's coefficients can be seen in Table 5.

Table 5

Pearson Correlations for Study Variables

Variable	*Median annual RSEI Score*	*Race: % non-White or minority*	*Median annual household income ($)*	*Educational attainment of high school level (%)*	*Average annual county P2 participation (% facilities participating)*
Median annual RSEI score	1.000				
Race: % non-White or minority	.11	1.00			
Median annual household income ($)	-.040	-.36**	1.00		
Educational attainment of high school level (%)	-.29**	-.38**	.65**	1.00	
Average annual county voluntary P2 participation (% facilities participating)	-.10	.11	.020	.079	1.00

Note. $N = 100$.
* $p < .05$, (1-tailed). ** $p <. .01$, (1-tailed).

Table 5 contains the Pearson's coefficients for the correlations between the variables in the study. The Pearson's correlation for the relationship between the independent variable, average annual county voluntary P2 participation, and the dependent variable, median annual RSEI score for Michigan counties, was $r = -.10$, $p = .152$. This correlation was insignificant because $p = .152$. Also, a Pearson's coefficient of $r = -.104$ represents a small effect size. The Pearson's coefficients for the relationship between median annual RSEI score and each demographic control variable is discussed in the next paragraphs.

The Pearson's correlation was calculated for the relationship between each control variable in the study and the dependent variable, median annual RSEI score. The Pearson's correlation for the relationship between percentage of non-White or minority and median annual RSEI score was $r = -.11$, $p = .144$. This value also represents a small effect size. The correlation was considered insignificant because $p = .144$. The Pearson's correlation for the relationship between median annual household income and median annual RSEI score was $r = -.040$, $p = .348$. This value also represented a small effect size. The correlation was considered insignificant because $p = .348$. Lastly, the Pearson's correlation for the relationship between educational attainment and median annual RSEI score was $r = -.29$, $p < .01$ (one-tailed). This value represented a medium effect size. The correlation between educational attainment and media annual n RSEI score was also considered significant because $p = .002$.

In summary, the presence of an insignificant Pearson's coefficient indicated there was no significant correlation between voluntary P2 participation and median annual RSEI scores when controlling for the demographic variables percentage of non-White or minority, median household income, and educational attainment. Upon further investigation of effect size and correlation of study variables using Pearson's coefficient, a significant Pearson's correlation was seen for the relationship between educational attainment and median annual RSEI score. Next, the analysis of variance output for the study will be discussed.

The analysis of variance output in Table 6 was the result of the hierarchical multiple regression analysis. In the analysis of variance for this study, the demographic control variables were entered into the model first and are represented in the output of Model 1. Next, the independent variable, voluntary P2 participation, was added to the regression model as represented by Model 2 in Table 6.

Table 6

Hierarchical Regression Analysis of Variance of Median Annual RSEI score by Michigan County Demographic Factors and Average Annual Michigan County P2 Participation

Source	*df*	*SS*	*MS*	*F*	*p*
Model 1					
Regression	3	45,400.56	15,133.52	4.64	.004[b]
Residual	96	312,986.43	3260.28		
Total	99	358,386.99			
Model 2					
Regression	4	47,587.45	11,896.86	3.64	.008[c]
Residual	95	310,799.54	3271.57		
Total	99	358,386.99			

Note. Dependent Variable: Median Annual RSEI Score
[b]Predictors: (Constant), Educational Attainment of High School Level (%), Race: % Non-White or Minority, Median Annual Household Income ($)
[c]Predictors: (Constant), Educational Attainment of High School Level (%), Race: % Non-White or Minority, Median Annual Household Income ($), Average Annual County P2 Participation (% facilities participating)

Table 6 includes the analysis of variance results. An analysis of variance in the regression models showed that the effect of the demographic control variables on the dependent variable RSEI score was significant as seen by $F(3, 96) = 4.64$, $p = .004$. When the independent variable voluntary P2 participation was added to the demographic control variables as seen in Model 2, the analysis of variance also indicated significance to be able to predict the dependent variable RSEI score. This point was seen by $F(4, 95) = 3.64$, $p = .008$. However, the addition of the independent variable decreased the probability of the *F* statistic slightly, meaning the addition reduced the overall effect of the model slightly. Model 1 and Model 2 both significantly improve the ability to predict median annual county RSEI scores (Field, 2009). However, the addition of the independent variable, annual voluntary P2 participation, did not improve the model's ability to predict median annual RSEI scores. Also, a slight decrease in the adjusted R^2 was noted when the independent variable was added to the model. The decrease in adjusted R^2 means the addition of the independent variable, average annual county voluntary P2 participation, did not significantly improve the model's ability to predict Michigan county median annual RSEI scores. An overall summary of the statistical finding of the study was captured in Table 7.

Table 7

Hierarchical Multiple Regression 2 Step Model with Dependent Variable Median RSEI Score

Model	Unstandardized Coefficients			Standardized Coefficients
	b	*SE B*	*95% CI*	*β*
Step 1				
Constant[a]	815.26	226.16	[366.36, 1264.15]	
Race: % non-White or minority	0.188	0.63	[-1.06, 1.44]	0.031
Median annual household income ($)	0.002	0.001	[.00, .004]	0.27*
Educational attainment of high school level (%)	-9.85	2.77	[-15.35, -4.35]	-0.46**
Step 2				
Constant	800.44	227.26	[349.27, 1251.61]	
Race: % non-White or minority	0.027	0.64	[-1.00, 1.54]	0.044
Median annual household income ($)	0.002	0.001	[.00, .004]	0.27*
Educational attainment of high school level (%)	-9.59	2.79	[-15.13, -4.05]	-0.44**
Average annual county P2 participation (% TRI facilities participating)	-1.39	1.70	[-4.76, 1.98]	-0.079

Note. [a]Control variables included % non-White or minority, median annual household income, and % educational attainment of high school level.
N = 100. R^2 = .127 for Step 1 ($p < .01$), ΔR^2 = .127 for Step 1 ($p < .01$). R^2 = .133 for Step 2 ($p < .05$), ΔR^2 = .006 for Step 2 ($p > .05$).
* $p < .05$, ** $p < .01$.

Statistics illustrated in Table 7 show the individual significance of how well the independent variable, voluntary P2 participation, and the demographic control variables predict median annual RSEI score. Field (2009) indicated a relationship between an independent variable and a dependent variable is illustrated when the probability of the *t* statistic for the *b* coefficient, as illustrated by *unstandardized β* is $p < .05$. Statistical results presented in prior tables and Table 7 confirmed the independent variable, average annual county voluntary P2 participation, was not a significant predictor of median annual RSEI scores as seen by ($t(95) = -0.82$, $p = .42$). The value for the *standardized β* = -.08 for voluntary P2 participation meant that when voluntary P2 participation increases by one standard deviation, there was a statistically insignificant 0.08 standard deviation decrease in the dependent variable, RSEI scores. Next, the *unstandardized β* and *standardized β* for the demographic control variable, educational attainment will be addressed.

Educational attainment was one of three demographic control variables in this study. As mentioned previously, the demographic control variables were added into hierarchical multiple regression model first. When looking at the *t* statistic for educational attainment of high school level, the following results were noted: ($t(95) = -3.43$, $p < .01$). This information indicated educational attainment was a significant indicator or predictor for the dependent variable, median annual RSEI scores. When a predictor or independent variable has a high *standardized β*, it is said to have a greater influence and importance in the regression model (Field, 2009). For instance, when looking at the *standardized β* for the percentage of educational attainment of high school level, this variable had the highest absolute value for *standardized β* in the model with *standardized β* = -.44. This statistic was interpreted to mean the following: as educational attainment increases by one standard deviation, the dependent variable, median annual RSEI score, decreases by 0.44 units. This means the variable, percentage of educational attainment of high school level, had the highest importance as a predictor of RSEI scores based on the results of this study's hierarchical multiple regression model when compared to the other variables included in the analysis.

When looking at the other two demographic control variables, statistical insignificance was noted. For example, the *t* statistic for the demographic control variable, percentage of non-White or minority, was ($t(95) = 0.42$, $p = .68$ which indicated that variable was not a good predictor of the dependent variable, median RSEI score. When looking at the *t* statistic and *standardized β for* the control variable, median annual household income, first appearances suggested the variable might be a good predictor for RSEI scores as seen by ($t(95) = 2.09$, $p < .05$). Also, the *standardized* $\beta = .27$ for median household income suggested the variable was the second highest predictor for RSEI scores in the regression model. However, when looking at the correlation data from earlier tables, household income exhibited insignificant statistical correlation with median annual RSEI score, showed insignificant influence on median RSEI scores.

The statistical analysis of the study results was used to further assess the study's null hypothesis and alternate hypothesis defined as the following:

H_0: There is no influence of voluntary pollution prevention (P2) activity on the toxic chemical health risk scores, represented by U.S. EPA's Risk-Screening Environmental Indicators (RSEI) scores of chemical-related industry in Michigan counties, after controlling for county demographic factors.

H_1: There is influence of voluntary pollution prevention (P2) activity on the toxic chemical health risk scores, represented by U.S. EPA's Risk-Screening Environmental

Indicators (RSEI) scores of chemical-related industry in Michigan counties, after controlling for county demographic factors.

Because an insignificant correlation between voluntary P2 participation and median annual RSEI scores was seen by $r = -.10$, $p = .152$ and by ($t(95) = -0.82$, $p = .42$) as explained previously, the null hypothesis, H_0, of this study cannot be rejected. Thus, the null hypothesis that there is no influence of voluntary pollution prevention on the toxic chemical health risk scores, represented by U.S. EPA's RSEI scores of chemical-related industry in Michigan counties, after controlling demographic factors is true. It can also be concluded there is an insignificant influence of P2 activity to RSEI scores in Michigan counties when looking at the following research question: Does the voluntary P2 activity of chemical-related industry in Michigan counties influence toxic chemical health risk scores, represented by U.S. EPA's RSEI scores, after controlling county demographic factors? The answer to the research question can be stated as follows: Voluntary P2 activity of chemical-related industry in Michigan counties does not significantly influence toxic chemical health risk scores, represented by U.S. EPA's RSEI scores, after controlling for country demographic factors.

By controlling for the demographic variables, I obtained information on the influence of the demographic variables in the regression model. A statistically significant correlation between median annual RSEI scores and the percentage of educational attainment of a high school level education from 2007 through 2011 for Michigan counties included in the study was seen when the demographic variables were first entered without the independent variable into Step 1 or Model 1 of the hierarchical multiple regression analysis. The significant correlation between educational attainment and median RSEI score was still seen when voluntary P2 participation was entered in Step 2. In summary, no statistically significant correlation was seen when voluntary P2 participation was included in the second step of the model. However, a statistically significant correlation or influence was seen between the demographic variable, percentage educational attainment of a high school level education and median annual RSEI scores in Michigan counties from 2007 through 2011.

Tables and Graphics

The U.S. Census Bureau data and U.S. EPA data used in this study were gathered for the years 2007 through 2011. A breakdown of these data for each year of the study is included as a spreadsheet in Appendix A. Data in Appendix A represent s the data that were used in the SPSS statistical analysis. Values for the 5-year averages of the demographic and toxic chemical-related data for the Michigan counties are illustrated in Table 8 and in Figure 1 and Figure 2. I performed the calculations to better compare the county data for the entire timeframe of the study.

Table 8

5-Year Michigan County Data 2007-2011

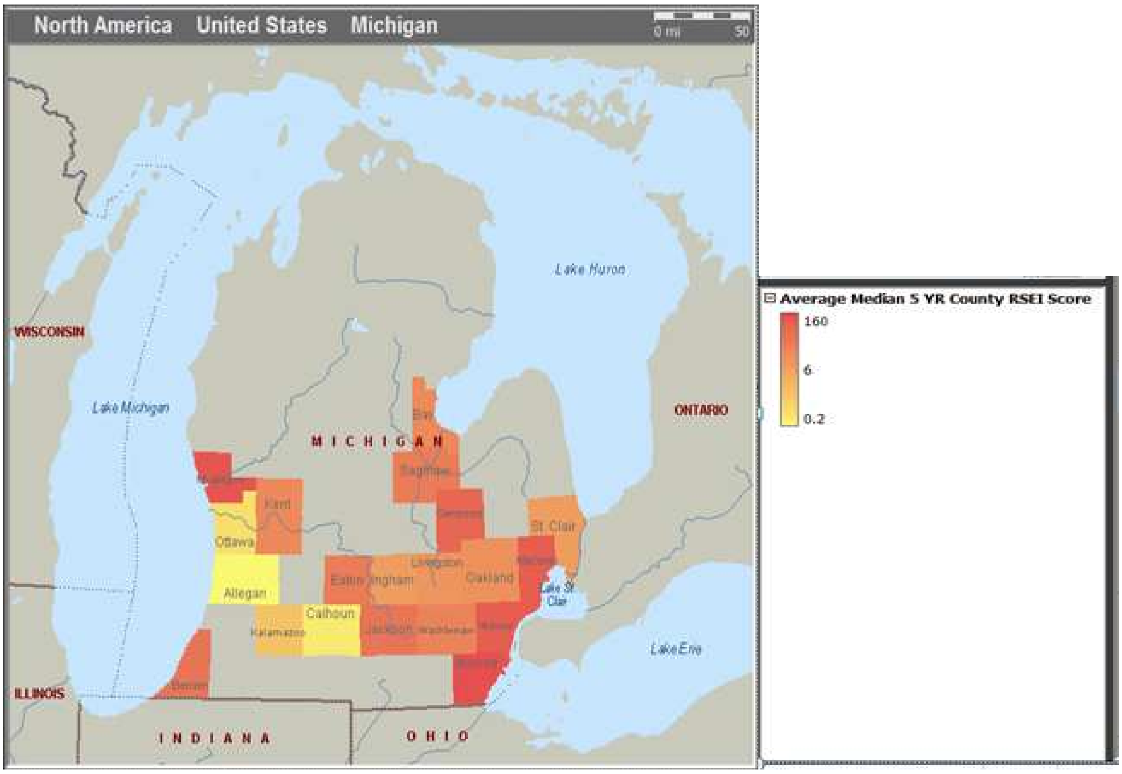
County	Average median 5-year county RSEI score[a]	% Average county 5-year P2 participation[a]	Race: % 5-year average non-White or minority population[b]	Average median 5-year household income[b]	% Average 5-year educational attainment high school[b]
Allegan County, MI	0.20	10.47	6.92	49,120	89.3
Bay County, MI	13.00	2.86	4.52	44,226	88.1
Berrien County, MI	29.20	5.67	20.80	41,052	86.8
Calhoun County, MI	0.40	12.45	16.10	40,485	87.8
Eaton County, MI	28.20	8.00	11.60	52,350	92.8
Genesee County, MI	52.40	7.14	24.30	41,753	88.3
Ingham County, MI	7.80	7.11	21.74	43,636	90.6
Jackson County, MI	31.80	10.55	11.92	44,284	88.8
Kalamazoo County, MI	1.80	5.08	16.84	44,111	92.1
Kent County, MI	15.00	8.08	17.82	49,172	88.4
Livingston County, MI	10.60	7.11	3.68	68,431	93.9
Macomb County, MI	85.80	5.36	13.84	52,221	87.8
Monroe County, MI	158.60	3.13	5.50	53,502	88.1
Muskegon County, MI	99.60	4.86	19.00	38,889	87.3
Oakland County, MI	11.20	6.32	21.36	63,693	92.3
Ottawa County, MI	0.60	6.73	10.46	53,399	90.4
Saginaw County, MI	25.40	4.44	23.88	41,213	87.1
St. Clair County, MI	7.40	3.02	5.76	46574	88.1
Washtenaw County, MI	19.40	9.26	24.74	57,198	93.8
Wayne County, MI	81.40	7.59	47.18	40,185	83.1

Note. [a]United States Environmental Protection Agency. (2014b). Envirofacts TRI database. Retrieved from http://www.epa.gov/enviro/facts/tri/search.html. [b]United States Census Bureau. (2014a). American fact finder. Retrieved from http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?fpt=table.

The 5-year Michigan county data in Table 8 were plotted using Microsoft MapPoint option within the Excel software. The resulting figures were geographical mapping of the data. The output consisted of two maps that illustrated the 5-year averages for the period from 2007 through 2011 for the independent variable, voluntary P2 participation, and the dependent variable, median annual county RSEI score in the Michigan counties included in the study. Varying highlighted areas represent the actual data measurements. These maps can be seen in Figure 1 and Figure 2.

Figure 1

Average Median 5-Year Michigan County RSEI Scores[a] (2007-2011)



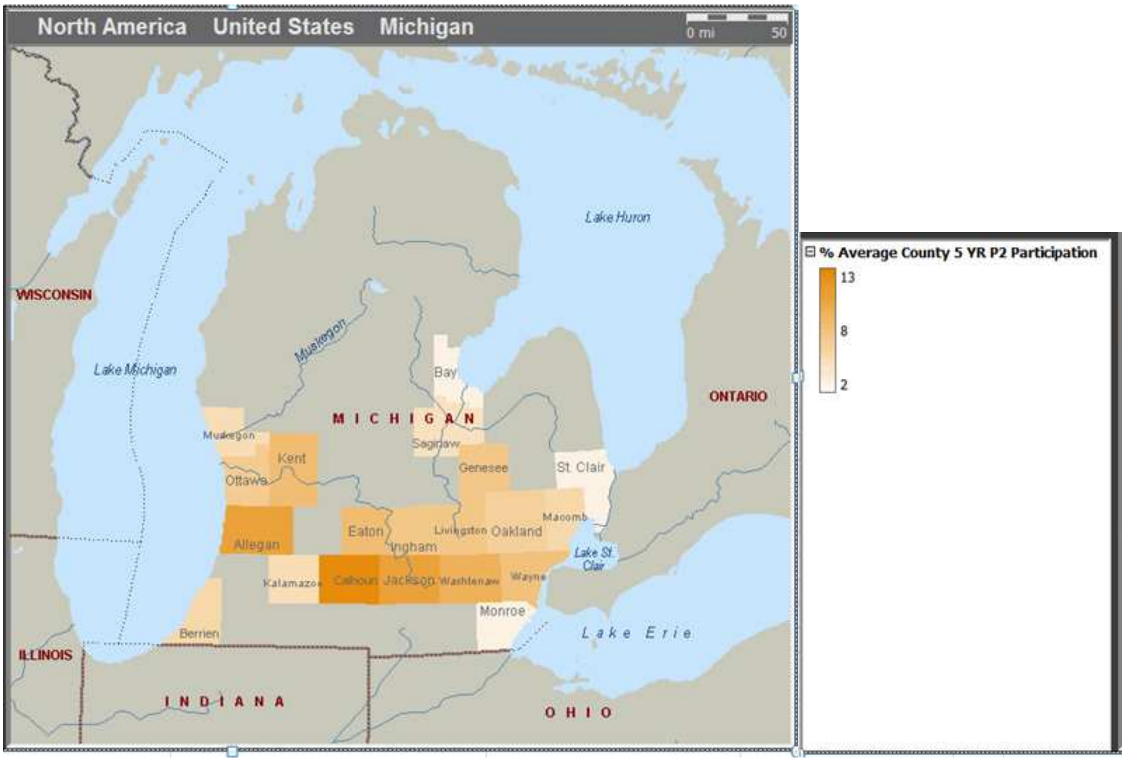
Note. [a]United States Environmental Protection Agency. (2014d). Envirofacts TRI database. Retrieved from http://www.epa.gov/enviro/facts/tri/search.html

The dependent variable of this study was median annual RSEI scores in Michigan counties during the 5-year period from 2007 through 2011. In Figure 1, the Michigan counties highlighted in red or the darkest highlights were found to have the highest median annual RSEI scores reported for their TRI-regulated facilities during the study time period. The yellow or light highlighted counties represent counties with the lowest median RSEI scores for TRI-regulated. For example, Monroe County reported the highest average median RSEI scores for TRI-regulated facilities between 2007 and 2011 with a score of 158.6. Allegan County reported the lowest RSEI scores for TRI-regulated facilities during the time period of 2007 through 2011. The average median RSEI score for Allegan County was 0.20 for the 5-year period. Next, 5-year data for voluntary P2 participation by TRI-regulated facilities in Michigan will be discussed in Figure 2.

The 5-year average for voluntary P2 participation in Michigan counties for 2007 through 2011 is seen in Figure 2.

Figure 2

Average 5-Year Voluntary P2 Participation[a] (2007-2011)



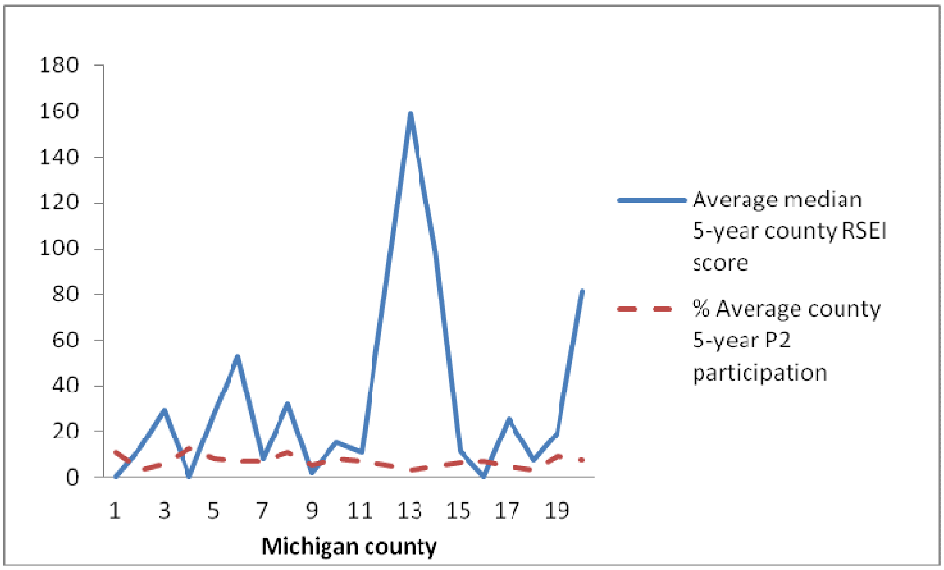
Note. [a]United States Environmental Protection Agency. (2014b). Envirofacts TRI database. Retrieved from http://www.epa.gov/enviro/facts/tri/search.html

The independent variable in this study was represented by voluntary P2 participation by TRI-regulated facilities in Michigan from 2007 through 2011. In Figure 2, Michigan counties indicated by the darkest highlights reported the highest percentage of voluntary P2 participation activity by their TRI-regulated facilities. The lightest highlights represent counties that reported the lowest percentage of voluntary P2 participation for their TRI-regulated facilities. For example, Calhoun County represented the Michigan county with the largest percentage of TRI-regulated chemical facilities reporting voluntary P2 participation during the study period. Calhoun County reported 12.45% of TRI-regulated facilities participated in voluntary P2 activities between 2007 through 2011. Allegan County reported the second highest level of voluntary P2 participation in Michigan during 2007 through 2011. It is interesting to note, Calhoun County and Allegan County also reported the lowest RSEI scores between 2007 through 2011 compared to the other Michigan counties included in the study. Monroe County reported the lowest level of voluntary P2 participation in Michigan counties with only 3.0% of TRI-regulated facilities reporting participation. However, Monroe County reported the highest RSEI scores out of all the counties included in the study. Even though it appeared there was an inverse correlation between median RSEI scores and voluntary P2 participation of TRI-regulated facilities in Michigan, hierarchical regression analysis proved the correlation to be non-significant. Further illustration of the 5-year data is seen in the following paragraphs.

The 5-year averages for median annual county RSEI scores and voluntary P2 participation of TRI-regulated facilities in Michigan during the period from 2007 through 2011 are depicted in Figure 3.

Figure 3

5-Year U.S. EPA Data[a] for Toxic Chemical Activity in Michigan Counties (2007-2011)



Note. [a]United States Environmental Protection Agency. (2014b). Envirofacts TRI database. Retrieved from http://www.epa.gov/enviro/facts/tri/search.html

Figure 3 illustrates the 5-year averages for median annual Michigan county RSEI scores and averge percentage of TRI-regulated facilities reporting voluntary P2 activity between 2007 through 2011. The RSEI scores varied considerably when the results for all 20 counties were compared. This point is illustrated by the varying slope of the plot of average median 5-year RSEI scores in Figure 3. However, when the plot of the voluntary P2 participation of TRI-regulated facilities in the counties was examined, little variation in slope was seen. This point is illustrated in Figure 3. As the slope of the plot of the 5-year average median RSEI score increases, there appears to be a decrease in the voluntary P2 participation of TRI-regulated facilities. This finding corresponds with the results of the statistical analysis presented earlier in the chapter as seen in the statistic r = -.10, p =

.152 which indicated a negative or decreasing statistically insignificant correlation between the two variables.

Summary

Hierarchical multiple regression analysis was performed using Michigan county U.S. Census data and U.S. EPA data for the time period of 2007 through 201 used the statistical analysis to analyze possible correlation between the univariate dependent variable, annual median Michigan county RSEI score, and the independent variable defined as the average annual percentage of Michigan county TRI-regulated facilities reporting voluntary P2 participation between 2007 through 2011. I performed the analysis by controlling for three demographic control variables. The control variables were defined as percentage of non-White or minority population, median annual household income, and percentage of educational attainment of at least a high school level education in Michigan counties. The demographic variables were introduced into the regression model in the first step before the independent variable, voluntary P2 participation. In this way, demographic variables were controlled. The first step allowed me to analyze the effects involving each demographic variable and the dependent variable, median annual RSEI score in the regression models.

A statistically insignificant, negative correlation was seen between voluntary P2 participation activity of TRI-regulated facilities and the dependent variable, county median RSEI scores in Michigan counties during the period from 2007 through 2011. The data indicated that some Michigan counties reporting low voluntary P2 participation of TRI-regulated facilities had high RSEI scores. Likewise, some Michigan counties with high voluntary P2 participation of TRI-regulated facilities reported lower median RSEI scores. Based on this statistically insignificant finding, I determined the study's null hypothesis that there is no influence of voluntary pollution prevention (P2) activity on the toxic chemical health risk scores, represented by U.S. EPA's RSEI scores of chemical-related industry in Michigan counties, after controlling for county demographic factors was true and cannot be rejected.

Even though my regression analysis did not illustrate a significant influence of voluntary P2 participation on median annual RSEI scores, my analysis did indicate statistically significant correlative effects between the dependent variable, median annual RSEI score, and the demographic control variable, percentage educational attainment of a high school level education. A statistically significant, negative correlation was seen between educational attainment of at least a high school level education and median RSEI scores in Michigan counties between 2007 through 2011. However, no statistically significant correlation was seen between either the control variable, percentage of non-White or minorities, and median Michigan county RSEI scores or the variables median annual household income and median Michigan county RSEI scores for the time period of 2007 through 2011.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to investigate whether toxic chemical facilities in Michigan counties practice different voluntary P2 participation and produce more potentially hazardous toxic chemicals, as seen through median annual RSEI scores, in counties that are less affluent, have lower education attainment, and greater racial diversity. This investigation was performed by hierarchical multiple regression with the independent variable, annual, average percentage of Michigan county toxic chemical facilities that reported voluntary P2 participation; a dependent variable, annual median Michigan county RSEI score; and three demographic control variables of percent of non-White or population, median annual household income, and percentage educational attainment of at least a high school level education in Michigan. Demographic variables were controlled in order to clarify whether the independent variable, voluntary P2 participation, had any impact on median annual RSEI scores. Then, a correlation between each demographic variable and median annual RSEI scores was addressed in order to gain a better understanding of the possible influence of demographics on toxic chemical activities of chemical-related industry in Michigan counties. The demographic variables were also controlled in order to determine how much each demographic variable affected median annual RSEI scores of the TRI-regulated facilities in Michigan counties. That determination was made through multiple hierarchical regression.

The multiple hierarchical regression was divided into two steps. The first step included the county demographic control variables and the dependent variable, median annual RSEI score. The control variables were percent of non-White or population, median annual household income, and percentage educational attainment of at least a high school level education in Michigan during the time period spanning from 2007 through 2011. This step was defined as Model 1 in the statistical output. The second step included the addition of the independent variable, annual, average percentage of Michigan county toxic chemical facilities that reported voluntary P2 participation into the model. This step was defined as Model 2 in the statistical output.

Key Findings

In the results of this study, I confirmed that voluntary P2 participation of TRI-regulated facilities in Michigan counties with over 100,000 inhabitants did not exhibit statistically significantly correlation with annual median U.S. EPA RSEI scores of TRI-regulated facilities in the Michigan counties from 2007 through 2011. These U.S. EPA data represented the two study variables for toxic chemical activity of chemical-related industry in Michigan. The voluntary P2 participation of TRI-regulated facilities in Michigan counties did not significantly influence the median U.S. EPA RSEI scores of the TRI-regulated facilities during the time period of 2007 through 2011when demographic factors are controlled. A statistically insignificant, inverse correlation between voluntary P2 participation and the annual, median county RSEI scores for TRI-regulated facilities in Michigan during 2007 through 2011 was noted. These finds were based on hierarchical multiple regression analysis performed using U.S. EPA datasets and U.S. Census Bureau data for Michigan counties from 2007 through 2011. Based on this information, the study's null hypothesis that there is no influence of voluntary P2 activity on the toxic chemical health risk scores, represented by U.S. EPA's RSEI scores of chemical-related industry in Michigan counties, cannot be rejected.

When controlling for Michigan county demographic factors, important information regarding the influence of the demographic variables on predicting median annual RSEI scores in Michigan was noted. According to hierarchical multiple regression analysis, a statistically significance correlation existed between the demographic control variable, percentage educational attainment of a high school level education, and the dependent variable, annual median Michigan county RSEI scores, for the period spanning from 2007 through 2011.

The idea of controlling for demographic variables in order to study a possible correlation between toxic chemical activity and exposure in environmental justice research is not a new one. For example, Campbell et al. (2010) controlled for the demographic factors, race/ethnicity, and income when looking at toxic chemical exposure based on proximity to TRI-regulated facilities. In this study, I controlled for three factors: percentage of non-White or minority, median household income, and educational attainment of a high school level education while assessing a correlation between voluntary P2 activity and RSEI scores calculated for TRI-regulated facilities in Michigan counties. Grant et al. (2010) controlled for median property value and manufacturing while analyzing the effect of race, income, and several other demographic variables on toxic chemical emissions illustrated by RSEI score levels. Downey and Hawkins (2008) also controlled for various demographic variables when determining the influence of income and race on toxic chemical activity as illustrated by RSEI and U.S. EPA TRI data during the period 2000. I used elements from these studies as guidance and framework for my study. For example, my choice of the dependent variable, RSEI scores, as an indicator for toxic chemical activity was based on the conclusions made by Downey and Hawkins and Grant et.al. The researchers used RSEI score data and demographic data to study correlations. I referred to elements of the study design by Campbell et al. to guide my selection of demographic control variables because the researchers controlled for demographic factors in their research.

I was not able to prove that there was a statistically significant influence between voluntary P2 participation and annual median county RSEI scores in Michigan during 2007 through 2011. In the results of the hierarchical multiple regression analysis, I also found how much influence each demographic control variable had on the dependent variable, median annual RSEI scores. There was a statistically significant relationship or correlation between the demographic variable, average percentage of educational attainment of at least a high school level education, with median annual RSEI scores of TRI-regulated facilities in Michigan counties from 2007 through 2011.

Interpretation of Findings

As noted in Chapter 2, there was limited peer-reviewed research analyzing relationships between Michigan county U.S. EPA toxic chemical data and U.S. Census Bureau demographic data. No studies were found on U.S. EPA voluntary P2 activity and demographic factors in relation to U.S. EPA RSEI scores. Also, no studies were found on

U.S. EPA data on toxic chemical activity and U.S. Census Bureau demographic data for Michigan counties during the time period of 2007 through 2011. Mohai (2002), Mohai and Bryant (1989, 1992a, 1992b), Bryant and Mohai (1992, 2011), and Downey (1998) used 1990 data from the Detroit Area Study, which included data from the Detroit metropolitan area. Mohai was cited as the principle investigator for the 1990 Detroit Area Study (Mohai, 2002). Michigan counties captured in the Detroit Study were Wayne County, Macomb County, and Oakland County.

When the results of the current study were compared with the findings indicated in the 1990 Detroit Area Study (Mohai, 2002), several differences were noted. One difference was the number of counties included in the studies. The present study included a larger number of Michigan counties than the prior Michigan studies mentioned. Other differences noted involved prior research conclusions of environmental inequality involving race based on the 1990 Detroit Study data (Mohai, 2002). In this study, I did not find race to be a contributing factor in the correlation analysis of toxic chemical activity in Michigan counties during the 5-year period, 2007 through 2011.

I found no statistically significant correlation between median annual RSEI scores and race or percentage of non-White or minority population. For example, Michigan counties reporting high RSEI scores also reported high percentages of Whites as well as non-White populations. I also found a large percentage of White populations in Michigan lived in counties with high RSEI scores during the period of 2007 through 2011. No environmental inequality based on race was seen in the results of the current study. As a result, no determination of environmental racism can be made from the findings of the present study.

Research by Bryant and Mohai (1992, 2011), Mohai (1989), and Mohai and Bryant (1992a, 1992b) focused on data from the 1990 Detroit Area Study. The researchers determined that low-income, Black populations in the Detroit area experienced environmental racism. Downey (1998) also used the 1990 Detroit Area Study data in environmental justice research on Michigan. Correlative results were seen by Downey when U.S. EPA TRI data and race data were compared. I could not substantiate the results of these prior studies from my analysis of Michigan county RSEI score data and demographic data for 2007 through 2011. In the prior Michigan studies, scholars focused on limited county data and environmental proximity data from a single time period, 1990. The prior findings of racial inequality involving environmental justice in Michigan and in other parts of the United States cannot be substantiated by the current study.

Various prior environmental justice scholars found relationships between race and unequal environmental justice conditions resulting from toxic chemical exposure when looking at other parts of the United States. Examples of this research were discussed in Chapter 2. For instance, United Church of Christ (1987, 2007) focused on populations next to landfills in Tennessee. Downey and Hawkins (2008) looked at 2000 race and toxic chemical data from a national level. Sicotte and Swanson (2007) addressed race and income in association with environmental justice in Philadelphia, PA. Campbell et al. (2010) looked at ethnicity and income in relation to proximity to new toxic chemical facilities in Arizona. Hite (2000) looked at race and social class relationships near Ohio landfills. Pastor et al. (2006) found a relationship between low income minorities in California and increased risk to toxic chemicals. Even though the geographical focus of these studies did not include Michigan, the researchers provided useful framework that helped me in variable selection, statistical methodology, and environmental justice interpretation.

Additional environmental justice studies focused specifically on the relationship between race and toxic chemical exposure. Norton et al. (2007) found relationships between race, income and proximity to toxic chemicals in North Carolina, Jones and Raney (2006) found a relationship existed between race and chemical exposure in Tennessee. Chakraborty et al. (2011) determined a relationship between race and chemical exposure in Florida. Godsil (1991) analyzed prior research involving race and proximity to landfills in North Carolina, Michigan, and other U.S. states. These researchers all concluded the presence of unequal environmental burden based on minority status. Grant et al. (2010) found an inverse relationship when comparing over 2000 TRI-regulated facility RSEI scores and the associated community race statistics from across the United States in 2002. That study indicated areas with a higher minority population experienced higher RSEI scores (Grant et al., 2010). Blodgett (2006) found relationship between race and toxic chemical exposure when looking at data for St. Parish, Louisiana. Adeola (1994) also found a relationship between race and toxic chemical exposure in Baton Rouge, Louisiana. I could not confirm the findings of a relationship between race and toxic chemical exposure as seen in these prior studies.

Possible explanation of why I did not find racial inequality in my research will be discussed in the next paragraph.

There are several explanations why prior results comparing race and toxic chemical exposure were not consistent with results seen in the current study. The most likely explanations are that the studies are not comparable because different geographical focus and different timeframes were used. Also, variations in the selection of demographic variables and toxic chemical data sets used in the prior could also account for variations seen in study findings and conclusions. For example , I did not use the same U.S. EPA variable, RSEI scores, to illustrate toxic chemical activity as the researchers mentioned earlier in this chapter, aside from Grant et al. (2010) The differences noted when comparing study findings can also be explained and supported through the environmental justice theoretical framework proposed by Bullard (1996).

Bullard (1996) indicated that it was difficult to use prior environmental justice research to generalize results in other geographical locations. Outside factors such as history and culture of the area could play a role in regional differences seen by researchers. These additional variables could often be used to explain variations in environmental justice research conclusions (Bullard, 1996). As a result, Bullard suggested environmental justice researchers should be careful when trying to draw conclusions and generalize results based on prior study findings.

Several researchers came to the same conclusion that I found through my research. The researchers found no significant relationship between race and toxic chemical activity but focused on different timeframes and geographic areas within the

United States. For example, Godsil (2004) found a relationship between toxic chemical exposure and economic variables and did not find a relationship between race and chemical exposure when researching prior environmental justice studies. Yandle and Burton (1996) did not find a relationship between race and toxic chemical exposure in their research involving Texas landfill data from 1990. Bowen et al. (1995) did not find a relationship between race and toxic chemical exposure when examining data for Ohio spanning the time period 1987 through 1990. However, Bowen et al. (1995) found a relationship between population income and toxic chemical exposure. I also found an insignificant relationship between race and toxic chemical activity in my study.

In my study, I also did not find a correlation between county RSEI scores for toxic chemical activity and annual median household income. These results are consistent with the results of Mohai and Bryant (1992a, 1992b). Mohai and Bryant did not find a correlation between income and toxic chemical exposure based on U.S. EPA data for Wayne County, Oakland County, and Macomb County, Michigan from the 1990 Detroit Area Study. However, the researchers did not use RSEI score data as a dependent variable. My conclusions substantiated the results of Mohai and Bryant (1992a, 1992b) in regard to finding no significant correlative effects between income and toxic chemical activity in the selected Michigan counties. When looking further into prior study results, I noted several environmental justice scholars that found a correlation between income and toxic chemical exposure. These studies will be presented in the following paragraph.

When studying the relation between income and toxic chemical activity, I did not find a correlation between median annual RSEI scores and the variable median household income in Michigan during 2007 through 2011. However, several prior researchers analyzed the correlation between income and toxic chemical exposure in other parts of the United States and found correlative results. For example, Downey (1998, 2005, 2006) and Smith (2007) found correlation between income level and exposure to toxic chemical emissions based on data from Detroit and the surrounding area. These researchers concluded that as income decreased, toxic chemical exposure increased in the geographical area of study. Downey used data from the1990 Detroit Area Study while Smith used U.S. EPA data from 1970 through 1990. These time periods were different than the timeframe I selected for my study. Hall and Kerr (1991) found a relationship between low income and higher toxic chemical exposure in the southern region of the United States. Prior studies by Bowen et al. (1995), Sicotte and Swanson (2007), Grant et al. (2010) found a relationship between income and toxic chemical exposure. These researchers found that as income decreased, potential toxic chemical exposure increased in Ohio, Philadelphia, PA, and in various parts of the United States respectively. Blodgett (2006) also found a relationship between low income and high toxic chemical exposure when looking at St. Parish, LA data. I did not find a relationship between income and toxic chemical activity in my study of Michigan counties.

My research incorporated data from counties across Michigan. My selection offered greater demographic diversity when compared to the selection of demographics in prior studies by Mohai and Bryant (1992a, 1992b) that address environmental inequality in Michigan. However, I did not find a significant relationship between income and toxic chemical activity illustrated by RSEI scores. My results indicated that, some

Michigan counties with high median annual RSEI scores reported for their toxic chemical facilities were in areas that reported high average annual household income when compared to other Michigan counties in the study. There were also Michigan counties that reported high RSEI scores and lower average annual house income. One possible explanation for some of the variation in my study findings could be that the chemical-related industry in Michigan counties with higher income produced active employment levels and higher paying manufacturing and technical jobs than counties with lower income levels. Thus, higher household incomes were reported in those areas. I saw no evidence of environmental inequality based on income level in my study. However, further research is suggested in order to substantiate that point.

Analysis of the third relationship involving demographic variables in my study that will be discussed is the relationship between educational attainment and toxic chemical activity as seen through median annual RSEI scores in the county. Prior research by Blodgett (2006) found relationships between lower educational attainment and higher toxic chemical exposure when looking at St. Parish, Louisiana. I also found a relationship between lower educational attainment and higher toxic chemical activity in my study. Thus, my study substantiates the relationship between education and toxic chemical exposure that Blodgett (2006) reported.

Lastly, prior studies that incorporated RSEI scores as a dependent variable and as an indicator for toxic environmental exposure will be discussed. My study used median annual RSEI scores as a dependent variable and also as an indicator for toxic chemical activity in Michigan. Prior studies by Grant et al. (2010), Sicotte and Swanson (2007), and Downey and Hawkins (2008) also used RSEI scores as a dependent variable and an indicator of toxic chemical exposure in the United States. These studies were described earlier in the chapter and all found a correlation between RSEI scores and several demographic variables associated with the communities facing high toxic chemical exposure. This point is consistent with the findings of my study.

As discussed, environmental justice scholars analyzed the influence of income, educational attainment, and race on toxic chemical release data in various parts of the United States. However, the prior results could not be used to generalize conditions in Michigan during the time frame of the current study. External influences such as differences resulting from regional factors, historical factors, and economic situations of the alternate periods could play an effect and influence study results (Bullard, 1996).

My study also supported the view of Mohai and Saha (2006) and Mohai and Bryant (1992a, 1992b), Grant et al. (2010), and the environmental justice framework of Bullard (1996) that stated environmental justice data cannot be generalized because strong influences from historical and regional factors in the area may account for results seen in environmental justice research. Bullard's framework applies to my study. Consideration of historical and regional factors in the Michigan counties included in the study is necessary when making any type of conclusion regarding environmental justice. Swift conclusions of environmental justice issues based on the correlations found in my study cannot be made. Further research to investigate this suggestion is warranted.

When looking at the conceptual framework of voluntary environmental responsibility as stated in Chapters 1 and 2, voluntary environmental responsibility was defined as an example of corporate social responsibility (Pava, 2008; Rahman & Post, 2012; Shum & Yam, 2011; Wirth, Chi, & Young, 2010). Government sponsored voluntary environmental programs such as voluntary P2 participation were put into place as a way for industry to practice voluntary environmental responsibility (Videras & Alberini, 2000; Khanna & Damon, 1999). However, as indicated in Chapter 2, prior studies by Dawson and Segerson (2008), Lyon and Maxwell (2007), Khanna and Damon (1999), Khanna et al., (2009), Brouhl et al. (2009), and Alberini and Segerson (2002) questioned the real value and effectiveness of voluntary environmental programs. I also found statistically insignificant findings when analyzing voluntary P2 participation in my research. My inconclusive finding and my findings showing a lack of participation of industry in Michigan also cause me to question the effectiveness of voluntary environmental programs.

In my study, I determined that voluntary P2 participation was not a statistically significant indicator of median annual RSEI scores. This finding was somewhat surprising because both study variables addressed the same TRI-regulated facilities and the facilities' associated toxic chemical activity. I expected to see some type of correlation between the variables. However, when statistical analysis was performed, only a negative, statistically insignificant correlation between the variables, voluntary P2 participation and median annual RSEI scores, was seen.

My research illustrated that annual voluntary P2 participation by the TRI facilities in the Michigan counties was quite low. I found that from 2007 to 2011, the annual voluntary P2 participation rate of Michigan toxic chemical companies registered in the P2 program was less than 13%. If voluntary P2 activity was meant to represent positive voluntary environmental responsibility by the chemical industry, then participation in the U.S. EPA's voluntary P2 program by chemical-related facilities in Michigan counties during 2007 through 2011 was marginal at best.

Voluntary environmental responsibility offered solid framework for the current study. The framework helped me to define the role of the variable, voluntary P2 participation in the current research. However, any conclusions regarding the level of positive or negative corporate environmental responsibility in Michigan, or conclusions regarding the level of social responsibility by chemical-related industry in Michigan cannot be made from the results of current study. After I disseminate the results of this study the hope is that the current study will increase overall awareness of the underutilization of voluntary P2 activity by chemical-related industry in Michigan counties. One positive outcome of this research is that policy makers will become aware of the low P2 participation levels. That awareness should then prompt researchers to further investigate the causes of the low voluntary P2 participation of chemical-related industry in the state. Perhaps better promotion of the voluntary P2 program would help draw the attention of policy makers and the public to question the lack of voluntary P2 activity in the state. The added awareness could then lead to lobbying efforts to push for improvement of the U.S. EPA's voluntary P2 program. Further investigation into why the participation levels are so low would ultimately benefit the public. Actions to reduce the adverse effects of toxic chemical activity as seen through voluntary environmental efforts such as voluntary P2 participation by industry help to protect the public and help to promote positive environmental well-being. More attention must be drawn to that subject.

Limitations of Study

In this study, I analyzed U.S EPA data and U.S. Census Bureau data from 2007 through 2011for Michigan counties with populations greater than 100,000 inhabitants. Based on the results of the statistical analysis of the data, the statistical significance of the overall multiple regression model was represented by the statistically significant *F* statistic discussed in detail in Chapter 4. The significance I found in the *F* statistic of the model indicated that the regression model very well could be used to generalize RSEI, voluntary P2 activity, and demographic factor relationships in other counties in Michigan during the time period spanning 2007 through 2011. However, I did not have enough statistical evidence to indicate the current statistical model could be used to generalize conditions for other time periods and for other areas outside of Michigan. These limitations will be discussed in the next paragraph.

One limitation noted in this study was the fact there was not enough evidence generated from this study to suggest my hierarchical multiple regression model could generalize conditions in Michigan outside of the time frame of this study with statistical success. There is the possibility that external conditions such as historical factors or regional economics could create problems if attempts were made to use the models to general results beyond Michigan. Such variables may have played a role in influencing the findings of the study. The concern over limitations to generalization of data and test results are consistent with the current study's theoretical framework of environmental justice presented by Bullard (1996).

The study's theoretical framework included environmental justice theory by Bullard (1996). Bullard's theory stressed that unwarranted generalizations of results by environmental justice researchers often lead to erroneous conclusions. Variables such as local influences and outside historical events could have important, but isolated impact on environmental justice outcome (Bullard, 1996). These points were noted in prior research by Downey and Hawkins (2008), Downey (2005), and Mohai and Bryant (1992a, 1992b) who all commented that regional and historical circumstances relating to local economics, regional housing trends, and community culture in the Michigan counties may have played a role in their environmental justice research finding based on the 1990 Detroit Area Study. The researchers also suggested that these outside influences prevented researchers from generalizing results in other locations. The same limitation holds true for this study.

Another limitation of my study was the fact that, based on statistical analysis, the research hypothesis that voluntary P2 activity significantly influenced the dependent variable, median annual RSEI scores of TRI-regulated facilities in Michigan counties during the period 2007 through 2011 could not be accepted. However, the only significant correlation seen in the model was between the demographic variable, annual percentage of educational attainment of a high school level education and the dependent variable, median annual RSEI scores. Further investigation is needed to attempt to prove or disprove that point.

Recommendations

Study findings did not indicate a correlation between the independent variable, voluntary P2 participation and median annual county RSEI scores. Further research could determine why this was the case. However, further investigation is needed regarding my study finding of the negative correlation between educational attainment and toxic chemical health risk as seen through U.S. EPA RSEI scores in Michigan counties. Counties with high RSEI scores were found to have lower percentages of educational attainment of a high school level education than counties than Michigan counties with lower RSEI scores. Within the scope of this study, high RSEI scores indicated high health risk associated with toxic chemicals in the county. This point leads to potential concern regarding the level of public awareness and understanding of toxic chemical activity in the counties with low educational attainment levels.

It is uncertain whether the differences between counties with high and low RSEI scores can be characterized an environmental inequality based solely on the results of my research. There is also not enough evidence from my study to indicate the results constitute environmental injustice findings. However, the study findings elevate this level of concern. This concern warrants the need for further investigation the possibility of environmental justice inequality facing the residents of Michigan counties with low educational attainment and toxic chemical activity as seen through high RSEI scores.

Information surrounding toxic chemicals is scientific in nature and can be difficult to interpret. The U.S. EPA offers extensive data in its website. However, the site is not user-friendly, and data were not easy to find. Once the data were located, the information can be challenging to understand, especially for the non-scientist. Based on that idea, it is suggested that the general public would have a difficult time understanding many of the U.S. EPA datasets that describe toxic chemical activity, including datasets used in this study. That point then draws concern surrounding the level of public awareness of toxic chemical information in counties with lower educational attainment levels because the current study found high levels of toxic chemical activity indicated by high RSEI scores. The potential for environmental justice concerns cannot be ignored. This information can be disseminated to public policymakers so they can gain understanding of the study findings and concerns.

In terms of environmental justice policy, policymakers and the public also need to have a reasonable understanding of the issues surrounding toxic chemical activity in their towns, counties and state so they can make informed decisions on how to better protect the public through modified public policy measures. Simms (2012) commented,

> At its most basic level, the greatest challenge of environmental justice implementation is ensuring that lawmakers, policymakers, and implementing officials recognize that the legitimacy of the concerns voiced by affected communities and make the appropriate inquiries before committing internal institutional resources toward a particular objective (p. 17).

This statement also means that the public needs to understand the issues and possible environmental inequality facing them and needs to have the appropriate tools to be able to ask right questions. If the public cannot understand or is not aware of potential hazards associated with the toxic chemicals in their counties, how can they protect themselves from toxic chemical risk? At that point, the policymakers need to step in and must have a good overall understanding of the problem and need to be able to make educated and appropriate policy decisions.

There are several recommendations that can be made based on the findings of this study. One recommendation is to expand the current study to include all of the counties in Michigan and also include other parts of the United States. In addition it would be of benefit to include a longer time period such as from 2005 through 2015 in order to expand the set of data used in the study. This suggested time period would also cover more recent data than prior environmental justice studies of the region. More data would be captured with the intent to create a more robust study. The broader focus provides a more in depth understanding of the relationship between toxic chemical activity and Michigan county demographic factors. Because the current study did not address causality, further research is necessary in order to understand why RSEI scores and voluntary P2 participation are not significantly correlated. Further study can also help determine if additional demographic factors correlate with RSEI scores. It is also suggested that additional dependent variables representing toxic chemical activity be investigated to see if there is better correlation with voluntary P2 participation and demographic factors.

Further research looking into relationship between RSEI scores of toxic chemical facilities and educational attainment in Michigan counties could lead to more insight surrounding community awareness of the conditions associated with toxic chemical activity where they live. That research could investigate the level of understanding the public has regarding toxic chemical activity in their neighborhoods. Research looking into possible causes of this phenomenon could be warranted. This thought is expanded in the next paragraph.

The current study was quantitative in nature. However, much could be learned from a qualitative study that incorporates public opinion data and data addressing public awareness of industry's toxic chemical activity. Results from such a study could then be used to see if there is a relationship between the public opinion and awareness datasets and educational level and RSEI scores in Michigan. This suggested research would capture broad ranges of demographic diversity and toxic chemical activity in the state. The use of public involvement in research is said to be very important. In environmental justice research Wing et al. (2008) indicated "community-based participatory research can promote action-oriented responses to research finding. Study participants gain confidence and a greater sense of legitimacy" (p. 1396). The qualitative research could also compare public perception of toxic chemical activity and awareness between Michigan counties. This comparison could then expand the understanding possible environmental inequality seen with the correlation between Michigan counties with low educational attainment levels of a high school level education and high RSEI scores seen in the current study.

Lastly, further research regarding public educational needs for improved transparency of information on environmental quality and toxic chemical activity in Michigan could determine if additional public outreach is needed. The research findings of this study do not warrant an interpretation of environmental injustice in Michigan communities at this time even though some inequalities were seen. This is an area for further investigation.

Implications

There are several implications for social change that result from this study. Results of this study can be disseminated and used to promote public and policymaker awareness of potential differences in Michigan county educational attainment levels in areas with high reported toxic chemical activity as seen through U.S. EPA RSEI scores. If there is higher toxic chemical activity in counties with lower educational attainment levels, there might be concern of environmental inequality and potential injustice that must be investigated in more detail. It is important to get a better understanding of what is happening in these counties. This can be achieved by performing further studies involving environmental justice in Michigan counties.

It is also important for the public and for environmental justice researchers to be able to provide enough information to the policymakers so they can make informed decisions and address the issue accurately. There could be potential concern that the inhabitants of counties with low educational attainment and high toxic chemical activity are exposed to unequal environmental burden than other counties and may not be adequately informed or aware of the environmental conditions in their area. These individuals might be disadvantaged because they do not have the tools to investigate and understand the conditions in their counties. These individuals also may not be as well informed as inhabitants in other counties.

This finding could warrant the need for enhanced public policy to expand public awareness programs regarding toxic chemical activity in Michigan counties. By creating programs to enhance public awareness of toxic chemicals in their neighborhoods, programs to increase public awareness of their environmental rights could be implemented in Michigan and expanded to other parts of the country. Programs such as open public discussion forums at county meetings are examples. These informational sessions could provide the public with tips on how to find and access environmental information about their communities and how to interpret the information found on the government websites. The suggestion for expanded public awareness programs and better transparency of information on toxic chemical can lead to positive social change in these counties and empower the public to better advocate for their environmental rights and help promote policy change when necessary.

In my research, I found high RSEI scores in areas with lower educational attainment and lower voluntary P2 activity. My findings indicated that only 3 to 12.5 % of the TRI-regulated facilities in Michigan counties participated in voluntary P2 activities between 2007 through 2011. Those percentages are much lower than expected. Additional research is needed to understand why the percentage of voluntary P2 participation in Michigan counties is so low. One recommendation is for the U.S. government to put more pressure on TRI registered facilities to participate in voluntary P2 activities. The participation could help reduce toxic chemical volumes and overall RSEI scores in the counties. Also, TRI facilities should be required to report their voluntary P2 participation measures in a more transparent way. The information is available on the U.S. EPA's website, but is hard to find. Increased transparency could also make it easier for the public in all counties to access this information. Modifications to the government's website and enhanced transparency of understandable information for the public could be implemented by United States policymakers.

One way to improve voluntary P2 participation of industry would be for the government to allow chemical companies to report specific measures taken to improve the transparency of chemical information to the public as voluntary P2 activity. Also, measures to promote more transparent public education and outreach by chemical industry should be recognized as a positive, voluntary P2 activity and promoted as such by the U.S. government. That step could help foster social change to enhance public awareness surrounding toxic chemical activity in Michigan counties and in other parts of the United States. These measures represent positive steps to help reduce and perhaps eventually eliminate threats of unequal environmental burden in Michigan. These steps can also help improve public understanding associated with toxic chemical activity in all counties of Michigan and in other parts of the United States.

Conclusions

Environmental justice research that focuses on communities throughout the United States is abundant. However, research involving the relationships between toxic chemical activities of chemical-related industry and demographic statistics in Michigan counties is not plentiful. Prior environmental justice research limitations that included narrow geographical focus and limited study timeframes did not allow past findings in

Michigan and other parts of the United States to be used to generalize current study results.

In this study, I utilized U.S. EPA and U.S. Census Bureau data from Michigan counties with over 100,000 inhabitants during the time period of 2007 through 2011. Twenty counties were included in the study. I concluded that voluntaryP2 activity of chemical-related industry in Michigan counties did not significantly influence toxic chemical health risk scores, represented by U.S. EPA's RSEI scores, after controlling for county demographic factors during the time period of 2007 through 2011. The null hypothesis that there was no statistically significant influence of voluntary P2 activity on the toxic chemical health risk scores, represented by U.S. EPA's RSEI scores of chemical-related industry in Michigan counties, after controlling county demographic factors was found to be true and was not rejected. Even though the correlation was not significant, a trend was seen where counties reporting low voluntary P2 participation reported high median RSEI scores. I also discovered that a low percentage of TRI-regulated facilities in Michigan reported annual participation in voluntary P2 activities during 2007 through 2011.

Correlations between additional study variables were also studied. I did not find a correlation between the dependent variable, median annual RSEI scores, or the percentage of non-White or minority inhabitants in the Michigan counties included in the study. High and low RSEI scores were reported in areas where both non-White and minority populations lived in Michigan counties. I determined there was no differentiation of RSEI scores based on race. There also was no evidence suggesting environmental racism. A significantly statistic correlation was seen between RSEI scores and average educational attainment in the Michigan counties between 2007 and 2011. Counties reporting high RSEI scores had lower average educational attainment than counties reporting low RSEI scores. That finding supported prior research. Lastly, an insignificant correlation was seen between median annual RSEI counties and average household income. High RSEI scores were reported in counties with high average household annual income as well as counties with low average household annual income. That finding did not support prior environmental justice research that focused on other parts of the United States during different time periods.

The contribution of regional and historical factors was also presented in the current study's theoretical framework as represented by Bullard's (1996) environmental justice theory. Even though environmental inequality was seen when comparing Michigan county educational attainment levels and median annual RSEI scores, claims of environmental injustice cannot be made based on the results of this study. More research is warranted before that determination can be considered.

The results of this study can be used to fill gaps seen in environmental justice research involving Michigan. These gaps can be filled in several ways. First, the current study covered a more contemporary timeframe that previous studies noted in the literature review. Next, in this study, I analyzed two variables representing toxic chemical activity, voluntary pollution prevention activity and RSEI scores that were not compared in prior studies. Then, I looked at correlation between RSEI scores and demographic factors in Michigan counties. Even though I determined that my research hypothesis that there was a significant correlation between voluntary P2 participation and toxic chemical risk as represented by RSEI scores was not valid, I uncovered other correlative affects. I uncovered an interesting finding that illustrated populations with a lower percentage of educational attainment in lived in Michigan counties reporting high RSEI scores during the time period of 2007 through 2011. This finding represented a statically significant correlation between the dependent variable, median annual RSEI score, and the percentage of educational attainment of a high school level education in the Michigan counties studied.

The results of this study can be disseminated so they can be used as a platform to inspire further research involving environmental justice in Michigan. I determined there were higher RSEI scores or higher hazard chemical risk in less educated counties in Michigan during the time period of 2007 through 2011. These results are concerning. These points could mean these individuals have the potential of being exposed to more toxic chemical risk. These individuals also might have less understanding of the toxic chemical hazards they may face due to limitations involved with their level of education levels when compared to other counties in Michigan. Further research expanding the timeframe and scope of the counties could help generate further data to confirm study findings. Also further study looking at the level of public awareness and public perception regarding toxic chemicals in counties in relation to educational attainment and RSEI scores could expand the understanding of environmental injustice conditions in Michigan.

This study draws attention to the possibility of unequal environmental burden in Michigan resulting from the effects of high toxic chemical risk and activity in communities that are less educated. The study also helps establish the initial conversation with policymakers regarding the need for social change surrounding the enhancement of public education and awareness programs relating to toxic chemicals. The policymakers can implement social change by enhancing public education to promote easy to access toxic chemical information more transparent data provided by industry and government information more easy for everyone to understand. This suggested step would allow for less informed individuals to become more educated and empowered with the knowledge gained by understanding their risks associated with toxic chemical activity in their neighborhoods.

Another suggestion stemming from the results of this study is to put enhanced policy in place to improve industry participation in the U.S. EPA's voluntary P2 program. Results of this study indicated low levels of annual activity in the Michigan counties. One suggestion to improve voluntary P2 participation is to add public educational outreach programs as voluntary P2 activity as a requirement for chemical-related industry. This approach not only proposes to increate voluntary P2 participation reporting levels, but also helps enhance public education regarding toxic chemical information. It is also suggested that policymakers look at the possibility of incorporating incentives for industry participation improvement in the voluntary P2 program.

When it comes to environmental justice issues, the overall goals of policymakers should be to make sure the public is adequately protected from risk and exposure associated with toxic chemicals and to make sure their rights are not compromised. In regard to toxic chemicals, the public policymakers must also strive to promote and protect public health initiatives that reduce the risk associated from industrial toxic chemical activity. This protection includes making sure all inhabitants have the right resources and tools to understand their legal rights under environmental justice guidelines. If unequal environmental burden is suspected, the public must be able to communicate those concerns to policymakers and to officials so that policy and social changes can be appropriately implemented. Without this empowerment and active voice, the public's environmental inequality concerns will not be heard. The importance of active participation of the public, industry, and the policymakers to promote positive environmental justice measures through the elimination of unequal environmental burden is a universal theme that applies not only to the United States, but also to countries across the world.

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Appendix A: Michigan County U.S. EPA and U.S. Census Data 2007-2011

County and Year	Median annual county RSEI score	% Average annual county P2 participation	Race: % non - White or minority	Median annual household income	% Educational attainment of high school level
012007	0	9.52	8.20	50,730	37.6
012008	1	14.29	7.20	49,201	38.0
012009	0	9.52	7.70	50,316	37.8
012010	0	9.52	6.00	44,847	42.2
012011	0	9.52	5.50	50,508	39.6
022007	14	0.00	5.70	42,375	37.4
022008	13	0.00	5.60	45,913	33.9
022009	11	4.76	6.20	44,029	36.0
022010	14	0.00	2.50	45,451	33.1
022011	13	9.52	2.60	43,361	33.9
032007	41	7.46	19.80	42,079	33.0
032008	41	4.48	20.70	42,512	30.3
032009	6	8.96	19.70	39,508	31.0
032010	37	2.99	21.90	40,329	33.1
032011	21	4.48	21.90	40,831	32.2
042007	1	13.21	15.60	41,150	36.3
042008	1	11.32	15.80	41,181	35.7
042009	0	15.09	15.50	38,507	31.8
042010	0	13.21	17.20	42,921	35.3
042011	0	9.43	16.40	38,666	37.3
052007	3	5.00	11.70	50,384	32.7
052008	15	5.00	10.90	57,335	28.9

(*table continues*)

052009	9	10.00	11.70	51,167	28.7
052010	56	10.00	11.50	52,042	31.1
052011	58	10.00	12.20	50,822	30.4
062007	18	4.76	24.00	43,112	34.6
062008	114	4.76	23.40	44,611	34.4
062009	50	9.52	23.80	41,382	33.1
062010	80	9.52	24.90	38,819	33.1
062011	0	7.14	25.40	40,843	34.6
072007	5	2.22	21.10	45,204	24.0
072008	10	8.89	20.30	45287	24.2
072009	5	6.67	20.20	42,469	24.5
072010	9	6.67	23.40	43,171	21.3
072011	10	11.11	23.70	42,047	22.2
082007	4	13.89	12.2	43,428	37.7
082008	130	8.33	11.3	46,896	37.8
082009	5	11.11	11.8	46,650	31.5
082010	13	11.11	12.4	42,862	33.0
082011	7	8.33	11.9	41,686	35.5
092007	4	4.48	16.5	43,861	25.4
092008	5	4.48	16.0	46,432	25.5
092009	0	5.97	16.4	41,339	25.8
092010	0	5.97	17.2	43,419	25.4
092011	0	4.48	18.1	45,502	24.2
102007	19	10.10	18.8	49,354	27.8

(*table continues*)

102008	16	9.13	18.6	50,530	26.7
102009	11	6.73	16.3	47,485	26.7
102010	13	6.25	17.5	47,781	27.9
102011	16	8.17	17.9	50,712	27.7
112007	3	6.67	3.7	70,735	27.2
112008	3	11.11	4.0	71,486	27.9
112009	6	6.67	3.9	67,296	26.3
112010	24	4.44	3.3	65,197	28.6
112011	17	6.67	3.5	67,441	27.1
122007	34	6.54	12.4	55,101	33.1
122008	78	7.19	13.1	55,399	31.0
122009	66	3.92	13.3	50,553	32.3
122010	50	3.27	14.9	49,160	31.7
122011	201	5.88	15.5	50,891	32.1
132007	303	6.25	5.9	53,750	38.9
132008	401	6.25	5.2	57,157	40.5
132009	11	3.13	5.7	52,824	37.7
132010	58	0.00	5.1	50,034	34.8
132011	20	0.00	5.6	53,744	37.2
142007	152	1.43	18.7	39,099	36.6
142008	124	7.14	18.6	40,827	36.0
142009	40	4.29	18.9	38,274	36.5
142010	96	5.71	19.6	38,621	35.9
142011	86	5.71	19.2	37,626	34.6

(*table continues*)

152007	28	7.25	20.4	66,483	22.8
152008	5	7.25	20.7	67,518	21.0
152009	4	5.70	20.7	62,308	20.8
152010	3	5.70	22.3	60,266	20.3
152011	16	5.70	22.7	61,888	21.5
162007	1	4.67	10.7	53,881	32.6
162008	1	6.54	10.8	55,459	31.9
162009	0	7.48	9.3	51,047	30.5
162010	1	4.67	11.0	53,056	31.2
162011	0	10.28	10.5	53,553	28.5
172007	8	3.70	23.4	43,051	36.9
172008	74	3.70	23.7	41,441	35.3
172009	12	11.11	23.7	39,200	35.4
172010	25	3.70	24.8	41,938	36.4
172011	8	0.00	23.8	40,434	34.5
182007	20	3.77	5.3	45,873	37.2
182008	3	0.00	5.5	45,377	35.9
182009	6	1.89	5.4	45,377	38.6
182010	6	1.89	6.0	44,369	37.3
182011	2	7.55	6.6	45,676	36.9
192007	25	11.11	24.8	61,049	18.2
192008	16	12.96	24.3	57,848	15.7
192009	16	11.11	23.3	54,603	16.4
192010	24	5.56	26.0	55,880	16.6

(*table continues*)

192011	16	7.41	25.3	56,612	16.0
202007	46	7.59	47.5	42,470	33.4
202008	70	7.59	47.1	42,376	32.6
202009	61	8.12	46.8	38,192	31.9
202010	162	6.81	47.6	39,408	31.0
202011	68	7.85	46.9	38,479	30.6

Appendix B: Figures and Table

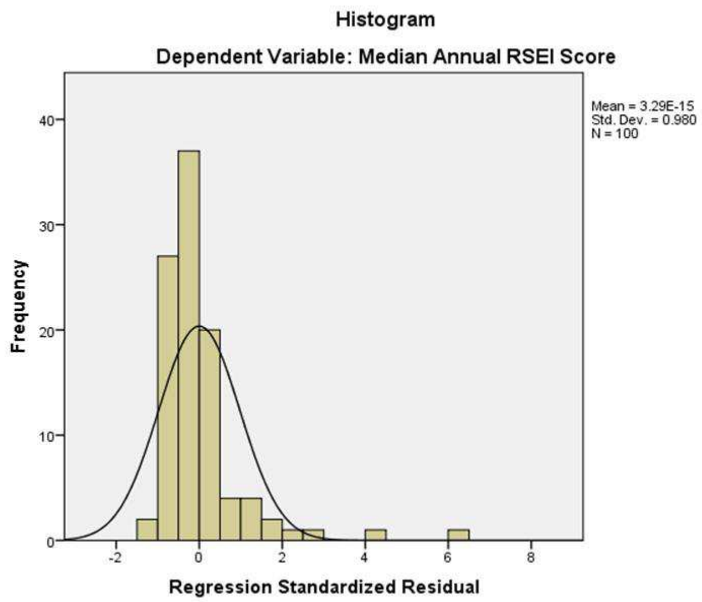

Figure B1. Histogram regression standardized residual

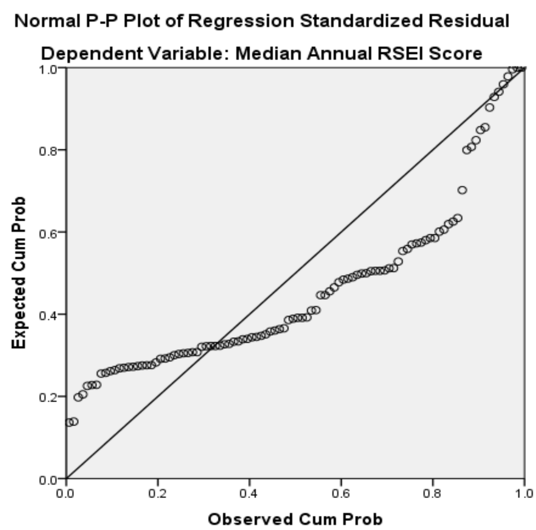

Figure B2. Normal P-P plot of regression standardized residual

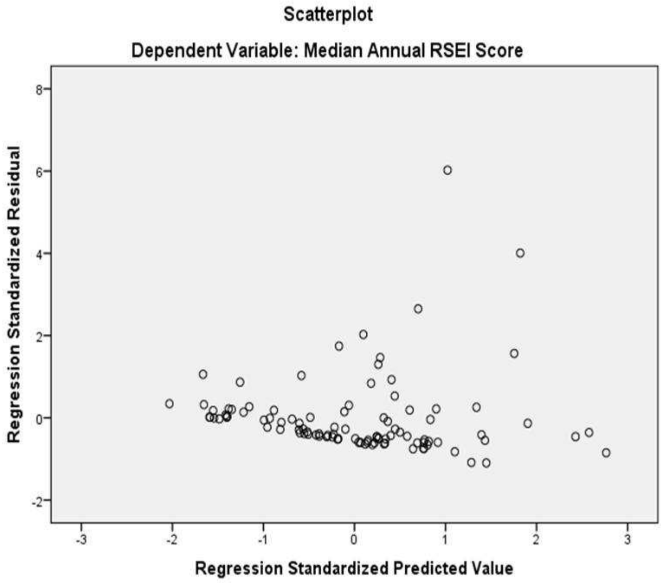

Figure B3. Scatter plot regression standardized residual versus regression standardized predicted value

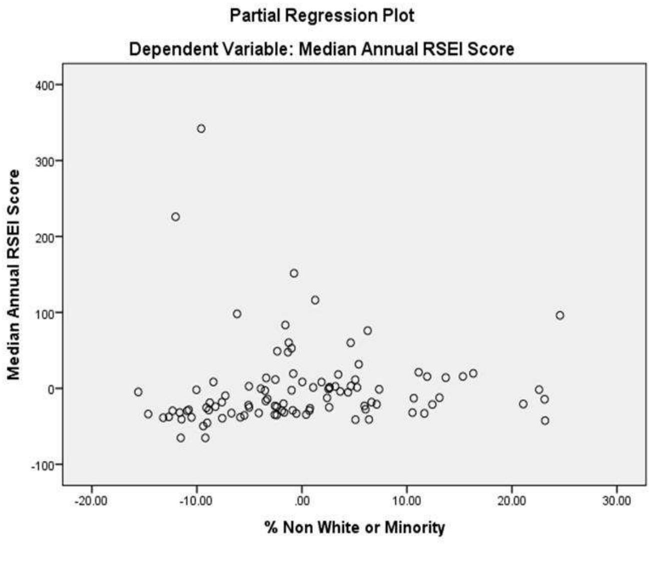

Figure B4. Partial regression median annual RSEI score versus % non-White or Minority

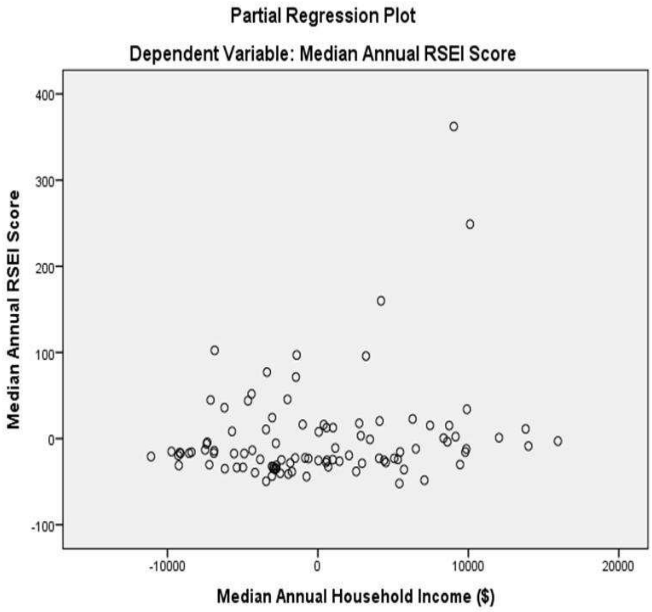

Figure B5. Partial regression median annual RSEI score versus median annual household income

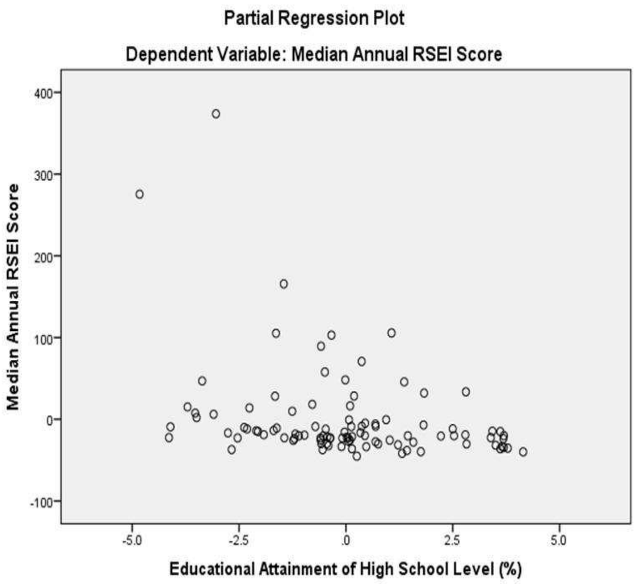

Figure B6. Partial regression median annual RSEI score versus % educational attainment

Table B1

Unstandardized and Standardized Coefficients for B and Beta, Confidence Interval, and Collinearity Statistics

Model	Coefficients					Correlation		Collinearity Statistics	
	Unstandardized		Standardized						
	B	*SE B*	*β*	*t*	*p*	*Partial*	*Part*	*Tolerance*	*VIF*
1[a]									
(Constant)	815.25	226.16		3.61	.00				
Race: % non-White or minority	.19	.63	.031	.298	.77	.03	.03	.84	1.19
Median annual household income ($)	.002	.001	.27	2.11	.038	.21	.20	.56	1.77
Educational attainment of high school level (%)	-9.85	2.77	-.46	-3.56	.001	-.34	-.34	.55	1.80
2									
(Constant)	800.44	227.26		3.52	.001				
Race: % non-White or minority	.27	.64	.04	.42	.68	.04	.040	.82	1.22
Median Annual Household Income ($)	.002	.001	.266	2.09	.039	.210	.200	.56	1.78
Educational Attainment of High School Level (%)	-9.59	2.79	-.44	-3.43	.001	-.33	-.33	.55	1.83
Average Annual County P2 Participation (% facilities participating)	-1.39	1.70	-.08	-.82	.42	-.08	-.08	.97	1.03

Note. [a]Control variables included Race: % non-White or minority, Median annual household income, and % Educational attainment of high school level.
N = 100.