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Environmental Inequality in Metropolitan America

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Abstract

This study compares the environmental hazard burden experienced by Blacks, Hispanics, Pacific Islanders, Native Americans, Asian Americans, and Whites in each of the 329 metropolitan areas in the continental United States, using toxicity-weighted air pollutant concentration data drawn from the Environmental Protection Agency's Risk-Screening Environmental Indicators project to determine whether and to what degree environmental inequality exists in each of these metropolitan areas. After demonstrating that environmental inequality outcomes vary widely across metropolitan areas and that each group in the analysis experiences a high pollution disadvantage in multiple metropolitan areas and a medium pollution disadvantage in many metropolitan areas, the authors test three hypotheses that make predictions about the role that residential segregation and racial income inequality play in producing environmental inequality. Using logistic regression models to test these hypotheses, the authors find that residential segregation and racial income inequality are relatively poor predictors of environmental inequality outcomes, that residential segregation can increase and decrease racial/ethnic group proximity to environmental hazards, and that the roles income inequality and residential segregation play in producing environmental inequality vary from one racial/ethnic group to another.

Keywords

environmental inequality; environmental racial inequality

In the past 20 years, academic knowledge concerning environmental inequality has grown steadily as researchers from a variety of disciplines have examined, with increasing sophistication, not only the distribution of social groups around environmental hazards (Bowen, 2002; Brulle & Pellow, 2005; Ringquist, 2005; Szasz & Meuser, 1997) but also the determinants of this distribution (Been & Gupta, 1997; Downey, 2005; Hamilton, 1995; Hunter, White, Little, & Sutton, 2003; Oakes, Anderton, & Anderson, 1996; Pastor, Sadd, & Hipp, 2001; Shaikh & Loomis, 1999) and the causal forces shaping this distribution (Berry, 2003; Browne & Keil, 2000; Gaard, 2001; Norgaard, 2006). Researchers have found income and poverty to be consistently associated with hazard presence in the expected direction: As environmental hazard presence increases, incomes decrease and poverty rates increase (Chakraborty & Armstrong, 1997; Derezinski, Lacy, & Stretesky, 2003; Hamilton, 1995; Krieg, 1995; Lester, Allen, & Hill, 2001; McMaster, Leitner, & Sheppard, 1997; Mohai & Bryant, 1992; Morello-Frosch, Pastor, & Sadd, 2001; Oakes et al., 1996; Ringquist, 2000; Smith, 2007; Stretesky & Hogan, 1998).

Findings regarding the existence of environmental racial inequality have been less consistent (Bowen, 2002; Pastor et al., 2001). Although many studies have found strong evidence of environmental racial inequality (Been, 1994; Brulle & Pellow, 2005; Downey, 1998, [2003], 2006b, [2007]; Hamilton, 1995; Krieg, 1995; Mohai & Bryant, 1992; Morello-Frosch et al., 2001; Ringquist, 1997; Stretesky & Hogan, 1998; Stretesky & Lynch, 2002), some have found evidence of environmental racial inequality for some minority groups but not others (Brown, Ciambrone, & Hunter, 1997; Pastor, Sadd, & Morello-Frosch, 2002; Sadd, Pastor, Boer, & Snyder, 1999), and some have found only weak evidence of environmental racial inequality, inconsistent evidence, or no evidence at all (Anderton, Anderson, Oakes, & Fraser, 1994; Atlas, 2002; Bowen, Salling, Haynes, & Cyran, 1995; Derezinski et al., 2003; Oakes et al., 1996; Yandle & Burton, 1996).

Studies have also varied according to the statistical methods employed, the racial and ethnic groups included in the analysis, the types of environmental hazard indicators used, and the geographic area and type of area (i.e., urban vs. rural) under examination (Downey, 2007). These methodological inconsistencies have limited our understanding of environmental inequality because it is impossible to determine whether the inconsistent findings noted earlier are the result of methodological variation across studies or whether they represent actual variation in environmental inequality outcomes across study areas.

In addition, most environmental inequality research examines either the nation as a whole (Hunter et al., 2003; Perlin, Setzer, Creason, & Sexton, 1995), the nation's urban areas as a whole (Ash & Fetter, 2004; Oakes et al., 1996), or a single or limited number of geographic areas at a time (Bowen et al., 1995; Brown et al., 1997; Downey, 2005; Pastor et al., 2002). One exception to this is Downey (2006a, 2007), who examines variation in environmental inequality outcomes across multiple metropolitan areas, using a singe set of data and a consistent methodology (within each study) to show that environmental inequality outcomes do vary across metropolitan areas. Downey (2007) also finds that metropolitan area residential segregation levels and metropolitan area income inequality levels do a poor job of predicting environmental inequality outcomes across U.S. metropolitan areas. However, Downey's descriptive findings only apply to metropolitan areas with more than 1 million residents, and like most quantitative environmental racial inequality researchers, Downey only examines Black and Hispanic environmental inequality.[1] In addition, Downey only includes a limited number of control variables in his analysis, and although he hypothesizes that residential segregation sometimes separates racial and ethnic minorities from environmental hazards, he does not formally test this prediction.

To overcome these gaps in the literature, this study compares the relative environmental hazard burden experienced by Blacks, Hispanics, Pacific Islanders, Native Americans, Asian Americans, and Whites in each of the 329 metropolitan areas in the continental United States. Using toxicity-weighted air pollutant concentration data drawn from the Environmental Protection Agency's (EPA) Risk-Screening Environmental Indicators (RSEI) Project, this study seeks to determine whether and to what degree environmental inequality existed in each of the nation's metropolitan areas in 2000 and whether environmental inequality outcomes varied across U.S. metropolitan areas at that time. Including Asian Americans, Native Americans, Pacific Islanders, and Whites in the study allows us to develop a more complete

[1]Researchers have, of course, attempted to determine whether other racial and ethnic groups experience environmental inequality. For example, Brown et al. (1997) examine the distribution of Asian Americans, Hispanics, Blacks, and Whites around environmental hazards in Boston, Pittsburgh, and Seattle, and Pastor et al. (2002) examine the distribution of Asian American, Latino, Black, and White schoolchildren around environmental hazards in the Los Angeles Unified School District (also see Ash & Fetter, 2004; Bullard, Mohai, Saha, & Wright, 2007; Morello-Frosch & Jesdale, 2006). Researchers have also investigated environmental inequality on Native American reservations (Akwesasne Task Force, 1997; Clark, 2002; Gedicks, 1993, 2004, 2005; Grinde & Johansen, 1995; Hooks & Smith, 2004, 2005; Sachs, 1996; Small, 1994**[PLS PROVIDE REFERENCE]**). Nevertheless, very few quantitative studies have examined Asian American environmental inequality, we are aware of no studies that investigate Pacific Islander environmental inequality separately from Asian American environmental inequality, and most studies of Native American environmental inequality are qualitative case studies of rural reservations. These studies have contributed greatly to our understanding of environmental racial inequality, but they do not tell us whether Asian Americans, Pacific Islanders, and Native Americans are disproportionately burdened by environmental hazards in most urban areas.

and nuanced understanding of environmental inequality in metropolitan America than we otherwise could, and using air pollutant concentration data rather than hazard proximity data allows us to compare the environmental hazard burden experienced by different racial and ethnic groups more accurately than has been possible in most prior research (Ash & Fetter, 2004).

Finally, this study also asks whether metropolitan area residential segregation levels and metropolitan area income inequality levels do a good job of predicting environmental inequality outcomes. In doing this, we expand on Downey (2007) by (a) running regression models for Asian Americans, Pacific Islanders, and Native Americans; (b) including additional control variables in the regression analyses; and (c) formally testing the hypothesis that residential segregation can separate racial and ethnic minorities from environmental hazards. Including additional control variables in the regression analyses increases our confidence in the validity of our results, and formally testing the hypothesis that residential segregation can separate racial and ethnic minorities from environmental hazards is important because several studies have shown that this can occur (Boone, 2002; Downey, 2005, [2007]; Krieg, 1995), but researchers have not attempted to generalize these results beyond a handful of metropolitan areas.

Theoretical Predictions

Environmental inequality researchers have developed several explanations for the existence of environmental inequality, arguing that poor and minority neighborhoods are more likely than other neighborhoods to house environmental hazards because (a) poor and minority communities lack the political power to keep hazardous facilities out of their neighborhoods (Hamilton, 1995; Mohai & Bryant, 1992), (b) housing market racism confines minorities to undesirable neighborhoods shunned by Whites (Bullard, 1993; Godsil, 1991; Mohai & Bryant, 1992; Morrello-Frosch & Jesdale, 2006), and (c) housing costs are relatively low in environmentally hazardous neighborhoods, making them more attractive to lower income people who are, in turn, disproportionately non-White (Hamilton, 1995; Mohai & Bryant, 1992; Oakes et al., 1996).

If environmental inequality researchers are correct in positing that environmental racial inequality is a function of income inequality, political inequality, and residential segregation, then environmental racial inequality should vary across metropolitan areas in accordance with metropolitan area variations in these factors. Political inequality is quite difficult to measure, so we will not test the political inequality hypothesis, but income and segregation measures are readily available for U.S. metropolitan areas. Thus, after presenting descriptive data that compare the relative environmental hazard burden experienced by Blacks, Hispanics, Pacific Islanders, Native Americans, Asian Americans, and Whites in each of the 329 metropolitan areas in the continental United States, we run a set of regression models that test the following hypothesis:

> *Hypothesis 1*: Racial and ethnic groups are more likely to experience a high pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience (a) relatively high levels of residential segregation or (b) relatively low income levels (compared to the income levels of other racial/ethnic groups in the same metropolitan area).

In contrast to most environmental inequality researchers, Downey (2007) argues that residential segregation can separate racial and ethnic minorities from polluted neighborhoods because the spatial distributions of environmental hazards and minority populations do not necessarily follow the same logic. As a result, in some metropolitan areas, environmental hazards may be dispersed relatively widely across urban space such that segregated minority groups live near some environmental hazards but not others; and in other metropolitan areas, environmental hazards and minority populations may both be residentially concentrated but in different parts of the same metropolitan area.[2]

Downey (2007) further argues that environmental inequality outcomes and the role that residential segregation and racial income inequality play in shaping environmental inequality outcomes appear to be highly contingent on local conditions that, in turn, are likely to be the product of historical forces that vary from one metropolitan area to another. If Downey is correct, then (a) environmental inequality outcomes should vary widely across metropolitan areas and (b) residential segregation should sometimes separate racial and ethnic minorities from environmental hazards.

In arguing that residential segregation sometimes separates racial and ethnic minorities from environmental hazards, Downey (2007) is suggesting that racial and ethnic minority groups may experience a large pollution disadvantage in some metropolitan areas and a large pollution advantage in other metropolitan areas (relative to other minority groups and to Whites). This is a very different expectation than is found in most environmental inequality research, and testing it requires that we develop hypotheses about the conditions under which racial/ethnic groups are likely to experience relatively high and relatively low pollution burdens (with a high pollution burden being synonymous with high pollution disadvantage, a low pollution burden being synonymous with high pollution advantage, and no pollution advantage or disadvantage being synonymous with relative environmental equality between two racial/ethnic groups).

Thus, Hypothesis 2 reformulates the predictions made in Hypothesis 1 to make these predictions consistent with the expectation that racial/ethnic groups sometimes experience a high pollution advantage relative to other racial/ethnic groups, and Hypothesis 3 formalizes Downey's (2007) prediction that residential segregation sometimes separates racial and ethnic minorities from environmental hazards:

> *Hypothesis 2*: Racial and ethnic groups are more likely to experience a low pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience (a) relatively low levels of residential segregation or (b) relatively high income levels (compared to the income levels of other racial/ethnic groups in the same metropolitan area).
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> *Hypothesis 3*: Racial and ethnic groups are more likely to experience a low pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience relatively high levels of residential segregation.

Pollution Data

The pollution data used in this article were derived from the EPA RSEI Project. The RSEI model from which the pollution data are derived models the toxicity-weighted concentration of air pollutants released from every facility listed in the EPA's year-2000 Toxics Release Inventory (TRI) (see Ash & Fetter, 2004, for a discussion of how these data differ from that found in the public RSEI release).

[2]In the Detroit metropolitan area, for example, industrial facilities expanded into the suburbs in the 1950s and 1960s in large part because automobile manufacturers wanted plenty of open space to build new factories. However, working-class Blacks were unable to move to Detroit's industrial suburbs in significant numbers until at least the 1990s because many of the White residents of these suburbs did not want to live with Blacks (Darden, Hill, Thomas, & Thomas, 1987; Downey, 2005; Sugrue, 1996). As a result, in 1990 and 2000, industrial facilities in Detroit's suburbs were surrounded primarily by Whites. Similarly, Boone (2002) and Downey (2007) show that in Baltimore, Blacks are highly segregated into neighborhoods with relatively few TRI facilities or pollution.

The TRI records the number of pounds of specified toxic chemicals released into the environment each year by industrial facilities that fall into one of seven industrial categories (manufacturing, metal mining, coal mining, electric generating facilities that combust coal or oil, chemical wholesale distributors, petroleum terminals, and bulk storage), employ the equivalent of 10 or more full-time workers, and manufacture, process, or otherwise use the specified chemicals in specified quantities. In 2000, the specified quantities were 25,000 pounds for facilities that manufactured or processed TRI chemicals and 10,000 pounds for facilities that otherwise used TRI chemicals (Rtknet, 2004). The TRI chemical list included more than 600 chemicals and chemical categories in 2000.

The RSEI estimates a 101-kilometer square pollution plume model (made up of one-kilometer square grid cells) for each air pollutant released by each TRI facility in a calendar year. Incorporating factors such as wind speed, wind direction, air turbulence, smokestack height, exit gas velocities, and rate of chemical decay and deposition, the RSEI model estimates a yearly, average air pollutant concentration value for each one-kilometer square grid cell in each air pollutant plume model. Each grid cell value in each air pollutant plume model is then multiplied by the toxicity weight of the modeled air pollutant, and the toxicity-weighted cell values for each air pollutant grid in the United States are then summed together to create a toxicity-weighted air pollutant concentration grid for the entire nation (see EPA, 2004, for technical details on the RSEI model).

To estimate the toxicity-weighted air pollutant concentration level in each census tract in the continental United States, we calculated the proportion of each census tract covered by each grid cell that overlapped it and then calculated the weighted average of each tract's overlapping grid cells, using the proportion overlap as our weighting variable. For example, if Grid Cells 1 and 2 covered 40% and 60% of Tract A, respectively, and if the toxicity-weighted concentration values of these grid cells were 10 and 20, respectively, then the toxicity-weighted concentration value, or toxic concentration value, of Tract A would equal [(10 * .4) + (20 * .6)].[3]

RSEI data represent a real improvement in many respects over hazard proximity data, which have been used in most environmental inequality research.[4] The most important difference between RSEI data and hazard proximity data is that RSEI data provide researchers with much better estimates of the relative, exposure-related risk of living in specific neighborhoods or near specific facilities than do hazard proximity data, which tend to ignore chemical fate, transport, and toxicity and which have been heavily criticized by several researchers (see Bowen, 2002).[5]

Another important difference between RSEI data and hazard proximity data is that the RSEI plume modeling approach allows the concentration of air pollutants and, therefore, the estimated relative risk associated with these air pollutants to (a) decline continuously as distance from the emitting source increases and (b) vary in intensity according to compass direction. In addition, the pollution plume models used to derive RSEI risk estimates extend for miles in all directions. Thus, unlike most hazard proximity data models, the RSEI model

[3]It is important to note that RSEI data are not exposure estimates. They are unitless measures that (a) allow researchers to “assess the relative hazard and risk of chemicals, facilities, regions, and industries” and (b) are only meaningful in relation to other RSEI data values (EPA, 2004). Thus, the tract-level, toxicity-weighted, air pollutant concentration data used in this study provide estimates of the relative risk of each census tract in the study area in relation to every other census tract in the study area.

[4]Most environmental inequality researchers have used hazard proximity data because of the difficulty of obtaining pollutant concentration and exposure data rather than because they think that proximity data are superior to pollutant concentration and exposure data.

[5]RSEI data cannot be used to determine a specific individual's exposure to toxicity-weighted TRI facility emissions, but they do assess the relative exposure-related risk, all else being equal, of living in one neighborhood versus another.

allows hazards and emissions in one analysis unit to affect people living in analysis units quite far removed from the hazard's host unit.

RSEI data are not without their own set of limitations, however. For example, RSEI data are derived from plume model estimates of TRI air releases and as a result do not directly measure neighborhood-level air pollutant concentration levels or estimate non-TRI air pollutant concentration levels. In addition, several simplifying assumptions have to be made to estimate pollutant concentration models for tens of thousands of facilities and hundreds of thousands of releases across the entire United States. For example, the RSEI model assumes continuous and constant pollutant emissions rates, and smokestack height has to be imputed for many TRI facilities (Bouwes & Hassur, 1999; EPA, 2004).

Finally, the health risks associated with pollution exposure (Evans & Kantrowitz, 2002) are not the only set of risks associated with environmental hazards. Environmental hazards can also negatively affect nearby property values, psychological stress, local employment opportunities, sense of community, and local economic activity (Downey & Van Willigen, 2005; Liu, 2001; Mohai, 1995; Sadd et al., 1999). For researchers interested in these potential negative impacts, hazard proximity data may very well be more appropriate.

Nevertheless, because (a) environmental inequality researchers and activists are very interested in the physical health risks associated with exposure to industrial pollutants, (b) it is impossible to create a national industrial air pollutant concentration data set without making simplifying assumptions, and (c) the RSEI is the only database of its kind that currently provides national air pollutant concentration estimates for the year 2000 (the year of the most recent decennial census), it is a very valuable research tool that will be used increasingly by researchers and activists alike.

Demographic Date

The demographic data for this study were obtained from the 2000 U.S. census. The data for the descriptive analyses are derived from tract-level population counts of the number of Hispanics, non-Hispanic Blacks, non-Hispanic Native Americans, non-Hispanic Pacific Islanders, non-Hispanic Asian Americans, and non-Hispanic Whites in each census tract in each of the 329 metropolitan statistical areas (MSAs) and primary MSAs (PMSAa) in the continental United States (MSAs and PMSAs are defined by the U.S. Census Bureau).

The independent variables in the regression analyses include a commonly used measure of metropolitan-level residential segregation (the dissimilarity index),[6] a metropolitan-level measure of racial/ethnic income inequality, and a set of metropolitan-level control variables drawn from previous environmental inequality research. The income inequality variable measures, for each racial/ethnic group in each metropolitan area, the ratio of that group's median household income to the median household income of all households in the metropolitan area (unfortunately, the U.S. census does not provide a median household income measure for all nongroup households in each metropolitan area).

The dissimilarity index measures the proportion of minority [group] members that would have to change their area of residence to achieve an even distribution [across the metropolitan area], with the number of minority members moving being expressed as a proportion of the number that would have to move under conditions of maximum segregation. (Massey & Denton, 1988, p. 244)

[6]We also ran regression analyses that used the isolation index to measure residential segregation. Because the results of these analyses are substantively identical to the results presented here, we did not include the “isolation index analyses” in the article.

The dissimilarity index is usually calculated for a single minority group in relation to the White population. However, we are interested in determining how segregated each racial/ethnic group is from all out-group members. Thus, we calculate for each metropolitan area a set of dissimilarity scores that compares the spatial distribution of each racial/ethnic group included in the study to that of all nongroup members in the metropolitan area.

The control variables were selected based on their importance in prior research (Anderton et al., 1994; Ash & Fetter, 2004; Downey, 2005, [2007]; Morello-Frosch & Jesdale, 2006; Oakes et al., 1996; Pastor et al., 2001; Sadd et al., 1999; Shaikh & Loomis, 1999). They include the percentage of Hispanics, non-Hispanic Blacks, non-Hispanic Asian Americans, non-Hispanic Pacific Islanders, non-Hispanic Native Americans, and non-Hispanic Whites in each metropolitan area; the total population in each metropolitan area; the percentage of employed people 16 years old and older engaged in manufacturing occupations (percentage manufacturer); the number of metropolitan area residents per square mile (population density); median property value; the percentage of the civilian labor force that is unemployed; the percentage of housing units that are vacant; a dummy variable for each U.S. census division (with the East South Central division as the reference category); and an environmental hazard variable (defined below) that estimates the pollution burden experienced by the average person in each metropolitan area. We do not include a control variable for median household income, percentage poverty, or per capita income because these variables are too highly correlated with our income inequality measure to be included in the analysis without inflating the standard errors of the income inequality coefficients.

The census division dummy variables are included in the analysis to control for regional variation that is unaccounted for by the other control variables. Regions were defined by the U.S. census and include New England, the Mid-Atlantic, the East North Central, the West North Central, the South Atlantic, the East South Central (the excluded category), the West South Central, the Mountain, and the Pacific. Percentage manufacturer is included because researchers have hypothesized that industrial facilities and industrial workers tend to locate near each other (Anderton et al., 1994). As a result, it is likely that metropolitan areas with a greater density of industrial workers are also likely to have a greater density of industrial pollution. Total population is included because it is likely that the factors shaping environmental inequality vary according to population size; median property value is included because researchers have hypothesized that industrial facility presence tends to lower property values (Downey, 2005); percentage vacant is included because racial and ethnic minorities may be better able to avoid living in hazardous neighborhoods when they live in metropolitan areas with relatively high vacancy rates (and therefore plentiful housing options); the environmental hazard variable is included because racial and ethnic minorities may experience higher levels of environmental inequality in highly polluted metropolitan areas (where the burden of living in polluted neighborhoods is greatest); percentage unemployed is included because the unemployment rate provides an indirect measure of the health of the regional economy, which is likely to be associated with the amount of industrial pollution generated in the metropolitan area; and population density is included because (a) industrial facilities are often located in areas with plenty of open space (Downey, 2005) and (b) some researchers have argued that local officials work to reduce pollution levels in areas with high population densities (Ash & Fetter, 2004; Sadd et al., 1999).

Finally, the dependent variables are a set of dummy variables, calculated for each racial/ethnic group in each metropolitan area, that take on a value of 1 or 0 depending on whether the group experiences (a) a high pollution burden relative to all other racial/ethnic groups in the metropolitan area (Variable 1), (b) a low pollution burden relative to all other racial/ethnic groups in the metropolitan area (Variable 2), (c) the highest pollution burden in the metropolitan area (Variable 3), or (d) the lowest pollution burden in the metropolitan area. Since each dependent variable measures the relative pollution burden experienced by a single racial/ethnic group, each regression model that includes control variables controls for the percentage of that group's population in each metropolitan area. For example, when the dependent variable is one of the Pacific Islander dummy variables, the regression models control for percentage non-Hispanic Pacific Islander but not for the percentage of any other racial/ethnic group included in the study.

Descriptive Results

To determine whether environmental inequality outcomes vary across metropolitan areas, Table 1 indicates the number of metropolitan areas in which each of the racial/ethnic groups included in the study is the most "pollution burdened" or second through sixth most "pollution burdened" group included in the study. We determined the relative pollution burden experienced by each racial/ethnic group in each metropolitan area by calculating the neighborhood toxic concentration value of the average person in each racial/ethnic group in each metropolitan area. For example, if we were studying a metropolitan area containing three census tracts, with 20, 30, and 50 Hispanics, respectively, and toxic concentration values of 0, 5, and 10, respectively, the average Hispanic person in this metropolitan area would live in a census tract with a toxic concentration value equal to [(20 * 0) + (30 * 5) + (50 * 10)] / (20 + 30 + 50).

After calculating the pollution burden experienced by the average member of each racial/ethnic group in each metropolitan area, we determined the number of metropolitan areas in which each group was the most pollution burdened and the second through sixth most pollution burdened group included in the study.[7] Thus, Table 1 tells us that in 2000 Blacks were the most pollution burdened racial/ethnic group in 107 (32.5%) of the 329 metropolitan areas in the continental United States, the second most pollution burdened group in 84 (25.5%) of the 329 metropolitan areas, and the third and fourth most pollution burdened group in 43 (13.1%) and 46 (13.9%) of the metropolitan areas, respectively. Hispanics were the most pollution burdened group in 74 (22.5%) metropolitan areas, Pacific Islanders in 52 (15.8%) metropolitan areas, Native Americans in 44 (13.4%) metropolitan areas, Asian Americans in 38 (11.6%) metropolitan areas, and Whites in 14 (4.3%) metropolitan areas.

These results are surprising in several respects. First, although blacks or Hispanics are the most pollution burdened group in 181 (55%) of the 329 metropolitan areas and the second most pollution burdened group in 176 (53.5%) of the 329 metropolitan areas, Pacific Islanders, Native Americans, and Asian Americans are each the most pollution burdened group in at least 11% of the metropolitan areas. Second, Whites experience the greatest or second greatest pollution burden in 40 (12.2%) of the 329 metropolitan areas. Third, each group is well represented in each rank. For example, Blacks are the fifth most burdened group in 32 (9.7%) metropolitan areas and the least burdened group in 17 (5.2%) metropolitan areas, and Native Americans never hold more than 67 (20.4%) or less than 41 (12.5%) spots in any specific ranking position.

Thus, Table 1 indicates that Blacks and Hispanics are more likely than any of the other racial/ethnic groups included in the study to be the most or second most pollution burdened group in a metropolitan area. Nevertheless, the relative pollution burden experienced by each racial/ethnic group varies greatly across metropolitan areas, with each group being more burdened than most or all of the other groups in some metropolitan areas and less burdened than most

[7]We ranked every group in every metropolitan area even when two groups' average toxic concentration values were not statistically different from one another. We did this because groups could have virtually identical average toxic concentration scores but still experience a much higher pollution burden than the other groups included in the study.

or all of the other groups in other metropolitan areas. Table 2 explores this variation in more detail by indicating the number of metropolitan areas in which each group experiences low, medium, or high levels of environmental inequality relative to each of the other groups included in the study (in Tables 2 and 3, results are presented only for comparisons that are statistically different from one another at at least the 5% confidence level).

For example, the top portion of Table 2 (under the heading “White Environmental Inequality”) indicates that Whites experienced a statistically significant higher pollution burden than Blacks in 68 (38 + 20 + 10) metropolitan areas (pollution burden once again equals the neighborhood toxic concentration value of the average person in each racial/ethnic group). In 38 of these metropolitan areas, the White pollution burden was between 1 and 1.25 times greater than the Black pollution burden (low environmental inequality); in 20 of these metropolitan areas, the White pollution burden was between 1.25 and 1.75 times greater than the Black pollution burden (medium environmental inequality); and in 10 of these metropolitan areas, the White pollution burden was at least 1.75 times greater than the Black pollution burden (high environmental inequality).

Table 2 indicates that when Whites experience a statistically significant higher pollution burden than other racial/ethnic groups, their pollution disadvantage tends to be in the low and medium ranges, though they do experience a high pollution disadvantage relative to other groups in several metropolitan areas. When Blacks experience a higher pollution burden than other racial/ethnic groups, their pollution disadvantage is more likely to be in the medium and high ranges than in the low range, though they experience a low pollution disadvantage in more cases than any group except Hispanics. In addition, when Blacks experience a higher pollution burden than Hispanics, they are more likely to experience a low or medium pollution disadvantage than a high pollution disadvantage.

When Native Americans experience a pollution disadvantage relative to other groups, their disadvantage is most likely to be in the medium range. However, they experience a high pollution disadvantage relative to Pacific Islanders in 51 of the 75 metropolitan areas in which they are disadvantaged relative to Pacific Islanders. When Asian Americans experience a pollution disadvantage relative to other groups, their disadvantage tends to be in the low and medium ranges, but they experience a high pollution disadvantage relative to Pacific Islanders in 27 of the 48 metropolitan areas in which they are disadvantaged relative to Pacific Islanders and a high or low pollution disadvantage relative to Native Americans in an equal number of metropolitan areas (25 each).

When Pacific Islanders experience a pollution disadvantage relative to other groups, their disadvantage tends to be in the medium and high ranges, with very few cases in the low range. This is somewhat surprising given the lack of attention paid to Pacific Islanders in the literature. Finally, when Hispanics experience a pollution disadvantage relative to other groups, their disadvantage is most likely to be in the medium range, though they experience a low pollution disadvantage relative to Blacks in 62 of the 124 metropolitan areas in which they are disadvantaged relative to Blacks and a high pollution disadvantage relative to Pacific Islanders in 60 of the 97 metropolitan areas in which they are disadvantaged relative to Pacific Islanders. Hispanics are also more likely than any other racial/ethnic group except Blacks to experience a medium or high pollution disadvantage.

Overall, Table 2 indicates that compared to other racial/ethnic groups, Blacks and Hispanics are much more likely to experience a medium or high pollution disadvantage, and Whites are much less likely to experience a high pollution disadvantage. Nevertheless, when compared to each of the other groups in the study, each racial/ethnic group (including Whites) experiences a high pollution disadvantage in multiple metropolitan areas and a medium pollution disadvantage in many metropolitan areas. Thus, Table 2 further demonstrates that environmental racial inequality varies greatly across metropolitan areas and that no racial/ethnic group is able to completely escape the burden of environmental inequality.

To determine whether patterns of high pollution disadvantage vary according to metropolitan area pollution levels, Table 3 divides the 329 metropolitan areas into quintiles according to the pollution burden (toxic concentration value) experienced by the average person (regardless of race) in each metropolitan area. The left-hand data column provides information on the least polluted 20% of metropolitan areas in the continental United States, and the next-to-last data column presents information on the most polluted 20% of metropolitan areas (extremely polluted metropolitan areas). The top portion of the table shows that when Whites experience a high pollution disadvantage relative to other racial/ethnic groups, they are more likely to do so in metropolitan areas in the third (median) pollution quintile. However, 3 of the 10 metropolitan areas in which they experience a high pollution disadvantage relative to Blacks are among the most polluted fifth of metropolitan areas in the continental United States. Finally, the right-hand data column shows that Whites do not experience a high pollution disadvantage in any extremely polluted metropolitan area that has more than 1 million residents.

Unlike Whites, when Blacks experience a high pollution disadvantage, they are more likely to do so in highly polluted and extremely polluted metropolitan areas (quintiles 4 and 5). Blacks, along with Hispanics and Pacific Islanders, are also more likely than other racial/ethnic groups to experience a high pollution disadvantage in extremely polluted metropolitan areas with more than 1 million residents. For example, Blacks experience a high pollution disadvantage relative to Whites and Asian Americans in 5 extremely polluted metropolitan areas with more than 1 million residents. This represents 6% of all metropolitan areas in which Blacks experience a high pollution disadvantage relative to Whites and 6.7% of all metropolitan areas in which Blacks experience a high pollution disadvantage relative to Asian Americans. Finally, although patterns are not as readily apparent for the remaining racial/ethnic groups as they are for Blacks and Whites, it appears that when Native Americans and Hispanics experience a high pollution disadvantage, they may be more likely to do so in highly and/or extremely polluted metropolitan areas than in other metropolitan areas.

Regression Analyses

The analyses presented in the preceding section clearly demonstrate that environmental inequality outcomes vary widely across U.S. metropolitan areas. However, these analyses do not allow us to test Hypotheses 1 to 3, all of which make predictions about the role that residential segregation and racial income inequality play in shaping environmental inequality. The logistic regression models presented in this section allow us to test these hypotheses.

As previously noted, the dependent variables in these models are a set of dummy variables, calculated for each racial/ethnic group in each metropolitan area, that take on a value of 1 or 0 depending on whether the racial/ethnic group experiences (a) a high pollution burden relative to all other racial/ethnic groups in the metropolitan area (Variable 1), (b) a low pollution burden relative to all other racial/ethnic groups in the metropolitan area (Variable 2), (c) the highest pollution burden in the metropolitan area (Variable 3), or (d) the lowest pollution burden in the metropolitan area (Variable 4).

The high pollution burden variable (listed in Table 4 as "Environmental Inequality High," or EI High) was calculated for each racial/ethnic group in each metropolitan area by dividing the neighborhood toxic concentration value of the average person in each racial/ethnic group by the neighborhood toxic concentration value of the average person (regardless of race) in the metropolitan area. If the value of this ratio was greater than 1.5, the dummy variable was given a value of 1. Otherwise, it was given a value of 0.[8]

The low pollution burden variable (EI Low) was calculated similarly, but was given a value of 1 if the ratio was less than .667. This cutoff value was derived by dividing 1 by 1.5, and thus represents the same magnitude of inequality as the cutoff value for the EI High variable. The highest pollution burden variable (listed as Rank 1 in Table 4) was given a value of 1 if a racial/ethnic group was the most pollution burdened racial/ethnic group in a metropolitan area and 0 otherwise, and the lowest pollution burden variable (listed as Rank 6 in Table 4) was given a value of 1 if a racial/ethnic group was the least pollution burdened racial/ethnic group in a metropolitan area and 0 otherwise. The most and least pollution burdened designations were determined using the same method as was used to derive Table 1.

Table 4 presents results for logistic regression models. Because there are 24 dependent variables (4 for each racial/ethnic group), we only present results for the segregation and income inequality measures, with the left-hand side of the table presenting results for models that include no control variables and the right-hand side of the table presenting results for models that include all the control variables. Unlike most regression tables, the results are read from left to right because otherwise they would not fit in a single table. In addition, because logistic regression coefficients have little substantive meaning for most people, we present transformed coefficients that indicate the change in the odds of the outcome occurring given a one standard deviation increase in the independent variable.

Finally, we would have liked to have run the EI High and Rank 1 regression models without the EI Low and Rank 6 observations and the EI Low and Rank 6 regression models without the EI High and Rank 1 observations. However, because we only have 329 observations in our sample, we ran all the regression models with all the observations. Running the models with all the observations had almost no effect on the values of the coefficients but did make it more likely that the coefficients were significantly associated with the dependent variables.

Turning our attention to the first line of results in Table 4, we see that when no control variables are included in the regression model, a one standard deviation increase in the dissimilarity score increases the odds that Blacks experience a high pollution burden (relative to all other racial/ethnic groups) by a factor of 1.48 but that a one standard deviation increase in the income inequality ratio (inequality ratio) has no significant effect on the dependent variable. Examining the other reduced regression models for Blacks, we see that the dissimilarity score is not significantly associated with any of the remaining “Black dependent variables.” However, a one standard deviation increase in the income inequality ratio increases the odds that Blacks experience a low pollution burden by a factor of 1.65 and decreases the odds that Blacks are the most pollution burdened group in a metropolitan area by a factor of .7.

These results provide partial support for Hypotheses 1A and 1B, which hold that racial/ethnic groups are more likely to experience a high pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience relatively high levels of residential segregation (Hypothesis 1A) or relatively low income levels (Hypothesis 1B). This support is indicated in the table next to the “significance-level asterisks” with the terms 1A and 1B. For Hypothesis 1A to be fully supported, the dissimilarity scores would have to be significant and greater than 1 for both the EI High and Rank 1 regression models, and for Hypothesis 1B to be fully supported, the income inequality ratio would have to be significant and less than 1 for the EI High and Rank 1 regression models (Table 5 lists Hypotheses 1A through 3 and notes which pattern of findings are necessary to support each of these hypotheses).

[8]We wanted the cutoff value for the dummy variable to be 1.75, as it was in Tables 2 and 3. However, this provided too little variation in several of the dependent variables to run the regression models.

The reduced regression models for Blacks also provide partial support for Hypothesis 2B but no support for Hypothesis 2A or Hypothesis 3. Hypotheses 2A and 2B hold that racial/ethnic groups are more likely to experience a low pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience relatively low levels of residential segregation (Hypothesis 2A) or relatively high income levels (Hypothesis 2B). Thus, Hypothesis 2A is fully supported if the dissimilarity scores are significant and less than 1 for both the EI Low and Rank 6 regression models, and Hypothesis 2B is fully supported if the income inequality ratio is significant and greater than 1 for the EI Low and Rank 6 regression models (see Table 5).

The full regression models for Blacks show a different pattern of results. In addition to providing partial support for Hypotheses 1A and 1B, these models also provide partial support for Hypothesis 3, which holds that racial/ethnic groups are more likely to experience a low pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience relatively high levels of residential segregation. As a result, for Hypothesis 3 to be fully supported, the dissimilarity scores would have to be significant and greater than 1 for both the EI Low and Rank 6 regression models (see Table 5).

Turning our attention to the results for Hispanics, we see that Hypothesis 1A is the only hypothesis that is supported: It is fully supported by the reduced regression models and partially supported by the full regression models. This suggests that for Hispanics, residential segregation is strongly associated with greater residential proximity to toxicity-weighted TRI facility emissions.

For Asian Americans, on the other hand, the reduced regression models fully support Hypothesis 3. Moreover, according to the full regression models, a one standard deviation increase in the dissimilarity score increases the odds that Asian Americans are both the highest and lowest pollution burdened group in a metropolitan area, thereby partially supporting Hypothesis 1A and Hypothesis 3.

For Whites, the reduced regression models fully support Hypothesis 3 and partially support Hypothesis 2B, while the full regression models fully support Hypotheses 1A, 1B, 2B, and 3.[9] Thus, as with Asian Americans, the full regression models show that a one standard deviation increase in the dissimilarity score increases the odds that Whites are both the highest and lowest pollution burdened group in a metropolitan area.

Finally, for Native Americans, Hypothesis 3 is fully supported by the reduced regression models and partially supported by the full regression models, while for Pacific Islanders, Hypothesis 2B is partially supported by the reduced regression models (no other hypothesis is supported for either of these groups).

Taken collectively, the regression results suggest that the roles income inequality and residential segregation play in producing environmental inequality vary from one racial/ethnic group to another, even when multiple control variables are included in the analyses to control for variation in conditions across metropolitan areas that might be associated with the geographic distribution of different racial and ethnic groups. For example, the full model results demonstrate that as residential segregation increases across metropolitan areas, so too do the odds that (a) Hispanics experience relatively high levels of environmental inequality, (b) Native Americans are the least pollution burdened group in a metropolitan area, (c) Blacks experience relatively high levels of environmental inequality and are the least burdened group in a

[9]Hypothesis 1A could not be tested for Whites by the EI High variable because there was not enough variation in this dependent variable to run the model. Thus, Hypothesis 1A is fully supported for Whites by the only regression model that we ran that could test it.

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metropolitan area, and (d) Whites experience relatively low levels of environmental inequality and are the most and least burdened racial/ethnic group in a metropolitan area.

Similarly, the full model results demonstrate that as a racial/ethnic group's median household income increases relative to the median household incomes of other racial/ethnic groups, Blacks and Whites are less likely to be the most pollution burdened group in a metropolitan area and Whites are more likely to be the least pollution burdened group in a metropolitan area. However, these models also suggest that income inequality plays little or no role in shaping environmental inequality outcomes for Hispanics, Asian Americans, Native Americans, and Pacific Islanders.

Thus, while the full and reduced model results for specific racial/ethnic groups sometimes fully support Hypotheses 1A, 1B, 2B, or 3, the hypotheses rarely receive full support, different hypotheses are fully or partially supported for different racial/ethnic groups, and in some cases residential segregation both increases and decreases the odds of living in environmentally hazardous census tracts. In addition, most of the coefficients listed in Table 4 are statistically insignificant in both the full and reduced regression models; and with the exception of one regression model for Whites, the pseudo R-square values for the reduced models never exceed .0656 and are usually less than .03, suggesting that residential segregation and income inequality explain very little of the variance in most of the dependent variables.[10] Overall, these findings suggest that metropolitan area residential segregation levels and metropolitan area income inequality levels are relatively poor predictors of metropolitan area environmental inequality outcomes, a finding that contradicts most prior theorizing about the roles that these factors play in producing environmental inequality (Downey, 2007).

Conclusion

The analyses presented in the previous sections demonstrate that in metropolitan America, Blacks and Hispanics generally experience a greater pollution burden than do other racial/ethnic groups. Blacks are more likely than any other racial/ethnic group included in the study to be the most pollution burdened group in a metropolitan area, Blacks or Hispanics are the most pollution burdened racial/ethnic group in more than half the metropolitan areas in the continental United States, and Blacks or Hispanics are the second most pollution burdened racial/ethnic group in more than half the metropolitan areas in the continental United States. In addition, compared to other racial/ethnic groups, Blacks and Hispanics are much more likely to experience a medium or high pollution disadvantage; and when Blacks experience a high pollution disadvantage, they are more likely to do so in highly polluted and extremely polluted metropolitan areas than in other metropolitan areas.

Despite the clear environmental disadvantage experienced by Hispanics and Blacks in much of metropolitan America, the analyses presented in the previous sections also demonstrate that environmental inequality outcomes vary widely across metropolitan areas and that Pacific Islanders, Asian Americans, Native Americans, and Whites each experience a heavy pollution burden in many metropolitan areas. For example, analyses show that each of the six racial/ethnic groups included in the study is more burdened than most or all of the other racial/ethnic groups in many metropolitan areas and less burdened than most or all of the other racial/ethnic groups in many other metropolitan areas. In addition, compared to the other groups in the study, each racial/ethnic group experiences a high pollution disadvantage in multiple metropolitan areas, a medium pollution disadvantage in many metropolitan areas, and a medium or high pollution advantage in several or many metropolitan areas. Finally, the regression analyses

[10]These are McFadden's pseudo R-square values, which can be treated as analogous to Ordinary Least Squares R-square values (http://www.ats.ucla.edu/stat/mult_pkg/faq/general/Psuedo_RSquareds.htm)**[PLS MAKE REFERENCE]**.

demonstrate that (a) residential segregation and racial income inequality are relatively poor predictors of environmental inequality outcomes, (b) residential segregation can increase and decrease racial/ethnic group proximity to environmental hazards, and (c) the roles income inequality and residential segregation play in producing environmental inequality vary from one racial/ethnic group to another.

As with any study, caution must be taken in interpreting the findings reported here. For example, this study relies on a single environmental hazard indicator and a single type of study area (metropolitan areas). Thus, the results cannot be generalized to other environmental hazards or to nonmetropolitan areas. In addition, although RSEI data represent a real improvement in most respects over proximity-based hazard data (Ash & Fetter, 2004), proximity-based data likely provide better estimates of the non-exposure-related risks of living near environmental hazards (Downey, 2006b). As a result, future research should use proximity-based indicators, information about other types of environmental hazard, and data on rural regions of the United States to determine whether the patterns uncovered here hold for other environmental hazards and for rural America.

These caveats notwithstanding, this study contributes to the field in several ways. First, this is the only study that we are aware of that formally tests the hypothesis that residential segregation can separate racial and ethnic minorities from environmental hazards. Second, this is the first environmental inequality study to examine environmental inequality outcomes for all the major racial/ethnic groups in the United States in each metropolitan area in the continental United States. Downey's (2006a) study provides results for 14 separate metropolitan areas, and his 2007 study provides metropolitan-level descriptive results for 61 metropolitan areas and metropolitan-level regression results for Hispanics, Blacks, and Whites in 329 metropolitan areas. However, neither study presents results for Native Americans, Pacific Islanders, and Asian Americans, and no other study that we are aware of presents separate results for more than a handful of metropolitan areas.

Third, using a much more complete data set and set of control variables than Downey (2007) used, this study confirms Downey's findings that environmental inequality outcomes vary greatly across metropolitan areas. This study also confirms Downey's (2007) findings that there is great variation in the degree to which environmental inequality exists for specific racial/ethnic groups in specific metropolitan areas and that residential segregation and racial income inequality do a poor job of predicting environmental inequality outcomes.

Fourth, in demonstrating that environmental inequality outcomes vary greatly across metropolitan areas, that residential segregation can increase and decrease racial/ethnic group proximity to environmental hazards, and that the roles income inequality and residential segregation play in producing environmental inequality vary from one racial/ethnic group to another, this study strongly suggests that the factors shaping environmental racial inequality are highly complex and highly contingent on local conditions that vary widely across metropolitan areas. In fact, it may be this complexity and contingency that make residential segregation and racial income inequality such poor predictors of environmental inequality outcomes. For example, if residential segregation sometimes increases and sometimes decreases racial/ethnic group proximity to environmental hazards, it is unlikely to be a strong predictor of environmental inequality outcomes even if it plays an important role in shaping environmental racial inequality in many metropolitan areas.

Finally, this study suggests that if environmental inequality researchers want to fully understand environmental racial inequality and the ways in which local, regional, and national factors shape environmental racial inequality, they will have to include multiple racial/ethnic groups in their research. Although researchers' focus on Hispanics and Blacks is understandable given that Blacks and Hispanics generally experience a greater pollution burden than do other racial/ethnic groups, it is just as clear that Pacific Islanders, Asian Americans, Native Americans, and Whites also experience a heavy pollution burden in many metropolitan areas. Ignoring this fact will severely limit our understanding of environmental racial inequality in metropolitan America.

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Table 1

Race/Ethnic Group Rankings Across All 329 Metropolitan Areas in the Continental United States, 2000

Rank	Black	Hispanic	Pacific Islander	Native American	Asian	White
1	107 (32.5)	74 (22.5)	52 (15.8)	44 (13.4)	38 (11.6)	14 (4.3)
2	84 (25.5)	92 (28.0)	29 (8.8)	59 (17.9)	39 (11.9)	26 (7.9)
3	43 (13.1)	62 (18.8)	34 (10.3)	67 (20.4)	52 (15.8)	71 (21.6)
4	46 (14.0)	55 (16.7)	38 (11.6)	64 (19.5)	64 (19.5)	62 (18.8)
5	32 (9.7)	27 (8.2)	41 (12.5)	54 (16.4)	86 (26.1)	89 (27.1)
6	17 (5.2)	19 (5.8)	128 (38.9)	41 (12.5)	50 (15.2)	67 (20.4)

Note: The numbers in parentheses represent the percentage of metropolitan areas in the continental United States that the whole numbers to the left of the parentheses represent. The column percentages do not all add up to 100 because of rounding errors and because there are no results for Pacific Islanders in 7 metropolitan areas.

Table 2

Low, Medium, and High Environmental Inequality Across All 329 Metropolitan Areas in the Continental United States, 2000[a]

	White Environmental Inequality			
	Low EI[b]	Med EI	High EI	Total
Blacks	38 (11.6)	20 (6.1)	10 (3.0)	68 (20.7)
Native Americans	22 (6.7)	24 (7.3)	11 (3.3)	57 (17.3)
Asians	47 (14.3)	44 (13.4)	7 (2.1)	98 (29.8)
Pacific Islanders	3 (0.9)	12 (3.6)	10 (3.0)	25 (7.6)
Hispanics	37 (11.2)	20 (6.1)	3 (0.9)	60 (18.2)
Total	147	120	41	
	Black Environmental Inequality			
Pollution Category	Low EI	Med EI	High EI	Total
Whites	62 (18.8)	82 (24.9)	84 (25.5)	228 (69.3)
Native Americans	37 (11.2)	69 (21.0)	60 (18.2)	166 (50.5)
Asian Americans	50 (15.2)	73 (22.2)	75 (22.8)	198 (60.2)
Pacific Islanders	12 (3.6)	41 (12.5)	70 (21.3)	123 (37.4)
Hispanics	65 (19.8)	56 (17.0)	38 (11.6)	159 (48.3)
Total	226	321	327	
	Native American Environmental Inequality			
Pollution Category	Low EI	Med EI	High EI	Total
Whites	38 (11.6)	79 (24.0)	27 (8.2)	144 (43.8)
Blacks	21 (6.4)	27 (8.2)	9 (2.7)	57 (17.3)
Asian Americans	44 (13.4)	59 (17.9)	29 (8.8)	132 (40.1)
Pacific Islanders	6 (1.8)	18 (5.5)	51 (15.5)	75 (22.8)
Hispanics	28 (8.5)	29 (8.8)	13 (4.0)	70 (21.3)
Total	137	212	129	
	Asian American Environmental Inequality			
Pollution Category	Low EI	Med EI	High EI	Total
Whites	54 (16.4)	85 (25.8)	14 (4.3)	153 (46.5)
Blacks	32 (9.7)	19 (5.8)	17 (5.2)	68 (20.7)
Native Americans	25 (7.6)	40 (12.2)	25 (7.6)	90 (27.4)
Pacific Islanders	9 (2.7)	12 (3.6)	27 (8.2)	48 (14.6)
Hispanics	33 (10.0)	34 (10.3)	15 (4.6)	82 (24.9)

Total	153	190	98	
	Pacific Islander Environmental Inequality			
Pollution Category	Low EI	Med EI	High EI	Total
Whites	7 (2.1)	41 (12.5)	36 (10.9)	84 (25.5)
Blacks	5 (1.5)	15 (4.6)	15 (4.6)	35 (10.6)
Native Americans	3 (0.9)	36 (10.9)	25 (7.6)	64 (19.5)
Asians	7 (2.1)	23 (7.0)	28 (8.5)	58 (17.6)
Hispanics	4 (1.2)	22 (6.7)	17 (5.2)	43 (13.1)
Total	26	137	121	
	Hispanic Environmental Inequality			
Pollution Category	Low EI	Med EI	High EI	Total
Whites	74 (22.5)	95 (28.9)	54 (16.4)	223 (67.8)
Blacks	62 (18.8)	39 (11.9)	23 (7.0)	124 (37.7)
Native Americans	38 (11.6)	72 (21.9)	38 (11.6)	148 (45.0)
Asian Americans	50 (15.2)	85 (25.8)	51 (15.5)	186 (56.5)
Pacific Islanders	8 (2.4)	29 (8.8)	60 (18.2)	97 (29.5)
Total	232	320	226	

Note: The data in this table only refer to instances in which the average pollution burdens experienced by each racial/ethnic group pair are statistically different from one another.

[a]The numbers in parentheses present the percentage of metropolitan areas in the continental United States that the whole numbers to the left of the parentheses represent. These are not column percentages. Percentages are not given for the totals along the bottom of each minitable because these totals double-count metropolitan areas.

[b]EI = environmental inequality. Low EI exists when the pollution burden of the group in bold is 1 to 1.25 times greater than that of the comparison group. Medium EI (Med EI) exists when the pollution burden is 1.25 to 1.75 times greater. High EI exists when the pollution burden is at least 1.75 times greater.

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Table 3

High Race/Ethnic Environmental Inequality by Metropolitan Area Pollution Levels, the Continental United States, 2000

	High White Environmental Inequality[a]					
Pollution Category	Quintile 1[b] < 20th pc	Quintile 2 20th to 40th pc	Quintile 3 40th to 60th pc	Quintile 4 60th to 80th pc	Quintile 5[c] ≥ 80th pc	1 Million[d] Pollution > Pop. > 80th pc
Blacks	2 (0.61)	1 (0.30)	4 (1.22)	0 (0.00)	3 (0.91)	0 (0.00)
Native Americans	3 (0.91)	2 (0.61)	6 (1.82)	0 (0.00)	0 (0.00)	0 (0.00)
Asian Americans	2 (0.61)	1 (0.30)	3 (0.91)	0 (0.00)	1 (0.30)	0 (0.00)
Pacific Islanders	2 (0.61)	2 (0.61)	4 (1.22)	1 (0.30)	1 (0.30)	0 (0.00)
Hispanics	2 (0.61)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.30)	0 (0.00)
	High Black Environmental Inequality					
Pollution Category	Quintile 1 < 20th pc	Quintile 2 20 to 40th pc	Quintile 3 40th to 60th pc	Quintile 4 60th to 80th pc	Quintile 5 ≥ 80th pc	Pop. > 1 Million Pollution > 80th pc
Whites	8 (2.43)	14 (4.26)	12 (3.65)	24 (7.29)	26 (7.90)	5 (1.52)
Native Americans	5 (1.52)	11 (3.34)	14 (4.26)	13 (3.95)	17 (5.17)	2 (0.61)
Asian Americans	9 (2.74)	9 (2.74)	12 (3.65)	20 (6.08)	25 (7.60)	2 (0.61)
Pacific Islanders	9 (2.74)	8 (2.43)	15 (4.56)	18 (5.47)	20 (6.08)	1 (0.30)
Hispanics	5 (1.52)	3 (0.91)	5 (1.52)	8 (2.43)	17 (5.17)	2 (0.61)
	High Native American Environmental Inequality					
Pollution Category	Quintile 1 < 20th pc	Quintile 2 20th to 40th pc	Quintile 3 40th to 60th pc	Quintile 4 60th to 80th pc	Quintile 5 ≥ 80th pc	Pop. > 1 Million Pollution > 80th pc
Whites	5 (1.52)	1 (0.30)	4 (1.22)	8 (2.43)	9 (2.74)	1 (0.30)
Blacks	2 (0.61)	0 (0.00)	2 (0.61)	2 (0.61)	3 (0.91)	0 (0.00)
Asian Americans	4 (1.22)	3 (0.91)	5 (1.52)	10 (3.04)	7 (2.13)	1 (0.30)
Pacific Islanders	9 (2.74)	6 (1.82)	15 (4.56)	11 (3.34)	10 (3.04)	0 (0.00)
Hispanics	1 (0.30)	2 (0.61)	1 (0.30)	3 (0.91)	6 (1.82)	0 (0.00)
	High Asian American Environmental Inequality					

Pollution Category	Quintile 1 < 20th pc	Quintile 2 20th to 40th pc	Quintile 3 40th to 60th pc	Quintile 4 60th to 80th pc	Quintile 5 ≥ 80th pc	Pop. > 1 Million Pollution > 80th pc
Whites	3 (0.91)	2 (0.61)	1 (0.30)	5 (1.52)	3 (0.91)	0 (0.00)
Blacks	7 (2.13)	2 (0.61)	1 (0.30)	2 (0.61)	5 (1.52)	0 (0.00)
Native Americans	5 (1.52)	5 (1.52)	6 (1.82)	5 (1.52)	4 (1.22)	0 (0.00)
Pacific Islanders	8 (2.43)	5 (1.52)	5 (1.52)	3 (0.91)	6 (1.82)	0 (0.00)
Hispanics	3 (0.91)	2 (0.61)	2 (0.61)	4 (1.22)	4 (1.22)	0 (0.00)

High Pacific Islander Environmental Inequality

Pollution Category	Quintile 1 < 20th pc	Quintile 2 20th to 40th pc	Quintile 3 40th to 60th pc	Quintile 4 60th to 80th pc	Quintile 5 ≥ 80th pc	Pop. > 1 Million Pollution > 80th pc
Whites	4 (1.22)	6 (1.82)	6 (1.82)	11 (3.34)	9 (2.74)	3 (0.91)
Blacks	4 (1.22)	2 (0.61)	2 (0.61)	4 (1.22)	3 (0.91)	0 (0.00)
Native Americans	4 (1.22)	6 (1.82)	5 (1.52)	7 (2.13)	3 (0.91)	0 (0.00)

Asians	5 (1.52)	5 (1.52)	2 (0.61)	10 (3.04)	6 (1.82)	4 (1.22)
Hispanics	4 (1.22)	2 (0.61)	3 (0.91)	4 (1.22)	4 (1.22)	0 (0.00)
	High Hispanic Environmental Inequality					
Pollution Category	Quintile 1 < 20th pc	Quintile 2 20th to 40th pc	Quintile 3 40th to 60th pc	Quintile 4 60th to 80th pc	Quintile 5 ≥ 80th pc	Pop. > 1 Million Pollution > 80th pc
Whites	7 (2.13)	10 (3.04)	7 (2.13)	15 (4.56)	15 (4.56)	2 (0.61)
Blacks	5 (1.52)	2 (0.61)	3 (0.91)	7 (2.13)	6 (1.82)	1 (0.30)
Native Americans	5 (1.52)	9 (2.74)	8 (2.43)	9 (2.74)	7 (2.13)	1 (0.30)
Asians	7 (2.13)	7 (2.13)	5 (1.52)	22 (6.69)	10 (3.04)	2 (0.61)
Pacific Islanders	11 (3.34)	9 (2.74)	15 (4.56)	13 (3.95)	12 (3.65)	1 (0.30)

[a] The numbers in parentheses represent the percentage of metropolitan areas in the continental United States that the whole numbers to the left of the parentheses represent. These are not column percentages.

[b] The least polluted 20% of metropolitan areas (pc = percentile).

[c] The most polluted 20% of metropolitan areas (pc = percentile).

[d] Metropolitan areas with more than 1 million residents that are also among the most polluted 20% of metropolitan areas in the continental United States.

Table 4

Metropolitan Area Environmental Inequality Outcomes Regressed on Segregation and Income Inequality Measures, the Continental United States, 2000

	Blacks									
	Reduced Model[a]					Full Model[b]				
Dependent Variables	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*
EI High	1.4805	*1A	0.8706		0.0324	329	1.7576	**1A	0.9492		0.1327	322
EI Low	0.9608		1.6578	**2B	0.0610	329	1.1869		1.241		0.1963	322
Rank 1	1.1438		0.7035	* 1B	0.0236	329	1.0667		0.7358	†1B	0.1245	322
Rank 6	1.3064		0.9813		0.0090	329	3.1947	**3	0.6726		0.1868	272
	Hispanics											
	Reduced Model						Full Model					
Dependent Variables	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*
EI High	1.8420	**1A	0.9166		0.0656	329	2.2919	***1A	0.7944		0.1272	322
EI Low[c]	1.1770		0.7773		0.0142	329	—		—		—	
Rank 1	1.3399	*1A	0.8491		0.0257	329	1.1855		0.8892		0.0819	322
Rank 6	0.9747		1.2217		0.0056	329	1.4615		0.985		0.1786	248
	Asian Americans											
	Reduced Model						Full Model					
Dependent Variables	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*
EI High	1.4421		0.8674		0.0160	329	1.4637		0.8230		0.1128	322
EI Low	1.4445	†3	0.9915		0.0181	329	1.5128		0.9488		0.0879	322
Rank 1	1.1580		1.0680		0.0046	329	1.5092	†1A	0.9986		0.1102	322

Rank 6	1.3227 $^{\dagger}3$	0.9132	0.0110	329	1.5871 $^{*}3$	1.0546	0.0847	322

Whites

	Reduced Model				Full Model			
Dependent Variables	Dissimilarity	Inequality Ratio	Pseudo-R^2	*n*	Dissimilarity	Inequality Ratio	Pseudo-R^2	*n*
EI High^{c}	—	—	—		—	—	—	
EI Low	1.8976 $^{*}3$	2.0020 $^{**}2B$	0.1466	329	3.1670 $^{*}3$	1.6579 $^{\dagger}2B$	0.3374	261
Rank 1	1.1954	0.7057	0.0115	329	2.3993 $^{\dagger}1A$	0.4904 $^{\dagger}1B$	0.2362	248
Rank 6	1.3403 $^{*}3$	1.1122	0.0182	329	1.6958 $^{*}3$	1.5090 $^{*}2B$	0.1545	322

Native Americans

	Reduced Model				Full Model			
Dependent Variables	Dissimilarity	Inequality Ratio	Pseudo-R^2	*n*	Dissimilarity	Inequality Ratio	Pseudo-R^2	*n*
EI High	0.9598	0.7685	0.0088	329	1.0536	0.9406	0.1232	278
EI Low	1.5031 $^{*}3$	1.0643	0.0214	329	1.4892	0.9950	0.1378	295

Rank 1	1.0168		1.0508		0.0004	329	1.1114		1.1052	0.1043	322
Rank 6	1.4484	*3	0.8344		0.0271	329	1.5112	†3	0.7883	0.0927	322
	Pacific Islanders										
	Reduced Model						Full Model				
Dependent Variables	Dissimilarity		Inequality Ratio		Pseudo-R^2	*n*	Dissimilarity		Inequality Ratio	Pseudo-R^2	*n*
EI High[d]	0.9170		0.9350		0.0017	312	0.7882		0.9399	0.0992	305
EI Low	1.1138		1.2291	†2B	0.0097	312	0.7584		1.1607	0.1078	305
Rank 1[c]	—		—		—		—		—	—	
Rank 6	0.8490		1.1005		0.0063	312	1.0213		1.1450	0.0684	305

[a] Coefficients describe the change in the odds of the outcome occurring given a one standard deviation increase in the independent variable.

[b] Control variables include % Hispanic, % non-Hispanic Black, % non-Hispanic Asian American, % non-Hispanic Pacific Islander, % non-Hispanic Native American, % non-Hispanic White, total population, percentage manufacturer, population density, median property value, percentage unemployed, percentage vacant, region of the United States, and average toxic concentration value.

[c] The regression models could not be calculated because there is too little variation in the outcome variable (all values equal 0 or 1) or because too many observations had to be dropped because specific independent variables predicted the outcome perfectly.

[d] Observations had to be dropped because specific independent variables predicted the outcome perfectly.

† $p < .1$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 5

Testing Hypotheses 1A to 3

Hypothesis	Dependent Variables: EI High/ Rank 1	Dependent Variables: EI Low/Rank 6
1A	Dissimilarity significant and > 1	
1B	Inequality ratio significant and < 1	
2A		Dissimilarity significant and < 1
2B		Inequality ratio significant and > 1
3		Dissimilarity significant and > 1

Note: The hypothesis is supported if the condition listed in the table exists. Hypothesis 1: Racial and ethnic groups are more likely to experience a high pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience (a) relatively high levels of residential segregation or (b) relatively low income levels. Hypothesis 2: Racial and ethnic groups are more likely to experience a low pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience (a) relatively low levels of residential segregation or (b) relatively high income levels. Hypothesis 3: Racial and ethnic groups are more likely to experience a low pollution burden relative to other racial/ethnic groups in metropolitan areas in which they experience relatively high levels of residential segregation.