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Structural disadvantage and the concentration of environmental hazards in school areas: a research note

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Abstract Research shows that environmental hazards are disproportionately located in poor and minority communities, but most of these studies examine the association between community demographics and the presence (and/or frequency) of one type of environmental hazard at a time. The current study extends the prior research by examining the concentration of multiple forms of environmental hazards and structural disadvantage of school areas. School area structural disadvantage is associated with an increase in the number of environmental hazards, but the magnitude of the association is relatively small. Implications for future research are discussed.

Introduction

The terms "environmental racism" and "environmental classism" were coined to describe community group claims that a disproportionate number of environmental hazards (and thus a higher potential for exposure) are found in minority and lower class communities.[1] A number of empirical studies examine the association between

[1]A variety of terms are used to describe these claims (e.g., environmental inequality, environmental discrimination, environmental racism, environmental classism) and each term has a slightly different meaning. Environmental racism is similar to other forms of (non-environmental) racism. Although the law requires intent [32] environmental justice scholars define it as any environmental policy, practice or directive that differentially affects or disadvantages, regardless of intention, individuals, groups or communities based on race or color [9, 10]. Environmental justice is generally viewed as the solution to environmental racism/classism. The term encompasses multiple concepts, but goes beyond merely achieving equity [15]. Bryant [9], for example, defines environmental justice as "those cultural norms and values, rules, regulations, behaviors, policies and decisions to support sustainable communities, where people can interact with confidence that their environment is safe, nurturing and productive" ([9]; 6). The term often implies that inequity is due, in part, to racial discrimination [15].

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community race and class and the distribution of environmental hazards. In this research tradition, most scholars compare the racial and class/socioeconomic demographics of "host" communities to those of "nonhost" communities.[2] This literature addresses a number of different types of environmental hazards, but generally each study examines one type of hazard at a time. Most studies demonstrate a positive association between minorities, lower class residents and the presence of an environmental hazard.

In the current research, we provide a unique perspective by examining *multiple types* of environmental hazards currently located *in school areas*.[3] Specifically, we examine whether school area demographics co-vary with the concentration of three types of environmental hazards: Treatment, Storage, and Disposal Facilities (TSDFs), abandoned hazardous waste sites and Toxic Release Inventory (TRI) facilities. Rather than viewing race and class characteristics of school areas as competing and independent explanations, we recognize them to be interrelated concepts. Thus, we combine race and class into a scale to assess the relationship between structural disadvantage and the concentration of environmental hazards in school areas.

This research is important for several reasons. Several studies suggest that children are especially vulnerable to chemical exposure [11, 12, 23, 26]. Children are more susceptible to the adverse effects of environmental pollution because they fundamentally differ from adults in their physiology, metabolism and absorption and exposure patterns [11, 25, 26]. In addition, the negative effects of exposure go even further than serious health problems. Respiratory problems are statistically associated with poor overall school performance [26].[4]

The potential *concentration* of environmental hazards also has important implications for claims of environmental injustice. If multiple forms of environmental hazards are concentrated in the same area, previous studies that focus on only one type may underestimate the environmental burden placed on minority and lower class communities.

We begin our study with a brief summary of the existing literature on race, class and environmental hazards used to develop our hypotheses. Next, we describe the data used to test our hypotheses and our findings. Finally, we conclude the paper with a discussion of our results and their implications for future research.

Relevant literature

As noted, most studies indicate that environmental hazards are disproportionately located in low-income and/or minority communities. The research consistently

[2] Community is defined by census boundaries, most often census tract. Some researchers have moved toward distance based models to more accurately define community, but continue to rely on census boundaries to gather demographic data within a specified radius of the environmental hazard [21].

[3] This study is not designed to examine historical siting (placement) practices or to infer racist, classist, or discriminatory intent in siting decisions. We examine the current distribution of environmental hazards.

[4] Respiratory problems such as asthma may lead to more hospitalizations, limiting students' ability to maintain consistent school experience. According to the Center for Health, Environment and Justice [11], asthma is the primary cause of absenteeism, the third leading cause of hospitalizations among children under the age of 15 and the number one childhood illness in the United States.

shows an unequal distribution of TSDFs [6, 7, 20, 21, 24]; abandoned hazardous waste site [31, 35] for exceptions see 3, 18] and TRI facilities [1, 4, 28, 29; for exception see 8]. Studies also indicate that environmental risks may be greater in school areas where minorities and poverty are concentrated [11, 12, 25, 26].[5] Based on these findings, we hypothesize a positive relationship between minority populations and each form of environmental hazard and a positive relationship between economically disadvantaged populations and each form of environmental hazard.

Nearly all of the existing studies examine the association between race, class and specific types of environmental hazard: TSDFs, abandoned waste sites *or* TRI facilities.[6] Given the consistency of research findings across different types of hazards, it is likely that poor and minority school areas are burdened with *multiple types* of environmental hazards *at the same time*. In the current study, we move beyond single indicators to examine the association between race, class, and multiple types of environmental hazards in a national sample of public and private school areas.

In the environmental justice literature, community race and class are viewed as competing and independent explanations for the unequal distribution of environmental hazards. In nearly all of the studies, regression models contain race and class measures as distinct independent variables (for examples, see [4, 7, 20, 21, 24, 28, 29]). In some cases, conclusions regarding environmental racism/classism are based on whether race variables (e.g., percent black or percent nonwhite) retain a significant association with environmental hazards after social class is included in the model.[7]

We draw from sociology [33, 34] in which race and class are interrelated concepts. Community race and class are not completely distinct; they are overlapping forms of disadvantage. Groups at the bottom of the stratification hierarchy are more likely to experience environmental hazards [27]. The distribution of environmental hazards may not be related to *either* race *or* class. It may be the result of race *and* class structural disadvantage. Thus, we construct a measure of structural disadvantage (including race and class measures) and hypothesize that the level of disadvantage will be positively related to the concentration of environmental

[5] We recognize that the presence of an environmental hazard is not the same as exposure. Proximity, however, does increase the risk of exposure.

[6] A few studies have examined multiple indicators [15, 25]. Pastor, et al., [25] examine each indicator as separate outcome measures rather than a concentrated threat. Fricker and Hengartner [15] move beyond examining a single type of environmental hazard and incorporated into their analysis a "broader class of environmentally undesirable sites" ([15]; 36), which included landfills, incinerators, bus garages and sewage treatment plants in New York city. They find the proximity of minorities to undesirable sites varied by borough. Specifically, race was significantly and positively associated with the number of undesirable sites in Brooklyn, the Bronx and Queens; however, in Manhattan, the association was significantly negative and in Staten Island, the association was non-significant.

[7] For example, Mohai and Saha [21] use distance-based methods to determine "the relative importance of economic and sociopolitical factors in accounting for racial disparities in the distribution of the nation's TSDFs" ([21]; 378). Similarly, Daniels and Friedman [13] state that race effects "are largely explained by economic stratification and urbanization" ([16]; 257).

hazards in school areas. In the following section, we describe the data, measures and methods used to test these hypotheses.

Methodology

A national sample of schools was identified from the National Study of Delinquency Prevention in Schools [16]. Using a commercial mailing list provided by the National Center for Education Statistics, Gottfredson et al [16] sent surveys to a randomly selected, nationally representative sample of schools stratified by location (urban, suburban and rural) and school level (elementary, middle and high). We matched 1990 census and environmental hazard data (TSDF, abandoned hazardous waste sites and TRI facilities) to the school area using school zip code.[8] Table 1 provides a description of each of the variables used in the analysis.

Dependent variables

We collected information on the presence (or absence) of three forms of environmental hazard: TSDFs, uncontrolled waste sites (federal data, including NPL and other designations) and TRI facilities (see literature review for a detailed description of each type). We provide some analysis using each outcome as a separate indicator to support our assertion of a consistent relationship between race, class and each type of environmental hazard. Ultimately, we sum each dummy variable to create a count of the types of environmental hazards present in each school zip code (0–3).

Independent variables

Racial/Ethnic and class composition

Consistent with prior literature, we include measures of the percent of white, black, and Latino residents in the school area. We use multiple measures of socioeconomic or class status, including the percentage of households receiving government assistance; percentage of individuals with a college degree; median household income; unemployment; percentage of families living below the poverty line; and the percentage of single mothers living below the poverty line. Because of the high correlation between these measures (specifically percent black and measures of extreme socioeconomic disadvantage), we use principal component factor analysis to construct a "*structural disadvantage*" scale. Five measures load highly on one factor: percent black, percent unemployed, percent of families living below the

[8] We recognize the variation in and debate on the appropriate unit of analysis in the environmental justice literature [2, 24]. We also recognize the contribution of distance-based methods to define the "host" area [20, 21]. Unfortunately, none of the current specifications truly represent the boundaries of communities, schools or high-risk areas. The appropriate unit of analysis should be determined by the research question [17]. In the current analysis, we focus on schools. We consider zip code to be more representative of the "school area" because school assignments are often done on the basis of address.

Table 1 Variable names and definitions

Name	Variable description
Dependent variable	
Environmental hazards	Count of the types of environmental hazards in a zip code
Superfund	Presence or absence of a Superfund site
TRI	Presence or absence of a TRI facility
TSDF	Presence or absence of a TSDF facility
Race	
Percent white	Percentage of persons who are white
Percent black	Percentage of persons who are black
Percent Latino	Percentage of persons who are Latino
Structural disadvantage	Composite scale including percent black, persons receiving government aid, persons unemployed, percent of families living below the poverty line and percent of single mothers living below the poverty line
Class	
Government aid	Percentage of persons receiving government aid
College degree	Percentage of persons with a college degree
Median household income	Median household income
Unemployment	Percentage of persons who are unemployed
Poverty-families	Percentage of families with incomes below the poverty line
Poverty-single mothers	Percentage of single mothers with income below the poverty line
Industrial/housing	
Manufacturing	Percentage of persons employed in manufacturing
Housing density	Number of households in each zip code
Linguistic isolation	Percentage of persons who are non-English speaking
Residential stability	Percentage of persons living in the same house for 5 years
School location	
Rural	Rural metropolitan status of the schools
Urban	Urban metropolitan status of the schools
Suburban	Suburban metropolitan status of the schools

poverty line, percent of single mothers with income below poverty and percent receiving government aid.[9] Table 2 provides the communalities and the total variance explained for the factor variable structural disadvantage. The standardized communality loading of this variable is moderate (3.989) and explains 80% of the variability in these five items. The internal consistency reliability estimate (Cronbach's alpha) is 0.78 for this measure.

[9] We made the decision to exclude percent Latino from the structural disadvantage scale for empirical and theoretical reasons. Percent Latino is correlated with the class measures in the same direction as percent black, but the associations are much weaker. For example, the correlation between percent Latino and the percent of families living below the poverty line is 0.39 (see Table 5). The association with single mother families living below the poverty line is even lower (.25). School areas with higher percentages of black residents are more disadvantaged than those areas with a high percentage of Latino residents. This is consistent with prior theoretical literature. Wilson [33, 34] theorizes (and provides data) that deindustrialization had a significant impact on the class status of black communities. Moore and Pinderhughes [22] theorize that deindustrialization did not impact Latino communities as greatly. Essentially the authors argue that Latinos may not hold the "best" jobs, but they are working. Industries in which Latinos tend to be employed (e.g., electronics, garment manufacturing, etc) have experienced a "reindustrialization." Latinos also tend to work in the service jobs that have become widely available with the changing economy. Finally, many Latinos work in the informal economy and continue to make their living by being paid "off the books." As a result, Latino communities are not as disadvantaged [22].

Table 2 Factor analysis for structural disadvantage

Variable	Communalities
Percent black	0.567
Percent unemployed	0.760
Percent receiving government aid	0.864
Percent of families living below the poverty line	0.872
Percent single mothers living below the poverty line	0.927
Total sum of squared loading	3.989

Control variables

We include several control variables: percent employed in manufacturing; housing density; linguistic isolation (non-English speaking population) and residential stability (residents who have lived in the same house at least 5 years prior to the census survey). Environmental hazards are likely higher in school areas with more manufacturing [2]. Consistent with prior literature, we include percent employed in manufacturing [2, 29]. Housing density (the number of households in each zip code divided by the land area in square meters) is included because some environmental hazards (i.e., landfills) may be located in rural school areas with more available land [14].[10] Linguistic isolation is included in this research because language may be an important element of school area organization. If most individuals in a given area speak a foreign language, residents may have difficulties in organizing amongst themselves to fight the placement of new environmental hazards in their community. Finally, residential stability is also included because stable school area residents may strongly oppose any environmental hazards that may decrease property values [5]. These residents may also be more active because of their greater personal attachment to and past political involvement in the area [5].

We also include dummy variables for urban, suburban and rural location of the schools. This variable is included because environmental hazards may be concentrated in specific areas. TSDFs (especially landfills) may be located in rural areas while manufacturing facilities have historically been place in urban areas.

Description of the sample

The original sample for this study consisted of 996 school zip codes. Several school areas were removed from the sample due to missing census data, resulting in a final sample of 897 zip codes.[11] Table 3 provides the descriptive statistics of all the variables used in this analysis. The average school area is 76% white, 11% black and 8% Latino. On average these school areas have low levels of government assistance (6.86%), low unemployment (4.05) and few single mothers living in poverty (4.80). Just over 10% of families in the average school area live below the poverty line. In terms of class advantage, 55% of residents in the average school area have a college

[10] Because information on land area was collected from the 2000 Census, the housing density measure has some additional missing data.

[11] The sample size is slightly lower in the regression models due to the missing data on housing density (n=889).

Table 3 Descriptive statistics on demographic characteristics of the sample (N=897)

	Minimum	Maximum	Mean	Standard deviation
Dependent variable				
Environmental hazards	0	3	1.30	0.94
Abandoned hazardous waste sites	0	1	0.67	0.47
TRI	0	1	0.51	0.50
TSDF	0	1	0.11	0.32
Race				
White	0.43	100.0	76.62	25.85
Black	0.00	99.39	11.61	19.83
Latino	0.00	96.80	8.16	15.60
Class				
Government aid	0.00	50.60	6.86	6.07
College degree	8.86	361.01	54.53	25.14
Structural disadvantage	−1.14	7.02	0.00	1.00
Median household income	4,999.00	120,956.00	32,378.86	13,900.22
Unemployment	0.00	14.68	4.05	2.07
Poverty-families	0.00	75.49	10.55	9.91
Poverty-single mothers	0.00	60.03	4.80	5.99
Control				
Manufacturing	7.38	119.75	43.33	17.88
Housing density	0.00	2.31	0.05	0.15
Linguistic isolation	0.00	56.61	2.91	5.25
Residential stability	1.53	79.22	49.69	10.80
School				
Rural	0.00	1.00	0.30	0.46
Urban	0.00	1.00	0.34	0.48
Suburban	0.00	1.00	0.35	0.48

degree and the median household income is slightly over $30,000. Turning to the control variables, nearly 50% of school area residents lived in the same house for 5 years and 43.33% are employed in manufacturing. Less than 5% (2.91) of the residents are non-English speaking. Finally, 31% of schools are considered rural, 34% are urban and 35% are suburban.

Moving to the dependent variable, 67% of school areas contain a superfund site, 51% a TRI facility and 11% a TSDF. The average school area contains 1.3 environmental hazards. Table 4 provides additional information on the distribution of the count variable. Twenty-four percent of the school areas do not host any type of environmental hazard. At the opposite extreme, 9% host three environmental hazards. Most school areas fall in the middle: 67% of school areas contain one or two environmental hazards.

Analytic strategy

We use correlations (Pearson's R-Correlation statistic) to test bivariate hypotheses regarding the relationship between school area race, class, structural disadvantage and each type of environmental hazard (as separate indicators). Based on the supportive evidence, we subsequently examine whether the count/concentration of different types of environmental hazards varies by school area structural disadvantage. We use multivariate regression models to determine whether bivariate race/class associations remain significant when control variables are included. Count variables

Table 4 The distribution of the number of environmental waste facilities found within a census tract (N=897)

Number of facilities	Frequency	Percent
0	214	23.9
1	282	31.4
2	318	35.5
3	83	9.3

can assume any distribution, rendering ordinary least squares regression (OLS) inappropriate because of the normal distribution assumption [19].[12] Thus, we test our multivariate hypotheses regarding the relationship between structural disadvantage and the concentration of environmental hazards using a Poisson count model.[13]

Analysis and results

Bivariate analysis

Table 5 provides bivariate correlations. Based on the previous literature, we hypothesized that minority *and* lower income school areas are more likely to contain each type of environmental hazards and thus are also more likely to have a higher concentration of environmental hazards. The correlations in Table 5 support this hypothesis. Specifically, percent black in the school area is positively associated with the presence and concentration of environmental hazards. Percent white has a negative association.[14] Although in the expected direction, the percent of Latino residents in school areas is not significantly associated with the presence of most types of environmental hazards (TSDF and the concentration measure are significant).

Turning next to social class, all measures are correlated with environmental hazards in school areas in the expected direction and nearly all are significant.[15] School areas with a higher unemployment, more government aid, and more families/ single mothers living in poverty are more likely to host one and multiple forms of environmental hazard. Conversely, school areas with higher median household incomes and higher education are less likely to host environmental hazards. The reversal of the sign of the correlation supports environmental justice arguments. Education and income more accurately measure *advantage* and opportunity (and are

[12] OLS would result in inefficient, inconsistent and biased estimates [19].

[13] Poisson models assume “equidispersion,” that “the conditional mean of the outcome is equal to the conditional variance” ([19]; 218). In practice the distribution of many count outcomes violates this assumption, requiring a move to the negative binomial model [19]. Our data, however, are consistent with the Poisson assumption. The variance is not greater than the mean. Further, the log likelihood ratio test (chi-square distribution) indicates that the results of the negative binomial model are not significantly different from the Poisson model.

[14] The correlations between race and the presence of an abandoned waste site are not significant, but are in the expected direction. The correlations between class and abandoned waste sites are significant in the expected direction.

[15] The correlation between abandoned hazardous waste sites and the percent of families living below the poverty line is not significant.

Table 5 Correlations for variables included in the Regression Analysis (N=897)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 EnvHaz																					
2 Superfund	0.76***																				
3 TRI	0.80***	0.35***																			
4 TSDF	0.58***	0.20***	0.26***																		
5 White	−0.11***	−0.04	−0.08**	−0.13***																	
6 Black	0.11***	0.06	0.10***	0.09***	−0.72***																
7 Latino	0.07**	0.00	0.05	0.12***	−0.61***	−0.03															
8 Disadv	0.15***	0.09**	0.14***	0.10***	−0.76***	0.75***	0.32***														
9 Gov't aid	0.14***	0.07**	0.14***	0.09***	−0.67***	0.60***	0.37***	0.93***													
10 College	−0.15***	−0.10***	−0.13***	−0.09***	0.20***	−0.19***	−0.17***	−0.41***	−0.45***												
11 MHI	−0.13***	−0.08**	−0.13***	−0.07**	0.34***	−0.34***	−0.18***	−0.62***	−0.57***	0.48***											
12 Unempl	0.15***	0.08**	0.14***	0.10***	−0.70***	0.56***	0.38***	0.87***	0.77***	−0.41***	−0.56***										
13 PFamily	0.10***	0.06	0.09***	0.08**	−0.67***	0.58***	0.39***	0.93***	0.87***	−0.43***	−0.69***	0.78***									
14 PSMom	0.16***	0.11***	0.14***	0.10***	−0.69***	0.71***	0.25***	0.96***	0.89***	−0.34***	−0.57***	0.77***	0.90***								
15 Manuf	0.24***	0.10***	0.28***	0.12***	0.02	0.02	0.02	0.20***	0.26***	−0.64***	−0.39***	0.26***	0.23***	0.13***							
16 HouDen	−0.14***	−0.16***	−0.09***	−0.04	−0.28***	0.18***	0.19***	0.21***	0.24***	0.05	−0.02	0.17***	0.14***	0.21***	−0.19***						
17 NoEng	0.04	−0.00	0.03	0.07**	−0.59***	−0.00	0.85***	0.33***	0.38***	−0.13***	−0.16***	0.37***	0.41***	0.26***	−0.01	0.30***					
18 ResStab	−0.03	−0.01	−0.04	−0.02	0.10***	0.03	−0.15***	0.03	0.10***	−0.44***	0.01	0.01	0.03	−0.01	0.29***	0.04	−0.10***				
19 Rural	−0.08**	−0.01	−0.09***	−0.07	0.26***	−0.19***	−0.17***	−0.09***	−0.06	−0.24***	−0.22***	−0.07**	0.03	−0.12***	0.31***	−0.22***	−0.20	0.17***			
20 Urban	0.04	0.02	0.03	0.03	−0.39***	0.30***	0.26***	0.36***	0.31***	0.06	−0.24***	0.31***	0.31***	0.37***	−0.16***	0.29***	0.27***	−0.19***	−0.48***		
21 Suburban	0.05	−0.00	0.07**	0.04	0.14***	−0.12***	−0.09***	−0.27***	−0.25***	0.18***	0.44***	−0.24***	0.34***	−0.26***	−0.15***	−0.08**	−0.07**	0.02	−0.48***	−0.53***	

*p<0.10. **p<0.05. ***p<0.01.

negatively associated with environmental hazards) while government aid and poverty capture extreme *disadvantage* (and are positively associated with environmental hazards). When the measures of disadvantaged and race are combined into a structural disadvantage measure, results are again consistent with environmental justice arguments. Structural disadvantage is positively associated with the presence and concentration of environmental hazards.[16] In sum, these findings are consistent with and expand on prior research suggesting that race and class are related to the concentrate of environmental hazards.

Multivariate analysis

We use a Poisson model to test the relationship between structural disadvantage and the concentration of environmental hazards while controlling for the relevant covariates. Table 6 provides the results of the Poisson regression.[17]

Using the conventional 0.05 standard of statistical significance, the Poisson regression analysis indicates that structural disadvantage is positively (and significantly) associated with environmental hazards in school areas after including the relevant covariates. School area manufacturing employment and housing density are also significantly associated with the number of environmental hazards. As the density of houses in school areas increases, the number of environmental hazards in those areas decreases. Residential stability is associated with a modest decrease in the concentration of environmental hazards in school areas ($p=0.10$). Urban school area and percent of residents that do not speak English are not significantly associated with the number of environmental hazards in school areas.

Predicted values are used to interpret the regression coefficients meaningfully.[18] A one standard deviation increase in school area structural disadvantage increases the expected number of environmental hazards by 0.11 (a 9% increase). Similarly, a one standard deviation increase in manufacturing results in a 0.19 (or 16%) increase in the number of environmental hazards in school areas. The strongest predictor of

[16] Although we are primarily interested in our count outcome, we regressed structural disadvantage on each specific form of environmental hazard (using multivariate logistic regression models) to examine whether it remained significant after including the relevant control variables (data not shown). Structural disadvantage remained significant (in the expected direction) for every outcome (TSDF, TRI, and abandoned waste sites). Thus, in addition to prior research on each specific form of environmental hazard, our empirical results also justify moving to the count (concentration of environmental hazards) model.

[17] We do not include several covariates in the multivariate regression model because they are highly correlated with other measures in the model. For example, percent Latino and the percent of residents in the school area that do not speak English are correlated at 0.85. We entered these variables in separate models (with all other covariates). Like non-English speaking, percent Latino is insignificant. College education and median income are correlated with structural disadvantage (−0.41 and −0.62 respectively). When entered instead of disadvantage, both are insignificant. Percent white (also correlated with structural disadvantage, −0.76), however, is significantly associated with a decrease in the number of environmental hazards (when structural disadvantage is excluded).

[18] We first calculated the expected concentration of environmental hazards with all variables set to the mean value. We then changed the value for the variable of interest (to one standard deviation above the mean) and examined the difference in the expected concentration [19].

Table 6 Poisson regression with count outcome (N=889)

Variables	B
Constant	0.178
	(0.159)
Structural disadvantage	0.087***
	(0.032)
Manufacturing	0.008***
	(0.002)
Housing density	−1.47***
	(0.424)
Residential stability	−0.006*
	(0.003)
Linguistic isolation	0.004
	(0.006)
Urban	0.097
	(0.071)

*p<0.10. **p<0.05. ***p<0.01.

the number of environmental hazards in school areas is housing density.[19] A one standard deviation increase in housing density decreases the number of environmental hazards by 0.24 (a 20% decrease).

Discussion and conclusion

In the current study, we make several contributions to the environmental justice literature. First, we examine the distribution of environmental hazards in a national sample of public and private school areas. Although some have examined schools and environmental hazards, studies have been few in number and often are limited to schools in one location. We also add a unique outcome measure to the existing literature. Rather than examining one type of environmental hazard, we examine the concentration of three types of hazards in school areas. Finally, race and class are theoretically (and empirically) overlapping forms of disadvantage. Rather than treating them as independent and competing explanations, we create a scale of structural disadvantage that captures the overlap.

When examined separately at the bivariate level, race and class are associated with the presence and concentration of environmental hazards in school areas. Our scaled measure of structural disadvantage is also associated with school area environmental hazards in the expected direction. School areas higher in structural disadvantage have more environmental hazards.

In the multivariate Poisson model, several control variables also predict the concentration of environmental hazards in school areas. Consistent with prior research, the percent of school area residents employed in manufacturing is significantly (and positively) associated with environmental hazards. In addition, school areas with higher housing density have fewer environmental hazards. Although generally not included in environmental justice studies, school area residential stability also decreases the number of environmental hazards (p=0.10).

[19] This counters findings from prior research in that many found manufacturing to be the stronger predictor [13].

The findings from this study are important for several reasons. We extend the environmental justice literature to show that *disadvantaged school areas* face a greater environmental burden. This extension of the literature is particularly important because of the greater vulnerability of children and teens attending schools in these areas. In addition, we find an association between disadvantaged school areas and *multiple forms* of environmental hazards. Previous studies that focus on one type of hazard may underestimate the significance of the association. Proximity does not equate to exposure, but the presence of additional environmental hazards does increase the risk of exposure, negative health effects, missed school and so forth.

While we consider our findings important, we must take care not to overstate the effect of school area disadvantage. The magnitude of the effect of structural disadvantage is modest. In these data, the number of environmental hazards in school areas is less associated with structural disadvantage (or race and class alone) than with the percent of residents employed in manufacturing and housing density. In fact, a one standard deviation increase in structural disadvantage is associated with only a 0.11 increase in the number of hazards. Therefore, while findings are statistically significant, the magnitude of the effect is relatively small.[20]

Some may assume that the association between race, class and environmental hazards is weak because we focus on school area rather than community. We do not think that is the case for several reasons. First, our findings are consistent with the few existing studies in this area. Other school-based studies show an inequitable distribution of environmental hazards by race and class. In addition, many scholars assert that schools emerge from and reproduce community characteristics. In other words, school climate and culture intersect with neighborhood characteristics (for a review, see [30]). Thus, school areas are thought to be quite similar to the community in which they are located.

Measurement, scope, and sample might also affect our findings. Although our study makes a contribution by examining the concentration of environmental hazards, it is limited to only three types. Other types of environmental hazards (e.g., pesticide use) may be more strongly associated with school area disadvantage. Moreover, the range of the dependent variable (i.e., 0–3) is limited. Restricted variation may limit the size of the effects. Finally, our national sample may mask important city or regional variation in the influence of structural disadvantage on the concentration of school area environmental hazards. Some studies have found that race and class are stronger predictors of environmental hazards in certain areas of the country (see e.g., [4]). These are empirical questions that can guide future research.

We acknowledge all of these potential limitations, but are confident that these limitations are not unduly influential because our results are consistent with prior national and regional community research. While race and class matter, they may not be the *primary* determinants of the number of environmental hazards in a school area. Yet, given the potential consequences to poor and minority school children, we suggest that any association between race, class, and environmental hazards is problematic.

[20] Although distance based models have uncovered stronger race and class effects, the magnitude of the association is still modest in these studies [20, 21].

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