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Disparities in demographic and health indicators among communities by frequency of hazardous waste sites in Indiana, USA: differences by Superfund vs. brownfield classification

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Abstract

Background: The location of hazardous sites is a known environmental justice issue, but impact of site classification (Superfund vs. brownfield) is less clear. The objective of this study is to determine whether demographic and health indicators are correlated with the prevalence of brownfield and/or Superfund sites in Indiana, USA.

Methods: This is a cross-sectional, ecologic study using publicly available data on hazardous waste sites, demographics, and self-reported health status. Complete data were available for 1252 census tracts, with 2251 brownfield and 2264 Superfund sites. Adjusted Poisson and linear regression models were used to determine associations between hazardous site frequency with demographic and health characteristics.

Results: Approximately 24% of census tracts had >3 Superfund or brownfield sites. Higher brownfield frequency was significantly associated with a higher nonwhite population (adjusted $\beta=0.004$, 95% confidence interval (CI): 0.002, 0.006); in contrast, more Superfund sites were significantly associated with a lower nonwhite population (adj $\beta=-0.006$, 95% CI: -0.008, 0.004). Lower income was significantly associated with higher Superfund or brownfield site frequency. Results were consistent when limited to urban areas. Self-reported health measures were not associated with Superfund frequency. Census tracts with a higher number of brownfields were associated with a higher proportion of the population reporting poor general health (adj $\beta=0.057$, 95% CI: 0.010, 0.104) and poor mental health (adj $\beta=0.046$, 95% CI: 0.017, 0.075) compared to tracts without brownfield sites.

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Conclusions: These results concur with existing evidence on disparities related to the location of hazardous site; they additionally suggest these disparities may extent to how hazardous sites are classified.

Keywords

Hazardous waste site; Racial groups; Income; Environmental justice

BACKGROUND

Sites contaminated with hazardous chemicals, or hazardous waste, are an unfortunate legacy of industrial activity which pose substantial concerns for public health. Many hazardous sites have been documented as a source of exposure to numerous types of chemicals with established toxicity.^{1,2,3,4} This, in turn, is concerning as exposure to these contaminants present in hazardous waste sites is likely to contribute to a variety of adverse health outcomes,^{5,6,7} and residential proximity to hazardous waste sites has been reported to be associated with reduced life expectancy.⁸

It is clearly established that the location of hazardous waste sites is inequitably distributed. The United Church of Christ is credited with launching the environmental justice movement based on their documentation that hazardous waste sites were more likely to be present in communities with high concentrations of racial minorities within the United States (US).⁹ Since that time, ample research has reaffirmed and replicated the finding that hazardous waste sites are more likely to be located in communities with low-income and/or minority populations, as summarized in several recent excellent reviews.^{10,11} Similar patterns of inequitable hazardous waste locations have been reported worldwide.^{12,13,14}

Within the US, the majority of research has focused on Superfund sites, rather than other types of hazardous waste sites. Superfund sites are defined and managed per the US Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.¹⁵ Through this mechanism, hazardous waste sites deemed to have a high potential hazard are evaluated and remediated under guidance of the US EPA and funds to remediate the sites are obtained from the industries who contributed to the pollution.¹⁶ In contrast, the term brownfield sites, or brownfields, is generally used to refer to sites with either known or suspected environmental contamination.¹⁷ Evaluation and management of brownfield sites is generally delegated to individual US states, and funding for remediation is generally sought from federal or state grants.¹⁸ Remediation of brownfield sites, from a public health perspective, may also not be as thorough as would be required on Superfund sites.¹⁹

Although there have been several papers addressing brownfield sites within the US and their relationship with health outcomes,^{20,21,22} addressing potential disparities related to the siting of brownfields is also important. To the best of our knowledge, this research represents the first direct comparison of socioeconomic correlates of brownfield vs. Superfund site location. Another novel aspect of this research is that while existing literature has focused on hazardous waste sites in South Carolina,^{23,24} Florida,²⁵ and Michigan,²⁶ among others, little work has been done in Indiana despite the fact that Indiana has nationally-recognized hotspots of environmental contamination.^{27,28} Therefore, the goal for this analysis was to

add to the excellent and robust work on identifying environmental justice issues related to the location of hazardous waste sites, particularly comparing brownfield versus Superfund sites within Indiana.

METHODS

This was a cross-sectional, ecological study examining demographic characteristics and health outcomes associated with the number of brownfield and Superfund sites in Indiana at the census tract level. Data were combined for this analysis from 4 different sources: the US EPA (Superfund sites), the Indiana Department of Environmental Management (brownfield sites), the US Census Bureau (demographics), and the Centers for Disease Control and Prevention (health characteristics); these are summarized in Table 1. Due to data availability, Superfund, brownfield, and demographic data were from 2010 while health data were from 2021. As this study only uses data summarized at the census tract level, it is not considered to be human subjects research.

Superfund sites were identified using EPA databases (<https://www.epa.gov/superfund/search-superfund-sites-where-you-live>) and brownfield sites were identified using the Indiana Department of Environmental Management (IDEM) databases (<https://www.in.gov/ifa/brownfields/program-sites/>). Lists of US Superfund sites specify which sites are on the National Priorities List (NPL) versus the Superfund Alternative Approach sites (or non-NPL sites) (indicating the method of site management and remediation), as well as which are active, proposed, or removed. To be inclusive, we included any site listed within the EPA Superfund database regardless of NPL or remediation status, as done previously.²⁹ Both NPL sites and non-NPL sites undergo a hazard assessment, the same minimum level of potential hazard is required for both NPL and non-NPL sites. NPL sites are remediated as originally described within the Superfund legislation (a slow process often involving multiple lawsuits with potentially responsible parties) whereas non-NPL sites are remediated using a mediation approach with potentially responsible parties or via other programs within EPA. All sites were included regardless of remediation status because to be listed a substantial amount of contamination had to be present, typically for many years. Although active exposures may have declined through remediation, having prior exposure to contamination may still impact lifelong health.³⁰ Within Indiana, there are 53 Superfund sites on the National Priority List, but when including all available sites we identified a total of 2891 Superfund sites. We also identified 2513 brownfield sites in Indiana using the site list of brownfields considered for or provided resources through the Indiana brownfields program.

Census tracts represent the smallest geographical area for which many statistics are available within the US and they are relatively permanent. The population within a census tract ranges from 1200 to 8000 people and they generally follow visual and political boundaries.³¹ The US Census Geocoder and the Federal Financial Institutions Examination Council Geocoding/Mapping System were used to find the census tract code of each known sites. Indiana has a total of 1511 census tracts.³²

Demographic data from 2010 were also obtained from the US Census Bureau (<https://data.census.gov/all?q=2010+census>). Data were collected on age (percent ≥ 60 years), gender (percent female), income (median annual household income per \$1000), race (percent white), and ethnicity (percent Hispanic or Latino). The percent of area considered urban (percent urban) was also collected from the 2010 Census.

Health data from 2021 were obtained from the US Centers for Disease Control and Prevention PLACES dataset (<https://healthdata.gov/dataset/PLACES-Local-Data-for-Better-Health-Census-Tract-D/p6fn-8zmi>). For this analysis, we obtained data on self-reported health status measures: general health status (5-item Likert scale ranging from poor to excellent), mental health status (percent reporting mental health not good for ≥ 14 days in the past month among adults ≥ 18 years of age) and physical health status (percent reporting physical health not good for ≥ 14 days in the past month among adults ≥ 18 years of age). The percentage of adults who smoked cigarettes per census tract was also obtained. This database does not include data for census tracts with < 50 people. Health data were available for 1256 census tracts in Indiana with 2251 brownfields and 2264 Superfund sites. Of these, 4 tracts were missing census data, leaving $N=1252$ for analysis.

Data were analyzed using Stata 18 (Statacorp; College Station, TX, USA); maps were made using EpiInfo 7.2.5.0 (US CDC; Atlanta, GA, USA), p -values < 0.05 were considered statistically significant. Descriptive statistics, including mapping, were performed to describe the variables and their distribution. Analytic statistics using adjusted regression analyses were performed to compare the frequency of hazardous waste sites with demographic and health characteristics.

We considered variables for inclusion as covariates based on prior literature^{33,34} as well as creation of an a priori directed acyclic graph (DAG).³⁵ Covariates included in regression models were selected to avoid model collinearity: thus, percent females represented sex differences by census tract, and percent nonwhite represented racial differences by census tract. Urban/rural status was not included as a potential confounder because it was highly correlated with race (Spearman's $\rho=0.72$). At the state level in 2022, the population was 84% White, 10.3% Black, 2.8% Asian, and 2.4% two or more races.³⁶ Hispanic/Latino is considered independently from race. The association between demographic characteristics (independent variable) with the number of hazardous waste sites (dependent variable; either brownfields or Superfund sites) per census tract was assessed using adjusted Poisson regressions as the number of hazardous sites is count data which follows a Poisson distribution. Given the existing literature suggesting that combined race and income may be important, a second model using a combined measure of race and income, classified as either above or below the median value for each, was also evaluated. As the potential influence of urban versus rural status may still be important, the latter model was also analyzed on the subset of the census tracts with a high prevalence of urban areas ($> 80\%$ urban, $N=818$). The association between Superfund (0–1 sites / 2 sites / ≥ 3 sites) or brownfield (0 sites / 1–2 sites / ≥ 3 sites) site frequency with self-reported general health status (percent reporting fair or poor general health), mental health status (percent reporting poor mental health), and physical health status (percent reporting poor physical health)

was determined using linear regression, adjusted for sociodemographic characteristics and cigarette smoking.

RESULTS

The mean frequency of brownfields, Superfund sites, and total sites per census tract were 1.79 (95% confidence interval (CI):1.64, 1.95), 1.80 (95% CI: 1.69, 1.92), and 3.59 (95% CI: 3.37, 3.81), respectively. The graph displaying the correlation between the number of Superfund and brownfield sites per census tract is presented in Figure 1; the correlation was Spearman's $\rho=0.327$, $p\text{-value}<0.001$.

The geographic distribution of hazardous waste sites, by tertile, is displayed for Indiana (Figure 2) and Indianapolis, Indiana (Figure 3). Indianapolis is the state capital and located in the center of Indiana. Tracts with a smaller geographic area represent urban areas, as the tracts are designed to be relatively consistent in population size. The mean percent of urban area in census tracts is roughly 70%, but this is slightly smaller when looking at the tracts with the highest number of Superfund sites and significantly larger when looking at the tracts with the highest number of Brownfield sites (Figures 2,3 and Table 2).

Table 2 presents summary statistics and unadjusted comparisons for hazardous sites, demographic variables, and health outcomes. In this analysis an average 82.05% (95% CI: 80.75, 83.36) of the residents per census tract were white (11.6%; 95% CI: 10.4, 12.7) were black, and (1.3%; 95% CI: 1.1, 1.5) were Asian. There were 5.6% (95% CI: 5.2, 6.1) Hispanic or Latino residents per census tract, and median household income was \$56,000 (95% CI: 54,800, 57,100). Unadjusted comparisons (Table 2) demonstrated that census tracts in the highest tertile of brownfield and Superfund sites had significantly lower median household income, higher percentages of cigarette smokers, and more residents reporting poor general, physical or mental health compared to census tracts with the lowest number of Superfund or brownfield sites. Census tracts with the highest tertile of brownfield sites also had significantly higher proportions of Hispanic/Latinos; this was similar, but not statistically significant for Superfund sites. Census tracts in the highest tertile of brownfield sites had a significantly higher proportion of nonwhite residents compared to those in the lowest tertile of brownfield sites. However, census tracts in the highest tertile of Superfund sites had the opposite trend of significantly lower proportion of nonwhite residents compared to those in census tracts with the lowest tertile of Superfund sites.

Table 3 presents the results of adjusted Poisson regression models comparing selected sociodemographic variables with the frequency of Superfund or brownfield sites per census tract. Model 1 includes all the sociodemographic variables as individual, separate predictors. A higher number of Superfund sites per census tract was associated with a lower proportion of nonwhites (adjusted β : -0.006; 95% CI: -0.008, -0.004), a lower median household income (adjusted β : -0.014; 95% CI: -0.017, -0.011), a higher proportion of Hispanics or Latinos (adjusted β : 0.016; 95% CI: 0.012, 0.020), and a higher proportion of elderly (adjusted β : 0.015; 95% CI: 0.007, 0.023). A higher number of brownfield sites per census tract was significantly associated with a lower percentage of females (adjusted β : -0.022; 95% CI: -0.029, -0.015), lower median household income (adjusted β : -0.024; 95% CI:

−0.028, −0.021), a lower percentage of smokers (adjusted β : −0.021; 95% CI: −0.031, −0.011), but a higher proportion of nonwhite residents (adjusted β : 0.004; 95% CI: 0.002, 0.006). Notably, trends were opposite, but statistically significant, for the percentage of nonwhite residents per census tract when comparing results for Superfund sites versus brownfield sites in Indiana.

The impact of using a combined variable for race and income was evaluated in Model 2, Table 3. Census tracts with lower nonwhite populations (i.e., high proportion of whites) and high income were the reference category. Tracts with low nonwhite populations, but also low income were significantly associated with a higher number of Superfund or brownfield sites per tract. Similar significant associations were seen for tracts with high nonwhite populations but low income. Census tracts with high proportion of nonwhite persons and high income were also significantly associated with having a higher number of brownfield sites, but no significant association with the number of Superfund sites. Results from this model limited to the subset of census tracts with a high prevalence of urban areas is very similar to the results including all census tracts (Table 3, Model 3).

In summary, 1) the trends for the number of hazardous sites per tract for low income vs. higher income were the same regardless of race, 2) the trends for the number of brownfield sites per tract for higher nonwhite versus lower nonwhite were the same regardless of income; but 3) the trends for the association of race with the number of Superfund sites per census tract depended upon income.

Table 4 presents the adjusted linear regression model results examining the relationship between tertile of brownfield or Superfund sites per census tract with self-reported health status. There were no significant associations between any self-reported health measure (general health, physical health, mental health) status with the frequency of hazardous waste sites per census tract. There was a significant association of census tracts with higher number of brownfields sites having higher proportions of the population reporting poor or fair self-reported general health (adjusted β : 0.057; 95% CI: 0.010, 0.104) and poor mental health (adjusted β : 0.046; 95% CI: 0.017, 0.075).

DISCUSSION

In this cross-sectional ecological study, we investigated the relationship between demographic characteristics and the number of brownfield and Superfund sites in Indiana. We found that on average, census-tract level populations in Indiana were majority white and majority non-Hispanic. The majority of the nonwhite population was black. On average, there were 1 to 2 brownfields or Superfund sites per census tract. This analysis showed significant associations of census tracts with a higher number of brownfields or Superfund sites with lower household income and lower percent female. We observed that a higher number of brownfield sites was significantly associated with a higher proportion of nonwhite residents; however, contrary to our original hypotheses, a higher number of Superfund sites was significantly associated with a lower proportion of nonwhite residents (i.e., a higher proportion of white residents). A higher number of Superfund sites was also significantly associated with a higher proportion of Hispanic/Latino residents. A higher number of

brownfield sites per census tract was also significantly associated with a higher proportion of males and of those without health insurance; whereas a higher number of Superfund sites was also associated with a higher percentage of Hispanic or Latinos. These results were consistent when using the subset of census tracts which were in urban areas. There was also a significant association of a higher number of brownfield sites with poor or fair self-reported general health and poor self-reported mental health.

Our results for the association of income with the frequency of hazardous sites is similar to that reported by prior studies. Increased proximity to hazardous sites has been consistently found to be associated with lower socioeconomic status.^{37,38,39,40,41} A shorter distance from currently polluting facilities has been associated with lower socioeconomic status.^{42,43} and areas with worse air pollution are more likely to be of lower socioeconomic status.⁴⁴ Higher proportion of lower income residents were found in proximity to a hazardous incident/chemical release.^{45,46} Manual labor occupations, referred to as “blue collar” occupations, which typically are lower income, have also been reported to be more common in tracts with a higher number of Superfund sites.⁴⁷

Facilities releasing environmental contaminants have been associated with proximity to communities with a higher percentage of nonwhites^{48,49} or blacks.⁵⁰ Having a higher percentage of black^{51,52} or Hispanic residents⁵³ has also been associated with having a shorter distance from Superfund sites. Hazardous incidents or chemical releases were also more likely to be located near communities with high minority and Hispanic populations.^{54,55} This is generally consistent with our results for brownfield frequency.

However, like the totality of our results, the full scope of literature on the location of hazardous sites with race is complex. A study from South Carolina found that Superfund site location was associated with a higher percent black, however, it was also associated with a higher percentage of whites with lower socioeconomic status or lower education.⁵⁶ Brownfields in Baltimore, Maryland, were reported to be more common in white, lower-class areas.⁵⁷ These works by Burwell-Naney and colleagues as well as Litt and Burke imply that the combination of race and income may be important; our analysis which combined the two (Table 2, Model 2) did indicate that lower income communities, whether high minority or high white, were more likely to be in a census tract with higher Superfund or brownfield sites, consistent with prior work. However, the same model did find a negative, but non-statistically significant, association between a higher number of Superfund sites with communities that are higher minority and higher income when compared to communities with high white and high SES populations, but not with brownfield sites.

The underlying cause for our discrepant results for race in brownfield vs Superfund sites cannot be explained with the data used in this analysis. It is possible that some of this may be explained by racial differences in urban and rural areas within Indiana; however, the fact that our results were not changed when limiting the analysis to urban areas suggests that these trends are robust, at least in urban areas of the state. It is also possible that longer-term sociopolitical trends in identifying and listing Superfund versus brownfield sites may contribute to our observed results. A report by O’Neil suggests that fewer Superfund sites were identified in minority communities than expected; suggesting that

minority communities may not benefit from environmental cleanup opportunities offered by the Superfund program.⁵⁸ More recently, Shkembi et al., compared historical “redlining” maps (which encouraged racial segregation in communities across the US) report that within Detroit, MI, communities which had been historically redlined were more likely to be polluted.⁵⁹ Although there are individual differences in how any hazardous site is addressed, an important motivation of Superfund site remediation is to “protect human health and the environment by cleaning up sites”⁶⁰ whereas motivation to remediate brownfield sites is to clean areas that prevent “expansion, development or reuse” of properties.⁶¹ The lack of health promotion as a key motivating factor of brownfield remediation implies that over time, communities near these sites may have less extensive remediation⁶² and experience continued health hazards compared to communities near Superfund sites. Although we cannot identify the cause from our analysis, these disparities observed in our results and others, are consistent with larger sociopolitical and cultural trends that have historically contributed to structural racism within the United States.^{63,64}

Additionally, this work also identified that census tracts within Indiana with a higher number of brownfield sites were more likely to have higher self-reported poor general or mental health. Self-reported general health is an indicator for overall morbidity and mortality. Our results are consistent with literature linking hazardous sites with exposure to toxic chemicals and a variety of health impacts.^{65,66,67} Mental health outcomes have been reported as a health outcome of concern as a result of residing near waste sites,^{68,69} also somewhat consistent with our work. The reason why results were only observed for brownfields, but not Superfund sites is unknown, but is consistent with the fact that we observed different patterns in correlates of Superfund versus brownfield sites within Indiana.

There are a few limitations to this analysis. The cross-sectional design prohibits any consideration of temporality with our results. However, data on health outcomes was from a more recent survey compared to hazardous waste sites, which somewhat alleviates the limitation for these analyses. We were also missing complete data for a substantial number of census tracts; the majority of these omissions were due to low population numbers within these tracts. At the same time, any dataset not collected for research purposes may be subject to higher rates of missing or incomplete data compared to carefully managed datasets; this is only exacerbated when combining datasets from multiple sources. Some missing data on addresses precluded our ability to confidently conduct this analysis using a smaller geographic area such as block groups.

As an ecological study, we cannot rule out the possibility that the ecologic fallacy may play a role in our observed results. That is, that the relationship at the census tract level may not be the same as on an individual level. Alternative approaches have been demonstrated, such as assessment of a boundary area around each hazard or measurement of specific proximity to a hazard.^{70,71} As several of the addresses for brownfield sites had missing information, we were unable to implement one of these more precise approaches with our dataset, and used the smallest geographic area for we were confident that our data would be robust. These limitations should be kept in mind when interpreting results from this analysis.

This analysis also has several key strengths. The combination of data from multiple sources allowed for a more detailed analysis; specifically, of inclusion of Superfund versus brownfield sites as well as sociodemographic and health outcome data. As noted earlier, fewer studies to date have explored correlates of brownfield location within the US. Despite the limitations of this analysis, our results for race and socioeconomic status for Indiana are robust.

In conclusion, this analysis identifies key differences between correlates of Superfund vs. brownfield frequency per census tract in Indiana; specifically, that census tracts with a poor white community are more likely to have an increased number of Superfund sites but census tracts with poor minority communities are more likely to have an increased number of brownfield sites. Although there are limitations to this analysis, when taken into consideration with prior research, this suggests active steps should be taken to reduce disparities related to the listing and management of hazardous sites.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Availability of data and materials.

Data used in this analysis is publicly available from the United States Census at <https://data.census.gov/all?q=2010+census>, the United States Centers for Disease Control and Prevention at <https://healthdata.gov/dataset/PLACES-Local-Data-for-Better-Health-Census-Tract-D/p6fn-8zmi>, the United States Environmental Protection Agency at <https://www.epa.gov/superfund/search-superfund-sites-where-you-live>, and the Indiana Department of Environmental Management at <https://www.in.gov/ifa/brownfields/program-sites/>.

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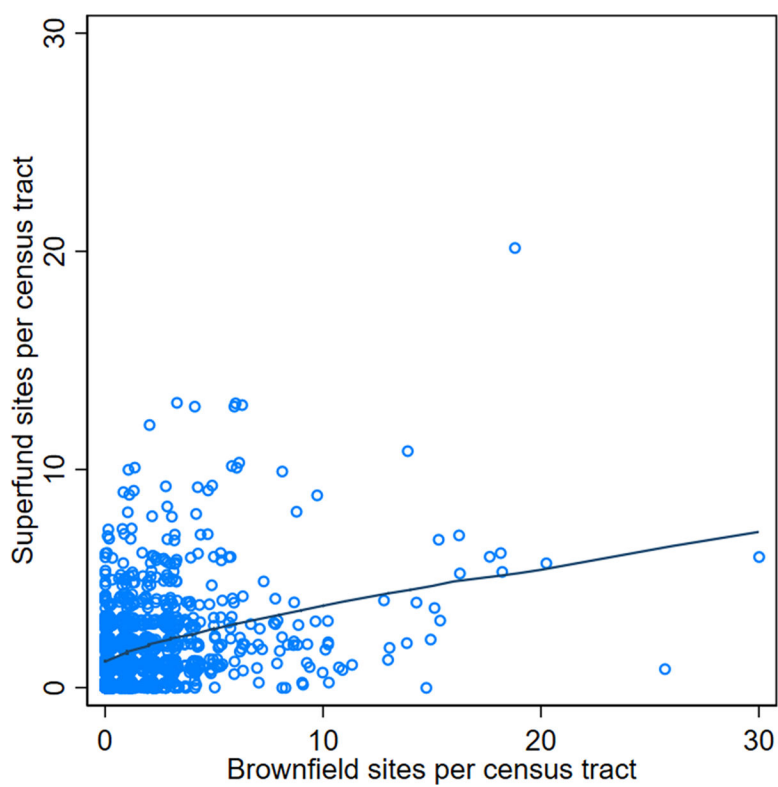


Figure 1. Frequency (jittered for clarity) and unadjusted trend line showing brownfield sites vs Superfund sites per census tract, Indiana, USA, N=1252.

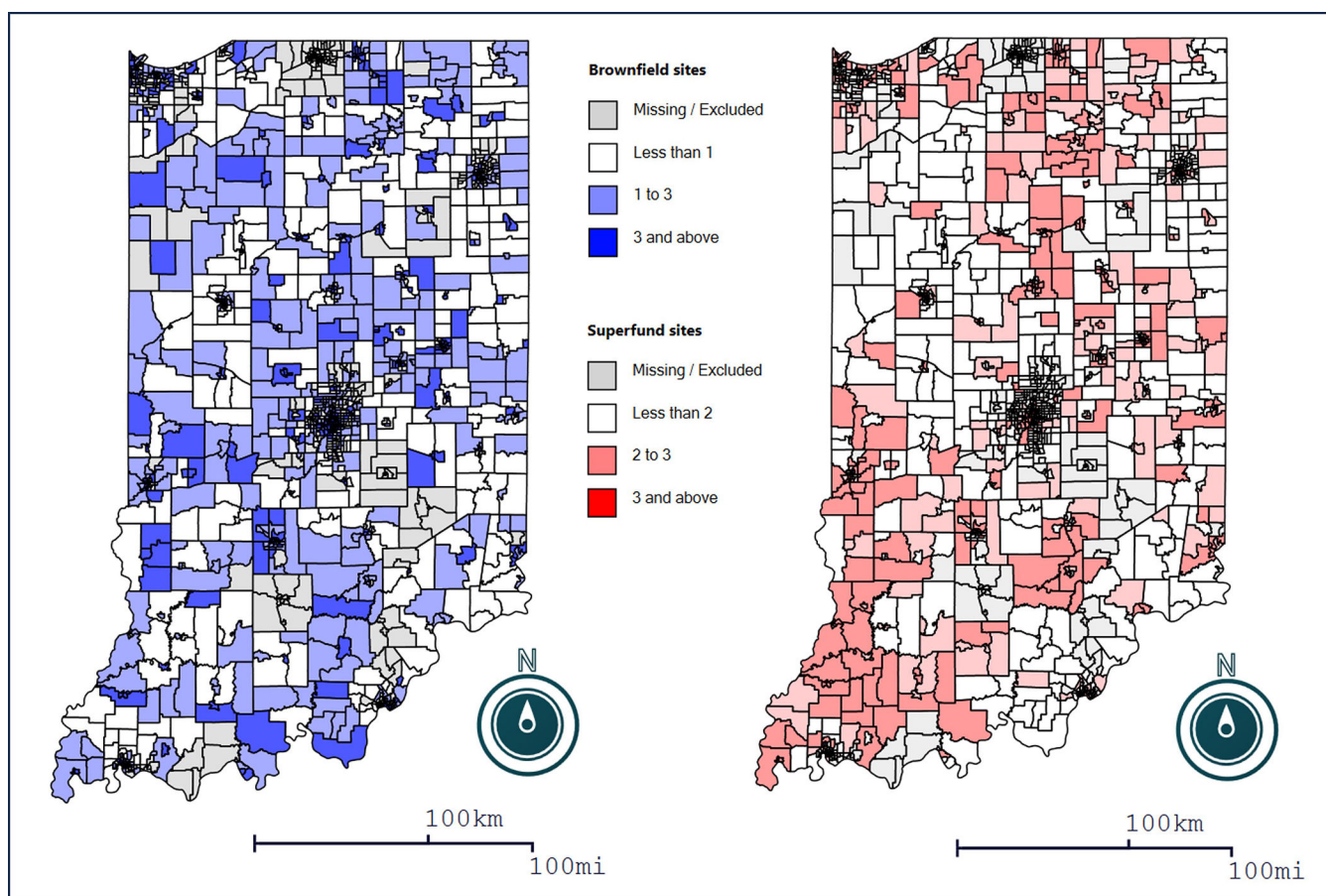


Figure 2. Distribution of brownfield (left, blue) and Superfund (right, red) sites per census tract, Indiana, USA.

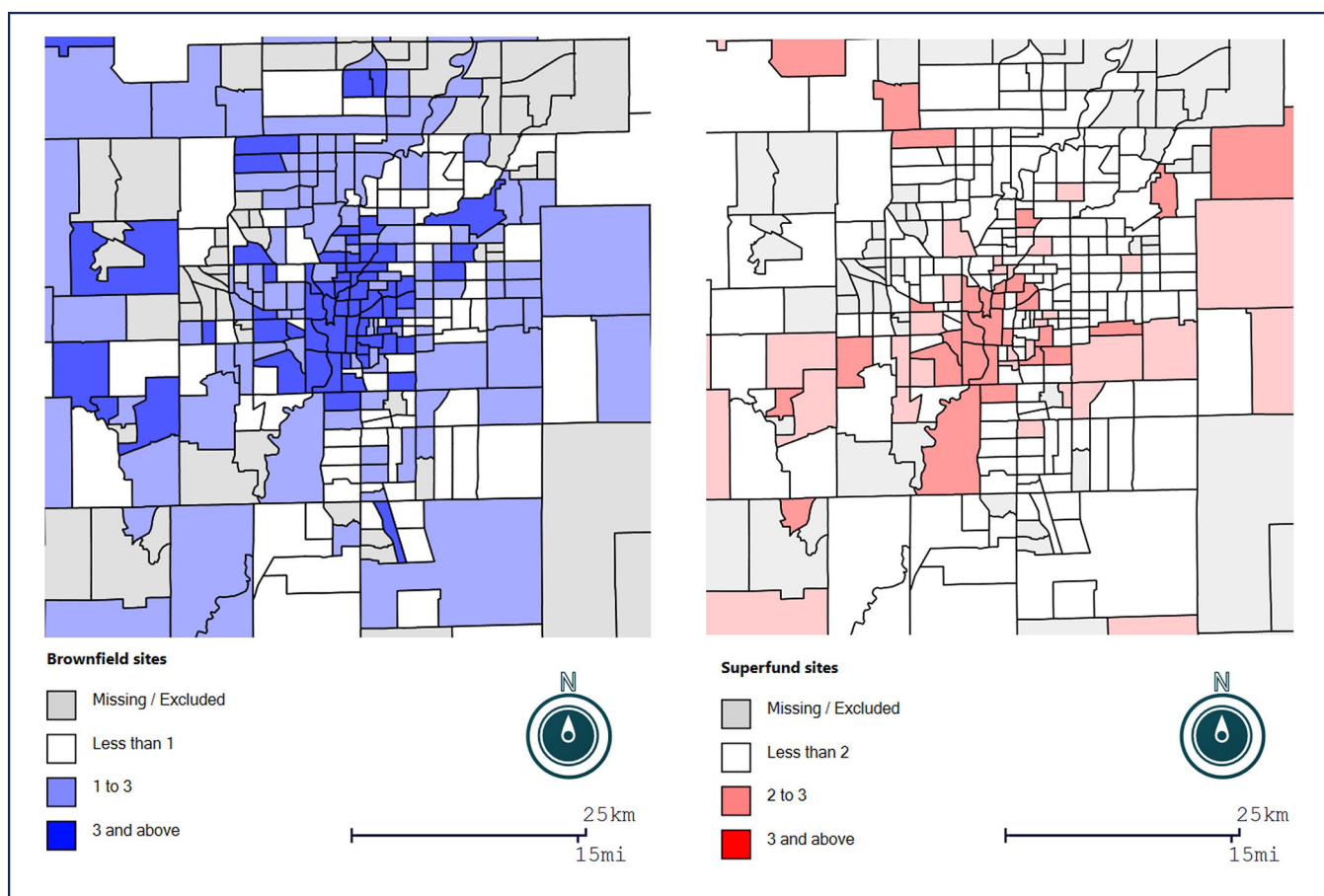


Figure 3. Distribution of brownfield (left, blue) and Superfund (right, red) sites per census tract, Indianapolis, Indiana, USA.

Table 1.

Dataset characteristics

Source	Data obtained	N obtained / N analyzed	Year of data	URL
United States Environmental Protection Agency	List of superfund sites (NPL and non-NPL sites) with addresses, dates	2891 / 2264 sites	Included in list in 2010	https://www.epa.gov/superfund/search-superfund-sites-where-you-live
Indiana Department of Environmental Management	List of brownfield sites and their locations, which were considered or provided resources by IDEM	2513 / 2251 sites	Included in list in 2010	https://www.in.gov/ifa/brownfields/program-sites/
United States Census Bureau, 2010 Census	Race, ethnicity, sex, income, percent elderly, percent urban per census tract	1511 / 1252 census tracts	2010	https://data.census.gov/all?q=2010+census
United States Centers for Disease Control and Prevention, PLACES dataset	Self-reported general health, physical health, mental health, and percent smokers per census tract	1256 / 1252 census tracts	2021	https://healthdata.gov/dataset/PLACES-Local-Data-for-Better-Health-Census-Tract-D/p6fn-8zmi

Table 2.

Mean (95% confidence interval) for census-tract level demographic and health characteristics by frequency of hazardous waste sites per census tract, Indiana, USA.

Characteristic	All census tracts	≥3 Superfund sites	≥3 brownfield sites
Number of census tracts	1292	299	300
Nonwhite, %	17.9 (16.6, 19.2)	16.0 (13.7, 18.4)^a	24.7 (21.6, 27.8)^a
Median household income, per \$1000	56.0 (54.8, 57.1)	51.7 (49.8, 53.6)^a	45.7 (44.1, 47.4)^a
Urban, %	71.2 (69.0, 73.5)	69.9 (65.3, 74.5)	86.0 (82.4, 89.5)^a
Female, %	50.8 (50.6, 51.0)	50.3 (49.7, 50.8)^a	50.4 (49.8, 51.0)
Hispanic or Latino, %	5.6 (5.2, 6.1)	6.4 (5.2, 7.5)	7.0 (5.9, 8.1)^a
≥60 years, %	18.4 (18.1, 18.8)	18.4 (17.7, 19.0)	17.6 (16.9, 18.3)
Current smokers, %	22.1 (21.8, 22.4)	22.7 (22.2, 23.2)^a	23.5 (22.9, 24.0)^a
Fair or poor general health status, %	22.2 (21.8, 22.6)	22.7 (22.1, 23.4)^a	24.2 (23.5, 25.0)^a
Physical health not good for >14 days, %	15.1 (14.9, 15.2)	15.5 (15.1, 15.8)^a	16.0 (15.6, 16.4)^a
Mental health not good for >14 days, %	16.6 (16.4, 16.8)	17.1 (16.7, 17.4)^a	17.8 (17.5, 18.2)^a

^a Comparison vs. the lowest tertile of hazardous waste sites (0–1 for Superfund sites, 0 for brownfields), unadjusted Wald test $p < 0.05$.

Table 3.

Adjusted β (95% confidence interval) indicating the association of demographic characteristics with brownfield or Superfund sites per census tract, Indiana, USA

Model	Characteristic	Superfund sites	Brownfield sites
Model 1 Individual factors N=1252	Nonwhite, %	-0.006 (-0.008, -0.004) ^a	0.004 (0.002, 0.006) ^a
	Household income, per \$1000	-0.014 (-0.017, -0.011) ^a	-0.024 (-0.028, -0.021) ^a
	Hispanic or Latino, %	0.016 (0.012, 0.020) ^a	0.002 (-0.002, 0.007)
	Female, %	-0.009 (-0.018, 0.0003)	-0.022 (-0.029, -0.015) ^a
	≥60 years, %	0.015 (0.007, 0.023) ^a	-0.005 (-0.013, 0.002)
	Current smokers, %	0.001 (-0.009, 0.012)	-0.021 (-0.031, -0.011) ^a
Model 2 Combined race, income N=1252	% nonwhite & household income		
	Low % nonwhite, low income	0.165 (0.037, 0.292) ^a	0.864 (0.720, 1.007) ^a
	Low % nonwhite, high income	Referent	Referent
	High % nonwhite, low income	0.127 (0.005, 0.248) ^a	1.153 (1.022, 1.28) ^a
	High % nonwhite, high income	-0.043 (-0.180, 0.095)	0.541 (0.387, 0.695) ^a
	Hispanic or Latino, %	0.015 (0.010, 0.019) ^a	-0.003 (-0.007, 0.002)
	Female, %	-0.012 (-0.021, -0.002) ^a	-0.027 (-0.034, -0.020) ^a
	≥60 years, %	0.016 (0.008, 0.023) ^a	-0.006 (-0.014, 0.001)
	Current smokers, %	0.018 (0.008, 0.027) ^a	-0.002 (-0.012, 0.007)
Model 3 >80% urban areas N=818	% nonwhite & household income		
	Low % nonwhite, low income	0.332 (0.132, 0.533) ^a	1.105 (0.886, 1.325) ^a
	Low % nonwhite, high income	Referent	Referent
	High % nonwhite, low income	0.206 (0.027, 0.386) ^a	1.082 (0.879, 1.285) ^a
	High % nonwhite, high income	-0.007 (-0.202, 0.187)	0.497 (0.280, 0.715) ^a
	Hispanic or Latino, %	0.016 (0.011, 0.020) ^a	-0.004 (-0.009, 0.001)
	Female, %	-0.010 (-0.021, 0.001)	-0.034 (-0.041, -0.026) ^a

Model	Characteristic	Superfund sites	Brownfield sites
	≥60 years, %	0.016 (0.007, 0.025) ^a	-0.010 (-0.018, -0.002) ^a
	Current smokers, %	0.019 (0.009, 0.030) ^a	-0.005 (-0.015, 0.005)

Results are from Poisson regression models adjusted for all variables in the table.

^aWald test $p<0.05$

Table 4.

Adjusted β (95% confidence interval) indicating the association of tertile of brownfield of Superfund sites with self-reported poor health outcomes per census tract, Indiana, USA, N=1262.

Health outcome	Superfund sites	Brownfield sites
General health ^a	0.007 (−0.057, 0.070)	0.057 (0.010, 0.104) ^d
Physical health ^b	0.014 (−0.017, 0.045)	0.016 (−0.006, 0.039)
Mental health ^c	−0.004 (−0.044, 0.035)	0.046 (0.017, 0.075) ^d

Results are from linear regression models adjusted for percent female, percent nonwhite, percent Hispanic or Latino, median household income per \$1000, percent ≥ 60 years old, and percent current smokers.

^a. Percent reporting fair or poor general health status out of a 5-item Likert scale.

^b. Percent reporting physical health not good for >14 days in the past month.

^c. Percent reporting mental health not good for >14 days in the past month.

^d. Wald test $p < 0.05$