

Socio-Economic and Environmental Factors Affecting Respiratory Cancer Rates: Texas Public Health Region 6 and 5-South

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Introduction

Many different factors can cause respiratory cancer, ranging from pollution from automobiles and large industries, behavioral patterns such as cigarette smoking and other substance abuse and, genetic make-up, which include ethnicity/race and or inherited genetics over several generations. Cancer is a major cause of death and illness in Texas. One in three residents are expected to develop cancer in his or her lifetime. By cancer of the respiratory system we are referring to: cancer of the trachea, bronchus, and lung. Public health is normally affected by three general factors, those are: 1.) Socio-economic factors (race, income level, age, etc.), 2.) Behavioral patterns (i.e. smoking, exercise, etc.) and, 3.) Environmental factors (i.e. air pollution, water quality, etc.). Due to the geographic location of Public Health Region 6 and 5-South there should be some interesting observations made on the issue of environmental justice in this area.

Environmental justice is to make sure that no particular groups of people are exposed, either deliberately or by circumstances to a nation's or county's pollution. One of the most telling solutions to the problem of environmental justice/injustice is by means of the Toxic Release Inventory (TRI). The TRI provides a consensus of health related risks due to the release and

exposure of toxic chemicals from industrial sites (Tiefenbacher et al. 1997). Statistical and visual observations of TRI along with aggregate number of motor vehicles (a major contributor to air pollution), socio-economic factors, such as race, median income and, respiratory cancer rates per county, along with the use of GIS (Geographic Information Systems) will determine if the presence of TRI sites and vehicle emissions influences the respiratory cancer mortality rate for Public Health Region 6 and 5-South. GIS is of great benefit to the research and location at or near hazardous chemical emitting sites because the researcher is able to create buffer zones around the lines or points that represent hazardous chemical emitting sites. The disease incidence data can then be merged with these buffer zones to determine how much or how little of the incidence rates fall within the buffer.

Cancer mortality rates will be higher in counties due to the direct relation of the number of TRI sites located within each county. And, environmental justice/injustice will be a larger issue in counties where minority populations are greater. Specifically, this research will 1.) Identify TRI sites within each county, 2.) Establish a correlation between the number of TRI sites and respiratory cancer mortality, 3.) Determine the percent of the population by race/ethnicity located within certain distances around TRI sites, 4.) Establish the average median income level by race/ethnicity that is located within certain distances around TRI sites and, finally 5.) Establish a relationship between TRI sites, race/ethnicity, median income levels and, cancer mortality cases. Due to the fact that more people are moving into urban areas it is important to determine what populations are affected by high concentrations of air pollution and whether there is the possibility for environmental justice being an issue.

Review of Literature

Air Quality and Respiratory Cancer

One of the leading issues of concern, presently and, in decades to come in the U.S. and globally, is air pollution. This can be observed in most of the larger cities, due to excessive emissions from automobiles, and also in industrial districts where smokestacks pump out large amounts of toxins annually but there is more than meets the eye (Kubasek et al. 1997). There are variations of the impacts that air quality takes part. Urban planning, distribution of the general population and, the location of industrial activity increases or decreases a communities risk of suffering from the release of toxic emissions (Tiefenbacher et al. 1997). There are several other, more specific, factors that decide an areas risk or “danger potential” due to the release of airborne toxic emissions and, they are the distance of polluting industrial sites in relation to the population, the amount of toxins these sites release into the air and, certain socio-economic characteristics of the population (Tiefenbacher et al. 1997).

Some of the main constituents, or chemicals, that are present in toxic emissions are: Sulfur dioxide, (SO₂), which causes lung and respiratory tract damage and contributes to acid rain, which damages trees and vegetation, buildings, and aquatic life. Sulfur dioxide comes from the burning of fossil fuels to generate electricity in which the U.S. relies on for most of its energy needs. Nitrogen Oxides, (NO₂), also contributes to acid rain and, also smog. Nitrogen oxide is largely created by automobiles and, is also found, in substantial amounts, in industrial emissions. Carbon monoxide, (CO), replaces oxygen in the bloodstream, causing angina, impaired vision, poor coordination, and lack of alertness. It also contributes to the formation of ozone and, is created by the incomplete burning of fossil fuels in automobiles. People with heart and lung problems are more severely affected by carbon monoxide in the air. Ozone is created when

nitrogen dioxide reacts with oxygen in the presence of sunlight and, is directly influenced by the amount of industrial activity.

Race/Ethnicity and Respiratory Cancer

Despite major technological and social accomplishments disparities in disease and mortality rates are still a huge concern for policy makers, health care providers and, the general public. This is clearly evident in the ratio between white and black mortality rates for certain diseases and health related issues. This is one of the key factors when determining whether certain populations are victims of environmental injustice. Among African-American males, lung cancer is the leading cause of death, despite small declines from 1973 – 1991 of lung cancer incidence and mortality rates among African-American males and females. Since 1991, rates of lung cancer and rates of lung cancer mortality have increased (Texas Department of Health 1999).

Unless certain actions are taken immediately, such as improvements in prevention, early detection and, treatment, the rate of cancer mortality will increase due to the aging of the general population (Texas Cancer Council 2000). Certain social factors, along with race/ethnicity, such as economic status and location of TRI sites are directly related to environmental justice/injustice due to the geographic distribution of these specific variables.

Methodology

Our study area is defined by Public Health Region 6 and 5-South (Figure 1) and includes the following counties:

- | | |
|--------------|-------------|
| ? Walker | ? Brazoria |
| ? Montgomery | ? Galveston |
| ? Waller | ? Chambers |
| ? Hardin | ? Liberty |
| ? Jefferson | ? Harris |
| ? Wharton | ? Fort Bend |
| ? Matagorda | ? Orange |
| ? Colorado | |

Public Health Region 6 and 5-South is in southeastern Texas and is bordered by the Gulf of Mexico to the south and, Louisiana borders Orange county to the east. This region mostly lies within the Gulf Coastal Plain predominately dominated by thick vegetation and marshy bogs (bayous).

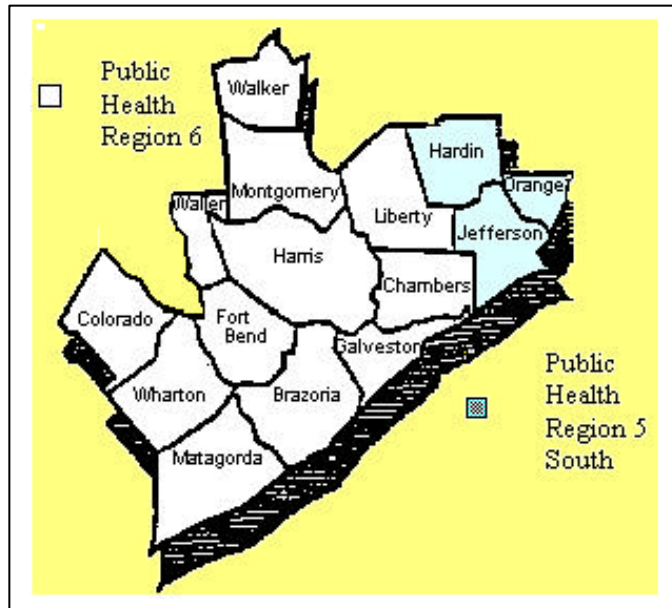


Figure 1. Counties within Public Health Region 6 and 5 South (Texas Department of Health 2001).

We chose this area to conduct our research for several reasons. One of the main reasons is the fact that most of it is urban (large population) and, it is a stronghold for the processing and refinement of fossil fuels. Another reason is because of the amount of industries that are related to the shipment of large amounts of raw materials that come in through the Houston ship channel

and, also the varying concentration of the geographic location of these industrial sites. Earlier research by (Tiefenbacher et al. 1997) concluded that Harris, Jefferson, Brazoria, and Galveston counties reported the highest quantities of toxic emissions in Texas and accounted for 52 percent of the total toxic air emissions in 1990. Counties such as Montgomery and Fort Bend due to their location (hazardous neighboring counties) tend to be exposed to high toxic releases.

Statistical analysis along with the application of GIS, were used to measure and observe trends in respiratory cancer mortality. Statistically, correlation and regression analysis were performed on the variables to determine whether factors had a direct relationship between each other and, how much the independent variables explain the dependent variable. In terms of GIS, coverage's of the counties included in the research with demographic data (1990) included were analyzed along with coverage's that included TRI sites and buffers around the TRI sites in increments of 1 mile and 500 feet (Figure 2). Coverage's of the counties along with demographic data were obtained from Environmental Systems Research Institute, Inc. (ESRI). Toxic Release Inventory (TRI) coverage's were obtained from the U.S. Environmental Protection Agencies (EPA) Toxic Release Inventory. Cancer of the respiratory system (trachea, bronchus, and lung) data (1995 – 1998 death rate (per 100,000)) was extracted from the Texas Department of Health, “Epigram TX”, database. Rates of cancer death are classified by underlying cause and, by place of residence. Respiratory cancer data came standardized to the 1970 U.S. population. According to the T.D.H., cancer data are reported from a number of sources including hospitals, hospital-based tumor registries, clinical laboratories, and cancer treatment centers. To ensure complete reporting, the regional registries work with all existing cancer-reporting sources in their areas.

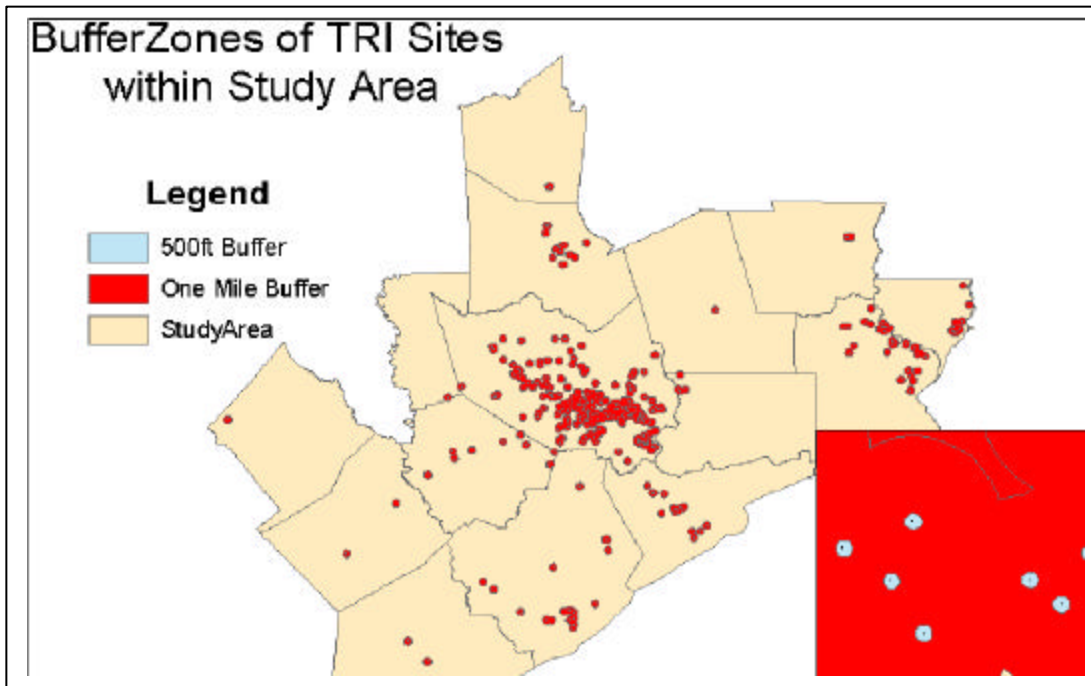


Figure 2. TRI sites with 1 mile and 500 feet buffer zones.

Analysis

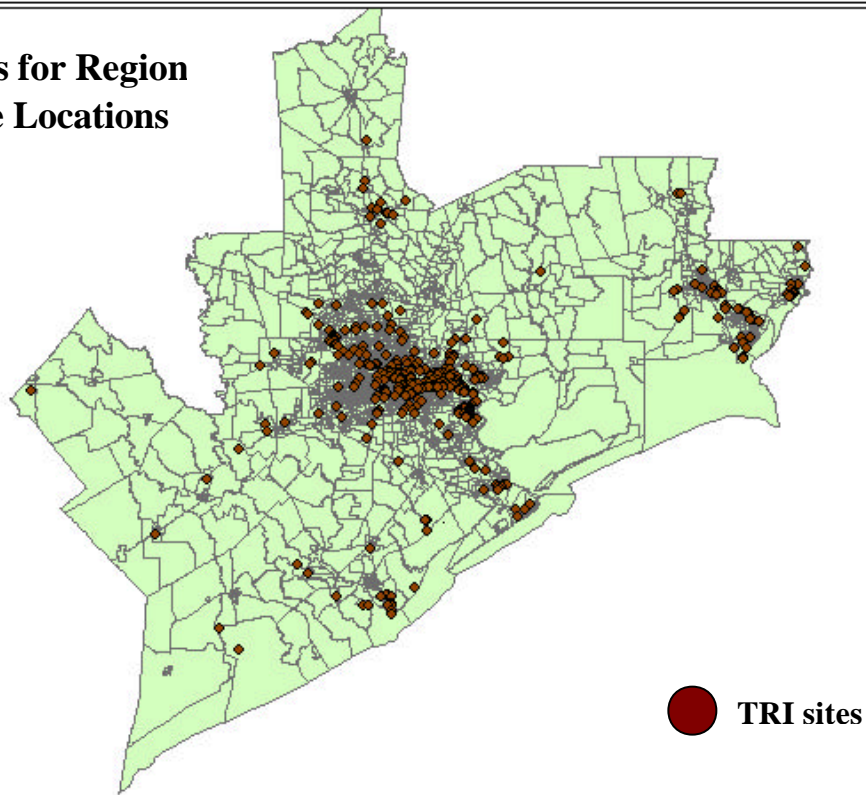
We began the analysis by retrieving coverage's, shape files, info tables and, Dbase tables into our workspace so all layers that were needed were easily accessible. To start off we converted the census block demographic boundary data into Arc Info coverage and demographic attribute file into an INFO table for each county in Public Health Region 6 and 5-South. Then each demographic INFO table was joined to each of the county coverage's. TRI site data came as a shape file of the actual points and also a separate Dbase file. These were converted to a coverage and INFO table respectively. After converting the shape file and Dbase file the respective coverage and INFO table were joined together. Next, we projected all of the coverage's into the Universal Transverse Mercator (UTM) coordinate system and rebuilt the topology. We then appended all of the county coverage's into one coverage to create a single

coverage of the entire Public Health Region 6 and 5-South. The TRI coverage was then clipped with the Public Health Region coverage so only those TRI sites within the Public Health Region are available in a new coverage. Most of these previous operations were performed to prepare the coverage's and create new coverage's that can be used in the actual analysis.

Overlaying the point coverage (TRI) with the polygon coverage (Public Health Region) begins the first round of actual analysis (Figure 3). These two coverage's were overlaid to create a new INFO table that included attributes from both the TRI coverage and the Public Health Region coverage. For each county, populations for White, Black, and Hispanic were summed. The total number of motor vehicles, median income and TRI sites in each county were also summed for latter statistical analysis. (Figure 4). Next began the second round of analysis where buffers of 500 feet and 1 mile were created around the TRI sites to obtain two new coverages.

Then populations for Whites, Blacks, Hispanics, total number of vehicles, median income, and TRI sites in each county within the buffer zone were summed for latter statistical analysis. Because respiratory cancer cases and total toxic emissions (total pollution) were already on the county level, we decided to add these attributes to the Public Health Region coverage last, but they could have been added at any time. The actual statistical operations that were performed were done by exporting tables to Dbase files and opened them in Microsoft Excel and used S-Plus to perform correlations and regression analysis on the variables.

Census Blocks for Region With TRI Site Locations



Counties in Region With TRI Site Locations

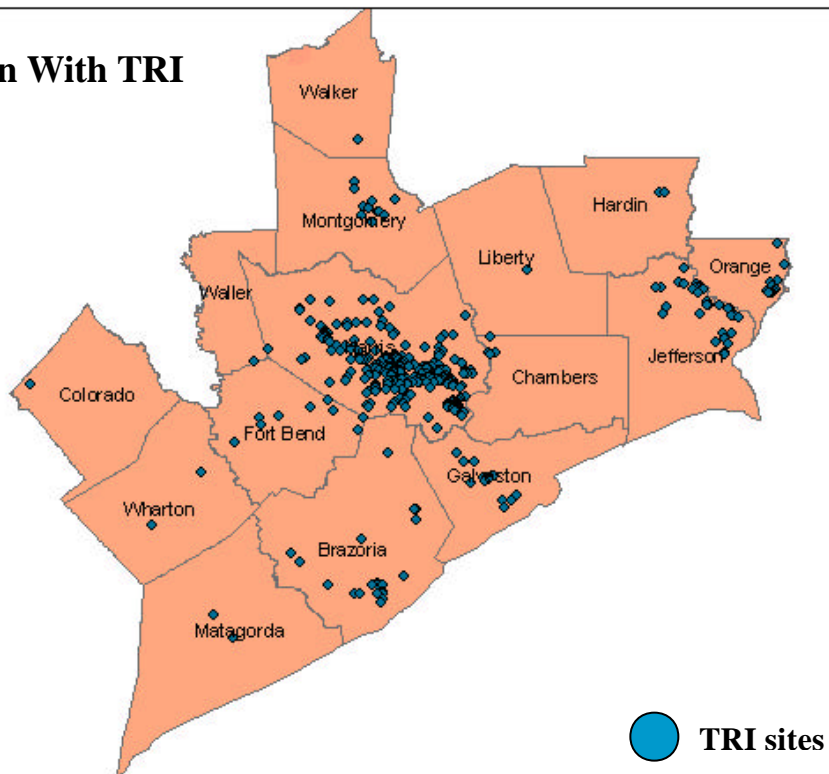


Figure 3. TRI sites in Public Health Region 6 and 5-South with census block groups, and TRI sites located in each county in Public Health Region 6 and 5-South.

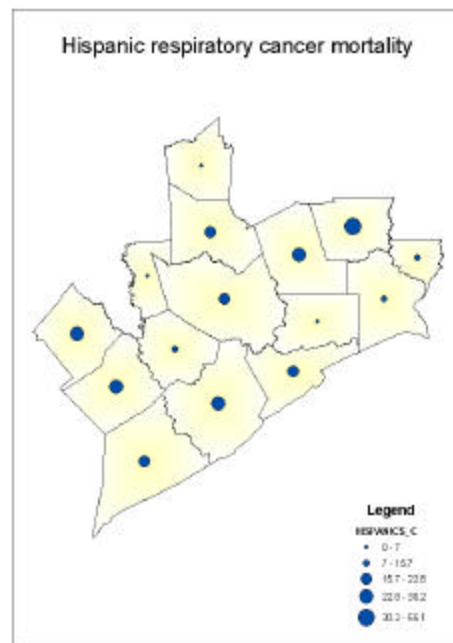
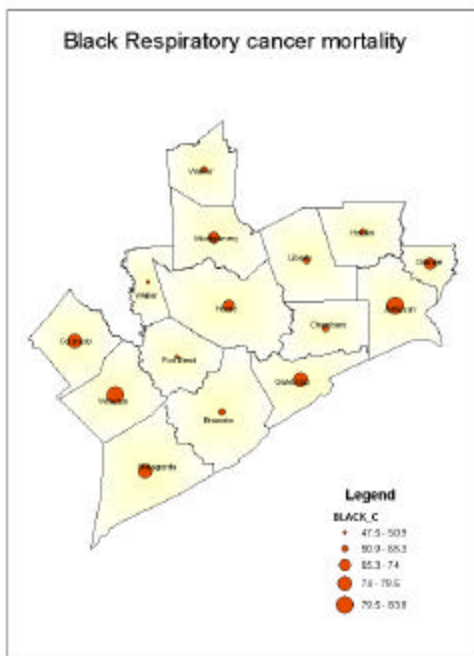
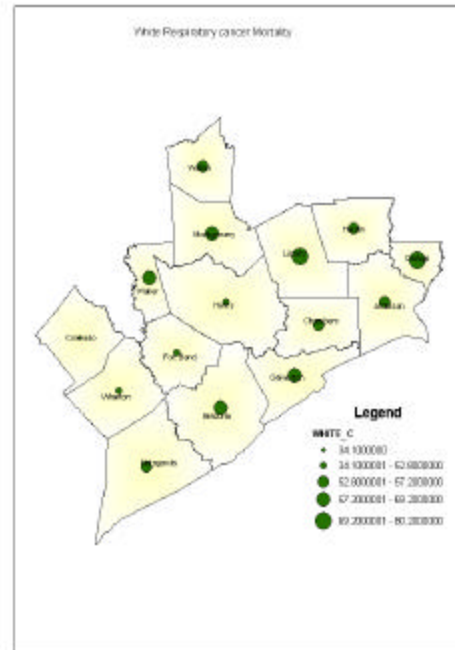
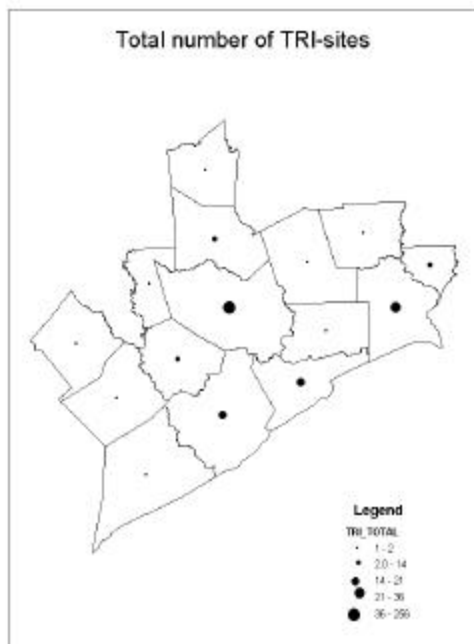


Figure 4. Rate of respiratory cancer for each county in comparison with the total number of TRI sites per county.

After running a correlation analysis on our data the coefficients that were returned began explaining in more detail the factors behind respiratory cancer mortality rates within Public Health Region 6 and 5-South. For example, as respiratory cancer mortality rates for Whites decrease those for Blacks and Hispanics increased. Unlike Whites and Hispanics mortality rates, rates among Blacks increased as total emissions increased. Also, places with high rates of respiratory cancer mortality for Blacks tended to have decreasing median income values. Except for Hispanics, both Black and White cases increased as the population of race within the buffer (Buff-mile White, Black, Hispanic and Buff-500 White, Black, Hispanic) increases at specified distances from the TRI sites. All of the correlations either show a positive or negative correlation, whereas a positive correlation means as one variables value increases the other variables value increases and a negative correlation means as one variables value increases the other variables value decreases or vice versa (Table 1).

	White Cases	Black Cases	Hispanic Cases	Total Emissions	TRI-Sites	Median Income
White Cases		-0.212	-0.055	-0.156	-0.153	0.098
Black Cases				0.307	0.134	-0.306
Hispanics Cases				-0.368	-0.047	-0.07
Buff-mile(White)	0.134					0.453
Buff-mile(Black)		0.567				0.23
Buff-mile(Hisp)			-0.18			0.48
Buff-500(White)	0.055					0.858
Buff-500(Black)		0.313				0.603
Buff-500(Hisp)			-0.068			0.898
Total Emissions					0.138	

Table 1. Correlation coefficients of variables used in research.

Regression analysis were performed based on the number of cases for each race or ethnic group against the variables used in this research; total emissions, aggregate number of vehicles, TRI sites, median income, and the number of cases that fell in the buffer zones. The R-square

values for each analysis were 0.478, 0.9433, 0.7177, for Whites, Blacks, and Hispanics respectively. Saying that the independent variables explain 48 percent, 94 percent, and 72 percent of respiratory cancer rates among Whites, Blacks, and Hispanics respectively. The P-values returned for the regression were 0.9099, 0.04142, and 0.5407 for Whites, Blacks, and Hispanics respectively. Saying that there is more of a linear relationship between the variables for the Black cases than for those of Hispanic and White.

Conclusion

Based on the results, we concluded that the factors observed in this research play a significant role in the assessment of respiratory cancer rates in relation to TRI sites, median income level, race/ethnicity and emissions from automobiles. But, we also concluded that there are probably some underlying factors, such as behavior and genetics that are contributing to the rates of respiratory cancer among minority groups. Results from the analysis confirm the first hypothesis that areas with high numbers of TRI sites also experience higher incidence of respiratory cancer mortality. We also realized that the Hispanic population is more closely related to the White population when referring to respiratory cancer mortality rates. Despite the underlying factors (i.e. smoking, exercise, and genetics etc.) the causality of respiratory cancer among Blacks seems to have a stronger relationship with environmental factors such as pollution from TRI sites and motor vehicles than the White and Hispanic populations.

Some shortfalls of the research that we encountered were for one: TRI reports include only annual emission summaries and no other temporal information; simply reporting annual summaries fails to truly communicate the comparative vulnerability of place. Also, the number of people within a buffered region is based on the total population within a block group or

polygon in which the TRI site is located. And finally, the fact that respiratory cancer mortality cases are based on county level data, the location of where the person lives is impossible. Using a smaller study area could solve these problems. Where exact locations of respiratory cancer incidence can be mapped and other factors can be incorporated to resolve the shortfalls faced in this research. Ultimately, we hope that this research will help to develop more effective disease-risk mitigation and prevention programs. Also, identify populations with a high risk for respiratory cancer so that programs can be more specifically targeted at these populations. And finally, to detect cancer incidence trends that indicate environmental or other risk factors that can be controlled or removed by intervention.

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