

Place, Pollution, and Health: Environmental and Social Predictors of Asthma Hospitalization in the St. Louis Region

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Background

The St. Louis region has a number of industrial operations and an extensive network of interstates and roads, all of which contribute to air pollution and public health outcomes, including asthma.

- Regionally, 140 facilities report air emissions with effects on respiratory health to the Toxic Release Inventory (TRI).
- 84% of regional commuters drive alone to work, logging over 70 million miles per day.

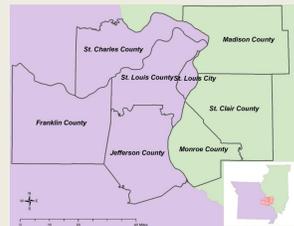
Regional disparities in exposure to pollutants in combination with access to care contribute to poor outcomes for vulnerable groups, such as elevated emergency room visits for asthma in the region.

A number of public data sources are available to examine potential relationships between regional air pollution, social demographics, and health outcomes.

Research Aims

- Determine strength of association between toxic point sources reported to TRI and asthma hospitalization outcomes at the ZIP code level
- Examine toxic air releases alongside socio-demographic and asthma indicators to identify disparities in exposure to air pollution and asthma outcomes

Methods



This TRI University Challenge Project uses publicly available data to examine social and environmental predictors of asthma in eight counties in the St. Louis Region.

Figure 1. Study Area

Locations and air releases (in lbs) for facilities reporting respiratory health-related air releases to TRI in all ZIP codes in the eight-county region were mapped for the year 2010. Point-source emissions were compared to the 2005 National Air Toxic Assessment (NATA).

Sociodemographic indicators were from the 2010 Census and the 2011 American Community Survey. 3-year estimates were mapped at the ZIP code level.

Asthma hospitalizations by ZIP code (primary diagnosis, ages 15+) for the year 2010 came from Missouri and Illinois state health departments.

Cluster and spatial analysis using GIS was supplemented with linear regression and independent samples analysis to determine any significant environmental or social predictors of asthma hospitalization in the region.

Independent Variables: Percent African American, median household income, percent poverty, percent unemployed, percent in rental housing, distance to TRI and interstates (feet), TRI respiratory-related air releases (lbs)

Dependent Variable: Asthma Hospitalization (rate per 10,000)

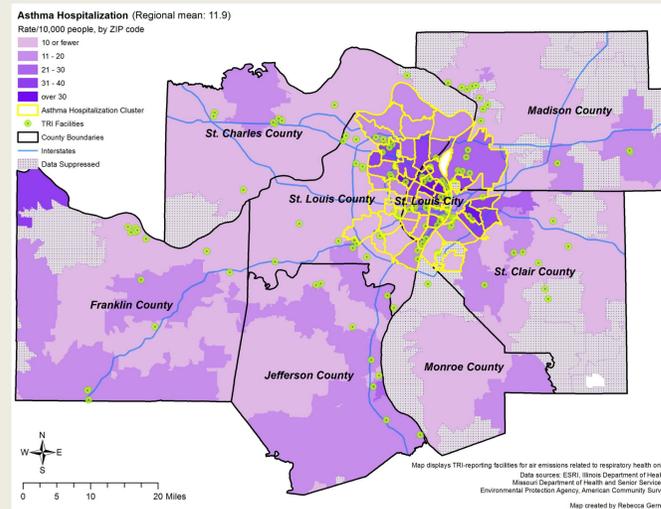


Figure 2. Asthma Hospitalization Cluster, 2010. Asthma hospitalizations are significantly clustered in ZIP codes in St. Louis City, north St. Louis County, and western Madison, Monroe, and St. Clair Counties (Moran's I=0.26; $p < .001$).

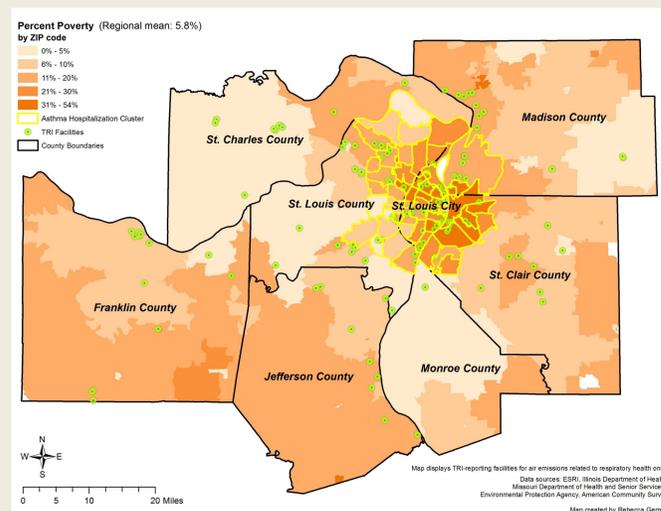


Figure 4. Asthma Hospitalization Cluster, TRI Facilities, and Percent Below Federal Poverty Level, 2010. Asthma hospitalizations were positively associated with ZIP codes with higher poverty ($\beta = .187$, $p < .01$)

Table 1. Descriptive Statistics

Variable	Regional Mean (n=182)	Mean outside cluster (n=126)	Mean inside cluster (n=56)
Asthma Hospitalization (rate per 10,000 people)	11.9	7.0	22.8**
African American (%)	17.6	3.4	49.6***
Unemployed (%)	5.8	4.6	8.3***
Below Federal Poverty (%)	13.1	9.1	22.3***
Median Household Income (\$)	56,785	63,816	40,965***
Air Releases (lbs)	23,256	26,745	15,407
Distance to TRI site from ZIP code centroids (feet)	22,420	29,014	7,583***
Distance to Interstates from ZIP code centroids (feet)	21,556	28,722	5,432***

Independent Samples t-test significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

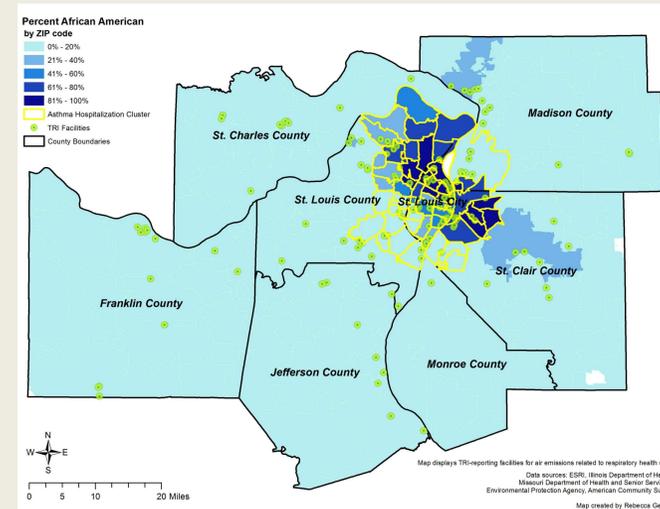


Figure 3. Asthma Hospitalization Cluster, TRI Facilities, and Percent African American. Asthma hospitalizations were positively associated with majority African American ZIP codes ($\beta = .498$, $p < .001$)

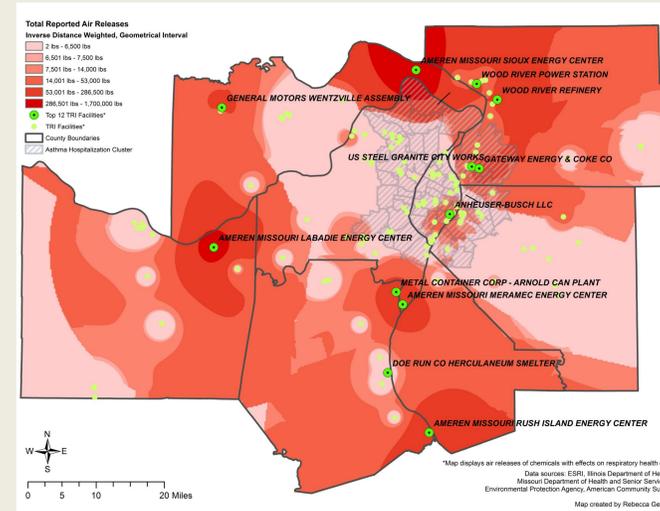


Figure 5. Asthma Hospitalization Cluster, TRI Facilities and Air Releases. Asthma hospitalization clustered ZIP codes were closer on average to TRI facilities, but had lower average TRI releases. This map shows the facilities reporting the highest respiratory-related air releases.

Table 2. Model Coefficients

Variable	Beta	t
African American (%)	0.498	5.65***
Below Federal Poverty Level (%)	0.187	2.67**
Distance to Interstates (feet)	0.082	1.38

F=55.11, R²=.482

The population within the asthma hospitalization cluster differed significantly from the population outside the cluster on social and environmental indicators. ZIP codes inside the cluster have higher percentages of African Americans, higher percent poverty and unemployment, lower median household income, and are closer on average to TRI facilities and highways than ZIP codes outside the cluster.

Discussion

This analysis supports previous findings of higher asthma hospitalization rates in socially disadvantaged areas.

On average, ZIP codes with the highest asthma hospitalization rates are located closer to TRI facilities and highways. This information can help focus community efforts to reduce asthma hospitalization.

Key limitations to this study include:

- Exposure Assessment: TRI provides information on pounds released, and cannot be used to determine toxicity or exposure related to inhalation of releases. Additionally, social demographics and exposures may vary within ZIP codes.
- Summary Measures: TRI does not provide cumulative effects of releases or potential combinations of released chemicals (secondary sources).
- Modeling of Air Releases: This analysis does not account for prevailing winds or potential dispersion of TRI releases.

According to NATA, mobile and secondary sources accounted for over 97% of respiratory risk in the region in 2005 (fig. 6.), while point sources accounted for only 2% of risk. TRI air releases also decreased 42% from 2005 to 2010 (fig. 7).

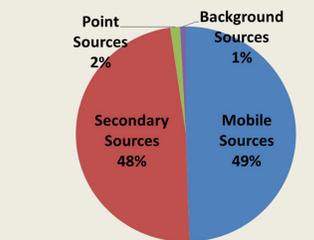


Figure 6. NATA Estimated Respiratory Risk, St. Louis Region 2005.

Future research should examine mobile sources of pollution such as highways, as well as potential contributors to secondary pollution to determine potential risks to respiratory health.

Analysis of health and socio-demographic data at smaller geographic levels could provide more detailed information on exposure and risk estimates within ZIP codes.

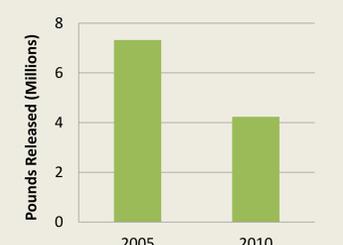


Figure 7. Total TRI Air Releases, St. Louis Region 2005-2010

Transdisciplinary Aspects

Mapping and analyzing TRI with health and socio-demographic trends is a replicable approach expanding the use and application of publicly accessible environmental and health data. The project is transdisciplinary in its data sources, analysis, and implications for policy and programs addressing community health.

Results will be shared with community educators, researchers, and policy makers in the region, including Metro East Community Air Project, Missouri Department of Health and Senior Services, Illinois Department of Public Health, East West Gateway Council of Governments, Illinois State Asthma Partnership, US Environmental Protection Agency, Washington University in St. Louis, and the University of Illinois.

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