

Environmental Injustice and the Mississippi Hog Industry

Sacoby M. Wilson,¹ Frank Howell,² Steve Wing,³ and Mark Sobsey¹

¹Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA; ²Department of Sociology, Anthropology, and Social Work, Mississippi State University, Starkville, Mississippi, USA; ³Department of Epidemiology, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

The recent growth and restructuring of the swine industry in the state of Mississippi has raised various environmental and socioeconomic concerns. We spatially examined the location and attributes of 67 industrial hog operations to determine if African American and low-income communities have a high prevalence of industrial hog operations located near their neighborhoods at the census block group level. We used spatial data and cross-classification analysis to compare the prevalence of industrial hog operations in neighborhoods that are primarily African American and low income with the prevalence in neighborhoods that are African American and affluent. We also used logistic regression to evaluate the relationship between the environmental justice variables and the location of the industrial hog operations. The block group characterization showed a high prevalence of hog operations in the four highest quintiles compared with the lowest quintile for percentage African American and percentage poverty. At increasing levels of percentage African Americans and percentage of persons in poverty, there are 2.4–3.6 times more operations compared with the referent group; additionally, scale adjustment to only the hog counties reduces this to 1.8–3.1 more operations compared with the referent group. The inequitable distribution of hog-confined agricultural feeding operations in these communities may have adverse environmental impacts associated with industrial hog production, such as increased health risks and quality of life degradation, as have occurred in other areas having similar facilities. *Key words:* African Americans, CAFOs, census blocks, confined agricultural feeding operations, disproportionate, environmental health, environmental justice, geographic information systems, hog industry, poor, rural. *Environ Health Perspect* 110(suppl 2):195–201 (2002).

<http://ehpnet1.niehs.nih.gov/docs/2002/suppl-2/195-201wilson/abstract.html>

Because of the application of vertical integration management practices, hog farming has in some locales been transformed into a high-density industrial production system. Production of large numbers of hogs in small confined areas produces a multitude of environmental impacts (e.g., air and water pollution) that potentially can have adverse outcomes for rural non-White and poor populations. Specifically, non-White and poor communities with limited political and economic resources to mitigate the problem may be disparately burdened. In this study we used environmental and census data to examine environmental justice issues associated with industrial swine production in Mississippi.

Mississippi, one of the poorest states in the United States, has used its ample land resources to draw economic development to the region (1). One of its prominent suitors has been the swine industry. Although the state's physical characteristics may play a role (1), there are other important reasons for the industrialization of hog production in the state. First, there was a rapid decline in large-scale packers in the South, with Bryan Foods as the only such packer in the region that employs more than 1,000 persons (2). Bryan Foods increased its packing capacity and developed a relationship with Prestage Farms, which would supply hogs to Bryan Foods (2). Second, in 1993, the state amended Section 69-2-19, Mississippi Code of 1972 to increase

the maximum amount of bonds that the Mississippi Department of Economic and Community Development could issue under the auspices of the Emerging Crops Fund (3). This amendment and later amendments in 1995, 1996, and 1998 helped provide the state of Mississippi with a bonded finance program for a broad range of agricultural production under the emerging crops fund, including Christmas trees, rabbit farming, poultry, and hogs (3). The fund was originally focused on helping both crop and animal farmers become more competitive. However, it has evolved into a mechanism that pork producers use to establish new large-scale operations (4). The reasons described above are not directly related to either poverty or race but within the 50- to 75-mile buffer around the large packing plant in West Point, Mississippi, race and poverty become important criteria for site selection (2).

Agricultural economists in the state estimated that its 1998 pork production had a 24% decline in value from the previous year (5). As result, many of Mississippi's independent producers have recently gone out of business or are at risk of losing their family-run operations (5). This economic loss has given out-of-state hog corporations the incentive to bring industrial swine production to Mississippi. For example, earlier in the 1990s, the state mainly had smaller farms with several hundred hogs and only

one or two industrial swine operations with over 1,000 animal units (AUs) that could be categorized as confined agricultural feeding operations (CAFOs) (6). The influx of large corporations has changed the entire landscape of hog farming in the state. The number of industrial hog facilities has risen from 0 to 60 in just the past 10 years, and production has increased despite the decline in the number of hog farms (4).

Some citizens of the state feel that corporate swine operators are adversely affecting their health and the vitality of their communities (7). Research has shown that industrial pork production may cause environmental health problems for ecosystems and humans (7–9). The new trend of large-scale production involves a high density of hogs grown in confinement houses and producing vast amounts of waste. The hog waste is collected and stored through different systems, including below-floor slurry storage (deep pit), underground slurry storage, anaerobic lagoons, and oxidation pits (10). One of the most popular methods is the storage of the waste in anaerobic cesspools, commonly called “lagoons,” where it undergoes microbial digestion. The hog waste effluent is later sprayed onto fields.

This system of pork production and waste management introduces several problems. Noxious gases are released through a ventilation system from the confinement houses (11), and environmental contaminants are also released via volatilization from the waste decomposing in lagoons, spray-fields, and other waste collection sites. Some of the environmental contaminants emitted

This article is part of the monograph *Advancing Environmental Justice through Community-Based Participatory Research*.

Address correspondence to S. Wilson, Dept. of Environmental Sciences and Engineering, School of Public Health, UNC at Chapel Hill, CB 7431, Rosenau Hall, Chapel Hill, NC 27599 USA. Telephone: (919) 960-2777. Fax: (919) 966-4711. E-mail: smwilson@email.unc.edu

This research was supported by the STAR Fellowship Program of the U.S. Environmental Protection Agency and grant R25-ES08206-04 from the Environmental Justice: Partnerships for Communication program of the National Institutes of Health. We thank E. Hammer and E. van Wijngaarden for their work on the project and acknowledge E. Mahaffey of the Mississippi Department of Environmental Quality for his assistance.

Received 13 August 2001; accepted 18 January 2002.

into the atmosphere include ammonia, hydrogen sulfide, volatile organic compounds, particulates, and other pollutants (12–14). The contaminants can cause health problems for individuals exposed occupationally in the confinement houses (12–14). In addition, community members who live close to the operations may have adverse health effects such as irritation to their eyes, noses, and throats (8,9,15); decline in quality of life (9); and possible mental health disorders (15,16). There are also water quality problems associated with leakage from the lagoons (17–19) and runoff from the sprayfields (7) that can contaminate surface and groundwater.

The concentration of the pollution-intensive swine industry in the northeastern portion of the state becomes an important environmental justice problem. Mississippi has a large population of rural citizens who are non-White and poor, which may make their communities more susceptible to health risks associated with residing near large numbers of hog facilities (20). The contaminants released from industrial hog operations pose a significant threat to public health, environmental quality, sustainable economic development, and community stability and vitality. Similar issues have been raised in other hog-producing states such as Iowa and North Carolina. For example, research studies in North Carolina have provided evidence at the county and block group level of environmental inequities in the distribution of industrial hog operations (21–24). The evidence also indicates that adverse social and environmental impacts of swine waste follow a course of less political resistance (24). In essence, industrial hog operations have located in non-White and low-income communities in eastern North Carolina, the state's poorest and most politically marginalized region (24).

Both Iowa and North Carolina have well-developed CAFO-based hog production systems. We do not yet know how issues of environmental equity fare in states where concentrated swine operations are present but less well developed than in Iowa or North Carolina. Moreover, the racial diversity of a state's population base may well affect the pattern of environmental equity observed. For instance, in Iowa, the African American population is very small as a percentage of the total population base, whereas African Americans heavily populate North Carolina's eastern territory. Mississippi has many counties with a significant to substantial percentage of the population identifying themselves as African American but where CAFO-style swine production has only recently emerged. Thus, the use of Mississippi as a study site facilitates the investigation of environmental equity issues during the initial development

phase of CAFO-style swine production. Using Geographic Information Systems (GIS) and sociodemographic data for census block groups, we examined the association between the location of industrial swine operations and their proximity to non-White (e.g., African American) and poor communities.

Materials and Methods

CAFO Definition and NPDES Data

We obtained a 1997 list of the National Pollution Discharge Elimination System (NPDES)-permitted swine operations in Mississippi from the Department of Environmental Quality (DEQ). NPDES regulates the discharge of pollutants from point sources to waters of the United States (25–27). The U.S. Environmental Protection Agency (U.S. EPA) Clean Water Act identifies CAFOs as point sources that are required to secure NPDES permits (26,27). The U.S. EPA defines a CAFO as an animal feeding operation (AFO) with more than 1,000 AUs confined at the facility. In addition, a CAFO can be an AFO with 301–1,000 AUs confined at the facility if *a*) pollutants are discharged directly into the waters of the United States through a man-made system or *b*) waters that originate off-site of the facility pass over, across, or through the facility or come in direct contact with the confined animals (26,27). The 1997 list obtained from the Mississippi DEQ included descriptive information on 69 hog operations classified as CAFOs. The information includes facility name, permit number, contact person, city/county location, number of animals, and latitude/longitude coordinates.

Geographic Information System Application

We used the GIS program to check and correct the latitude/longitude coordinates in the database (2). A list of corrected latitude/longitude coordinates covered 67 operations permitted or in the permitting process as of 1997. The hog operation coverage was generated in Arcview 3.1 (28) and included information on 67 of the 69 hog CAFOs. The two excluded facilities had incomplete information and therefore were not used in the analysis. We used the GIS program to attach information from the database to the hog coverage shapefile, a file that visually displays the geographic coordinates of the hog CAFOs.

Census Data and Environmental Justice Variables

We obtained data on race and poverty from the 1990 Census Summary Tape file (STF 3A) (29). Growth of corporate hog

production was just beginning around 1990, so census data for that period represent the characteristics of the populations of the areas chosen for expansion. Block groups are the smallest census aggregation that includes race/ethnicity and socioeconomic status (30). Census block groups contain, on average, approximately 1,000 persons or 500 households.

We defined poverty according to the federally established poverty threshold in 1990. This threshold is based on the definition originated by the Social Security Administration in 1964 and approved by the Office of Management and Budget in Statistical Policy Directive 14 (31). Population size and density of the census block groups were also obtained.

Analytic Methods

In Mississippi, as in most agricultural states, most livestock are raised in rural locations. There are no intensive livestock operations located in metropolitan areas such as the Biloxi–Gulfport area or the Jackson, Mississippi, metropolitan area. There is also an absence of large hog operations in small towns not in the northeast section of the state or in the Delta, the large geographic area on the western side of the state adjacent to the Mississippi River.

We organized our geographic analyses into two phases. In the first geographic analysis we examine the distribution of African Americans and persons in poverty in relation to the location of hog CAFOs in the entire State of Mississippi, which consists of 2,392 census block groups. In the second geographic analysis, we excluded most of the densely populated areas and municipal census blocks because they could distort the relationship between the hog operations and the environmental justice variables. The hog counties analysis contained the census block groups located in counties that had at least one industrial hog operation. Sixteen counties (containing 352 block groups) had at least one hog CAFO.

We first investigated the relationship between each environmental justice variable and the presence of hog CAFOs by dividing block groups into quintiles of each environmental justice variable and calculating the number of hog operations in the different levels of the study variables (22). The ratio of the number of hog CAFOs in each higher quintile compared with the lowest quintile is defined as the prevalence ratio. We mapped hog CAFOs and the environmental justice variables to exhibit their spatial relationships. In addition, the variables of percentage of poverty and percentage of African Americans were cross-classified in two-way tables. Because quintiles cannot be defined simultaneously for

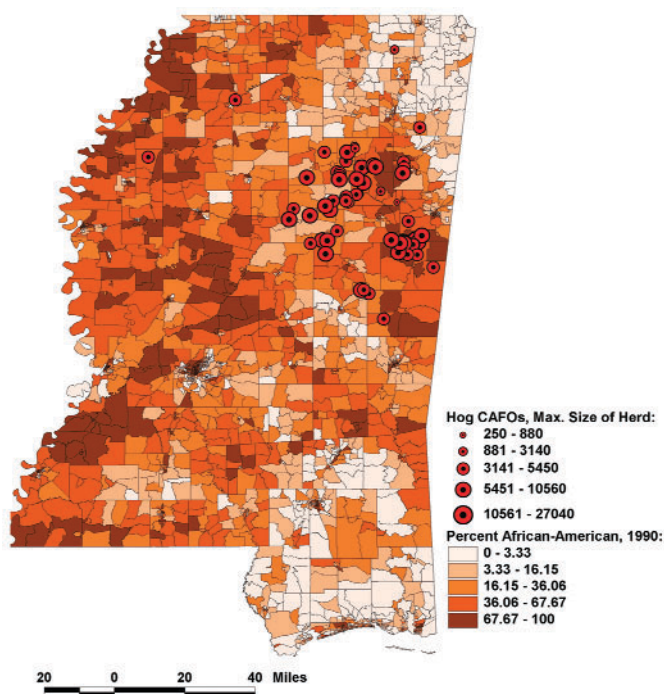


Figure 1. Hog CAFOs in proximity to percentage of African American, State of Mississippi, 1990.

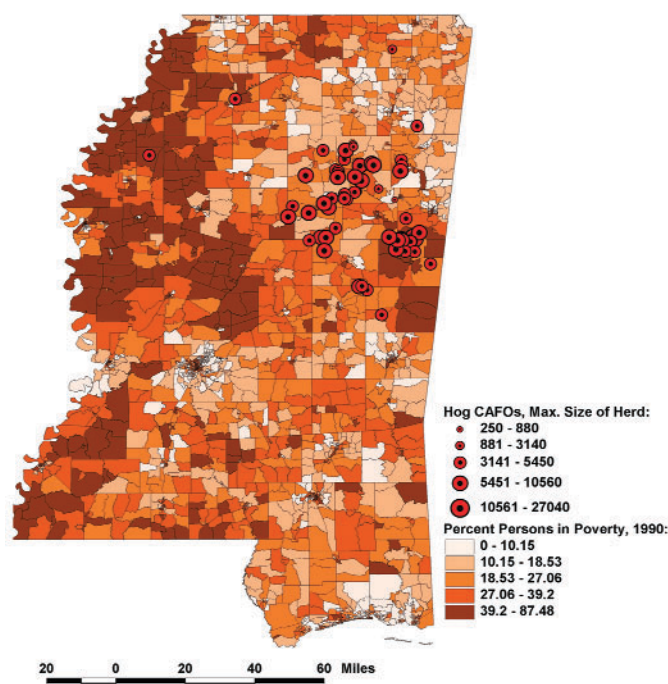


Figure 2. Hog CAFOs in proximity to percentage of poverty, State of Mississippi, 1990.

both variables, and univariate relationships were not linear, we chose boundaries for the cross-classification that corresponded to higher and lower ranges of prevalence: above or below 29% for African American and above or below 25% for poverty.

We used logistic regression to estimate odds ratios and their 95% confidence limits for the impacts of race and poverty on presence of CAFOs with adjustment for population density. A similar approach was used previously in a study of CAFO locations in North Carolina (22). Population density was included as a covariate to evaluate whether associations with environmental justice variables could be explained statistically by a measure of rurality. For block groups in the hog counties, we examined the presence or absence of one or more CAFOs (the dependent variable) in relation to race, poverty, the natural log of population density, and the interaction of race and poverty. Environmental justice variables were coded as in the cross-classification analyses described above. We used Statistical Analysis System (32) software to estimate parameters and their variances and covariances.

Results

State of Mississippi Analysis—Choropleth Maps

Figure 1 is a choropleth map displaying the spatial location of the hog CAFOs in relation to quintiles of percentage of African American for the entire State of

Table 1. Characteristics of block groups in relation to race in the State of Mississippi analysis.

Environmental justice variable	Quintiles	Total population	No. of hogs	No. of block groups	No. of CAFOs	Population density (per square mile)
Percentage of African American	0–3.33	461,960	0	478	0	1,892
	3.33–16.15	540,649	14,020	479	3	1,005
	16.15–36.06	534,042	118,900	478	25	925
	36.06–67.67	495,525	114,559	478	26	3,605
	67.67–100	541,040	94,240	479	13	2,421

Table 2. Characteristics of block groups in relation to poverty in the State of Mississippi analysis.

Environmental justice variable	Quintiles	Total population	No. of hogs	No. of block groups	No. of CAFOs	Population density (per square mile)
Percentage of persons in poverty	0–10.17	514,289	250	478	1	5,013
	10.17–18.56	531,202	50,260	479	11	854
	18.56–27.06	506,357	111,829	477	24	660
	27.06–39.2	503,544	92,640	478	19	996
	39.2–87.48	515,724	86,740	478	12	2,019

Mississippi. This figure shows the locations of the 67 swine operations in the entire state using red dots; each dot represents an active swine operation. The size of the dots signifies the size of each individual hog operation (see legend). The map shows that corporate pork production occurs mainly in a dense corridor in the northeastern section of the state. In addition, we see that approximately 35% of the state’s population is African American. There are high numbers of African Americans distributed across major geographic expanses of the state, especially in the central region and western portion of the state that borders the Mississippi River. The area that borders the

river is known as the Mississippi Delta, a fertile agricultural region in the western part of the state whose African American citizens are primarily the descendants of slaves and sharecroppers. However, in the northeastern extreme of the state and census block groups close to the Mississippi Gulf Coast, we see census units with low numbers of African Americans.

Figure 2 shows the distribution of poverty in the state. Approximately 25% of the persons in the state live below the poverty level (31). Some low-poverty areas and many high-poverty areas are located near the hog CAFOs. Most of the high-poverty areas are in census block groups in the Mississippi

Delta, central-west Mississippi, and Jackson, the capital of the state.

State of Mississippi Analysis—Prevalence Data

Tables 1 and 2 display the attributes of block groups in relation to percentage of African Americans and percentage of persons in

poverty. Block groups in the lowest quintile of percentage of African Americans have no hog operations. In addition, only three hog operations are located in the second quintile of percentage of African Americans. In contrast, the highest three quintiles of percentage of African Americans have 64 of the 67 industrial swine operations.

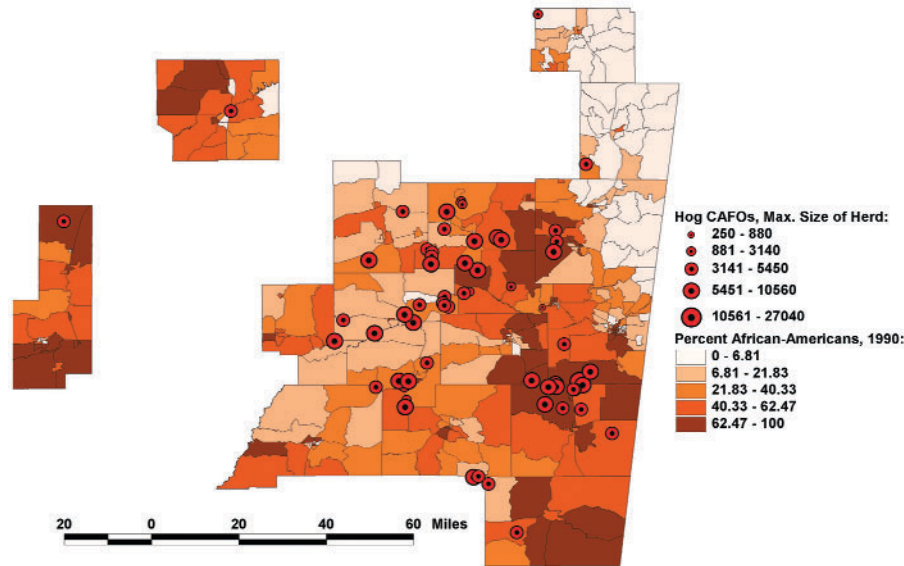


Figure 3. Hog CAFOs in proximity to percentage of African Americans, Mississippi hog counties, 1990.

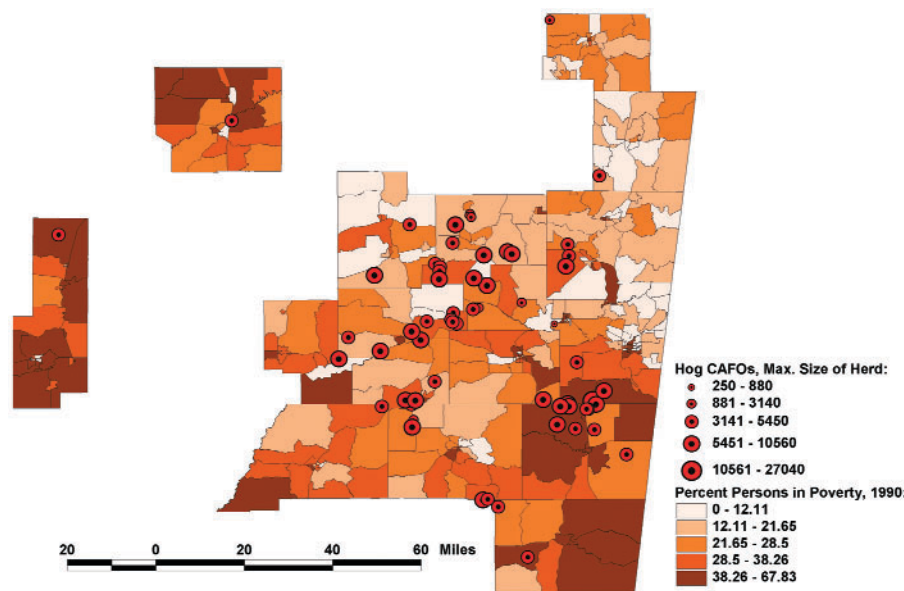


Figure 4. Hog CAFOs in proximity to percentage of poverty, Mississippi hog counties, 1990.

Table 3. Characteristics of block groups in relation to race in the Mississippi hog counties analysis.

Environmental justice variable	Quintiles	Total population	No. of hogs	No. of block groups	No. of CAFOs	Population density (per square mile)
Percentage of African Americans	0–6.81	61,501	3,140	70	1	458
	6.81–21.83	84,351	52,000	70	9	550
	21.83–40.33	70,976	78,030	71	19	487
	40.33–62.47	76,482	102,299	70	23	322
	62.47–100	93,781	106,250	71	15	920

Table 2 presents information on the characteristics of the block groups for the percentage of people in poverty variable for the state of Mississippi. In the lowest quintile of the variable, only one industrial hog operation and 11 hog CAFOs are located in the second-lowest quintile. In contrast, 55 hog CAFOs are in the highest three quintiles for the percentage of persons in poverty variable. The largest number of CAFOs occurs in the third quintile.

Mississippi Hog Counties Analysis—Chloropleth Maps

We created a second series of maps to examine the association between the study variables and the distribution of hog CAFOs in counties that had at least one operation. These chloropleth maps do not contain the block groups of metropolitan areas or non-hog CAFO counties. Figure 3 shows the geographic distribution of percentage African American populations for 352 block groups. The figure reveals that most of the block groups in this analysis have large populations of African Americans. The census block groups in the area with lower numbers of African Americans are located in the far northeastern portion of the study area near the Alabama border and in the central region of the map. Many of the hog CAFOs are located in block groups with greater than 22% African American population. Figure 4 shows the spatial distribution of poverty in the 352-block group study area. There are low numbers of persons living in poverty in census block groups in the northeastern portion of the study area and interspersed in the central region of the map. Some of the industrial hog operations are distributed in low-poverty areas. Figure 4 shows that the majority of the hog CAFOs are in areas with greater than 22% persons in poverty.

Mississippi Hog Counties Analysis—Prevalence Data

Table 3 shows the distribution of hog CAFOs in relation to the proportion of African Americans in the hog counties. In the lowest quintile for percentage of African Americans, there is only 1 hog operation. We find 9 industrial hog operations in the second quintile. In contrast, there are 57 industrial hog operations in the three highest quintiles of percentage of African Americans. In addition, the population densities are lower in the hog counties analysis, compared with the State of Mississippi geographic analysis. This is because of our exclusion of the urban and municipal block groups in the hog counties analysis. Block groups in the hog counties analysis are predominately rural and sparsely populated (Table 3).

Table 4 presents information on the characteristics of census block groups for the percentage of persons in poverty variable. There are 4 hog CAFOs in the lowest quintile of percentage of people in poverty and 13 in the second lowest quintile of the same variable. This compares with 50 hog CAFOs in the highest three quintiles of percentage of people in poverty (21.65–67.83% persons in poverty).

Prevalence Ratios

Table 5 shows the prevalence ratios for hog CAFOs cross-classified for combinations of the two environmental justice variables for the state of Mississippi geographic analysis. The table gives the prevalence (number of CAFOs per block group) for the cross-classified variables and the ratio of the prevalence of CAFOs at each level compared with the referent level. Together, block groups in the 0–25% poverty and 0–29% African American are the referent group. There are 3.64 times more hog operations in the high African American, low-poverty group compared with the referent group. There are 2.4 times more operations in the high African American, high poverty block groups compared with the referent group.

Table 6 provides prevalence ratios for the environmental justice variables in the Mississippi hog counties analysis. For this smaller area of study, a general decrease from the large values is seen in the prevalence ratios of the whole-state analysis. Block groups with 0–25% poverty and 0–29% African American are the referent group. The low-poverty and high African American block groups and the high-poverty, low African American block groups have prevalence ratios of approximately 3. At high percentages poverty and high percentages African American, the prevalence ratio is 1.79.

Table 7 shows results of a logistic regression model including race and poverty as indicator variables, their interaction, and the natural log of population density. Low African American, low-poverty areas are considered the referent group. Following adjustment for population density, there were 2.84 times as many CAFOs in high African American, low-poverty block groups compared with the referent, and 2.68 times as many in high-poverty, low African American block groups. The excess in high African American, high-poverty groups is 1.35 times; 95% confidence limits are fairly wide for

these estimates, partly because there were only 36 block groups with one or more CAFOs.

Discussion

We examined the locations of 67 industrial hog operations in relation to race and poverty in neighboring census block groups in Mississippi. We found that the majority of the Mississippi's industrial hog operations are located in areas with high percentages of African Americans and persons in poverty. This evidence supports the idea that industrial pollution sources are disproportionately located in proximity to non-White and low-income communities (23,24,33–40). The study found distributional inequities in the location of hog CAFOs in non-White (African American) and poor communities. The environmental contamination from hog CAFOs can expose the burdened populations to harmful pollutants. The disproportionate number of industrial swine operations in these areas raises concerns about public health and quality of life (8,9,41) and may lead to economic decline in the affected communities (8,24,35,42,43).

The joint effects of race and poverty are also of interest. In the Mississippi hog counties and adjusting for population density, there are approximately 3 times as many CAFOs in high African American, low-poverty block groups compared with the referent, and also 3 times as many in high-poverty, low African American block groups compared with the referent. However, in high levels of both poverty and African American block groups, there are only 1.79 times as many hog CAFOs (Table 7). In areas that have high percentages of African Americans and persons in poverty, there may be a lack of political and economic infrastructure present to attract any new industries, even hog CAFOs.

Research has shown that living near industrial hog operations is a major public health concern for disproportionately burdened communities. Studies indicate that emissions from swine confinement houses are associated with adverse respiratory problems (8,12,13,15) and a decline in quality of life for communities in proximity to the hog CAFOs (9,41). Other data reveal that people who lived near livestock operations such as a hog CAFO reported irritating odors that caused negative respiratory effects and impaired mood disorders (15,16). Results analogous to those mentioned above were found in a study of the physical and mental health of residents who lived near a large-scale operation in Iowa (8).

Furthermore, the high density of swine CAFOs in rural census block groups can release environmental pollutants that degrade the water quality of these communities (44)

Table 4. Characteristics of block groups in relation to poverty in the Mississippi hog counties analysis.

Environmental justice variable	Quintiles	Total population	No. of hogs	No. of block groups	No. of CAFOs	Population density (per square mile)

Table 5. Prevalence ratios of the numbers of hog CAFOs per block group for block groups classified by percentage of African American and percentage of poverty, state of Mississippi.

Percent poverty	Percentage of African American: 0–29				Percentage of African American: 29–100			
	Number of block groups	Hog CAFOs	Prevalence	Prevalence ratio	Number of block groups	Hog CAFOs	Prevalence	Prevalence ratio
0–25	1,066	15	0.014	1.00	254	13	0.051	3.64
25–100	210	10	0.048	3.38	860	29	0.034	2.40

Table 6. Prevalence ratios of the numbers of hog CAFOs per block group for block groups classified by percentage of African American and percentage of poverty, Mississippi hog counties.

Percent poverty	Percentage of African American: 0–29				Percentage of African American: 29–100			
	Number of block groups	Hog CAFOs	Prevalence	Prevalence ratio	Number of block groups	Hog CAFOs	Prevalence	Prevalence ratio
0–25	136	15	0.110	1.00	38	13	0.342	3.10
25–100	31	10	0.323	2.94	147	29	0.197	1.79

Table 7. Odds ratios and 95% confidence limits from logistic regression, Mississippi hog counties, 1990.

	0–25% Persons in poverty	25–100% Persons in poverty
0–29% African American	1.0 (referent group)	2.68 (0.75–9.56)
29–100% African American	2.84 (0.98–8.22)	1.35 (0.54–3.39)

and potentially increase the number of pathogenic microbial contaminants in surface and groundwater near swine lagoons and sprayfields (7). Lobao states (42) that an

agricultural structure that was increasingly corporate and non-family owned tended to lead to population decline, lower incomes, fewer community services, less participation in democratic processes, less retail trade, environmental pollution, more unemployment, and an emerging rigid class structure.

Moreover, other findings have shown that large farms adversely impact the economic health of rural communities (23,24,42,43,45). This leads to community concerns about reduction in quality of life (9), depression of land and property values (45), farm loss (23), and interference with the growth of environmentally sustainable industries (40,45). All these impacts can destroy the interconnectivity of the personal, environmental, economic, and social health (8) of rural communities that are disproportionately exposed to industrial hog facilities.

Even though this study does not attempt to ascertain the causes of the social and racial inequities in the distribution of the intensive swine operations, there are credible reasons for this particular siting pattern in the state. Corporate hog operations in many agricultural states like Mississippi tend to locate facilities on the basis of economic factors such as the sociopolitical structure of the host communities and contiguity to other related operations, slaughterhouses, transportation routes, and infrastructure (22,46). Various economic, political, and institutional factors are important in the siting of hog CAFOs. For example, a major integrator opened a large hog-feed mill in West Point, Mississippi, with the intention of supplying feed to its own nearby feedlots in northeastern Mississippi. It also planned to establish facilities in the area to supply local hogs to a major food production company (4,47). The corporate integrator intends to establish dozens of hog farms within a 50- to 75-mile radius of its feed mill to supply one of the largest slaughterhouses in the South, also in the West Point area (1,2,48). The above information provides evidence of some reasons for the restructuring of the industry in the state.

Other important factors to consider when examining the spatial distribution of industrial swine operations in rural communities are low land prices, lack of community-based organizations advocating for environmental protection and public health, absence of CAFO zoning regulations and county legislation, economic incentive packages, and lack of other opportunities for local farmers. Economic development and environmental policies

tend to result from the driving forces of production, (i.e., vertical integration) (49) and are often dominated and subsidized by state regulatory and commerce agencies (22). For instance, Mississippi state and county agencies offered millions of dollars in tax breaks and incentives to corporate integrators and paid for road improvements (4).

The aforementioned economic factors have contributed to the growth and restructuring of the swine industry in Mississippi. This pattern is similar to the growth and vertical integration of the industry in other states such as North Carolina, Minnesota, Utah, and Iowa. Unlike these other states, Mississippi does not have a large number of industrial hog operations. A 1998 moratorium and county zoning laws have combined to retard the growth of the industry (1,50). Future studies of environmental justice in the Mississippi swine industry should be conducted with more accurate data on the characteristics of the industrial hog operations to elucidate the nature of the geographic inequities. Information from the Mississippi DEQ database was not clear on type of operation, whether it was an independent operation or a corporate integrator (51). The calculation of prevalence ratios on the basis of operation type would show whether small independent farms or corporate integrators were more prevalent in non-White and poor communities than in affluent and White communities (22). In addition, a temporal analysis that includes operations that have pending permits can examine the potential future of the industry and ascertain whether the hog CAFOs are going to be located in areas where geographic inequities exist.

Conclusions

The inequitable distribution of swine operations is a threat to Mississippians because exposure to noxious odors, airborne contaminants, and microbial pollutants from the confinement houses, lagoons, and sprayfields is a concern for individuals with preexisting respiratory problems, children, elderly, and the uninsured. A new collective awareness has occurred in rural Mississippi (51). Citizens are concerned about the public health impact and ecologic risks introduced by intensive pork production. A number of non-White and poor communities have disproportionate numbers of hog CAFOs in their communities, which constitutes an environmental equity issue. The state could focus on attracting environment-friendly industries that could add to the economic stability and vitality of low-income and African American communities that currently have a disproportionate number of operations.

REFERENCES AND NOTES

1. Natural Resources Defense Council. Mississippi. In: America's Animal Factories: How States Fail to Prevent Pollution from Livestock Waste. Available: <http://www.nrdc.org/nrdcpro/factor/stmis.html> [accessed 2 April 2000].
2. Howell F. Unpublished data, 1998.
3. State of Mississippi, 1996. Section 69-2-19: Farm Reform Act of 1987: Emerging Crops Fund. 1996 Amendment. Special Session. Jackson, MS. 25 March 1996.
4. Sierra Club. Corporate Hogs at the Public Trough. Available: <http://www.sierraclub.org/cafos/report99/prestage.asp> [accessed 2 April 2000].
5. Breazeale L. Hog Producers Await Federal Assistance. Starkville, MS:Mississippi State University. Available: <http://ext.msstate.edu:80/ppe/news/news/agnews/990125mc.html> [accessed 2 April 2000].
6. Ammerman, J. Hog farm opponents face setback. The Clarion-Ledger (Jackson, MS), 7 Oct 1998.
7. Sobsey M, Hill V, Cole D. Unpublished data, 1998.
8. Thu K, Donham K, Ziegenhorn R, Reynolds S, Thorne PS, Subramanian P, Whitten P, Stookesberry J. A control study of the physical and mental health of residents living near a large-scale swine operation. *J Agric Saf Health* 3:13-26 (1997).
9. Wing S, Wolf S. Intensive livestock operations, health and quality of life among eastern North Carolina residents. *Environ Health Perspect* 108:233-238 (2000).
10. U.S. EPA. Feedlot Industry Sector Profile Revised Draft Report. Washington, DC:U.S. Environmental Protection Agency, 1998.
11. North Carolina Swine Odor Task Force. Options for Managing Odor. Raleigh, NC:North Carolina State University, 1995.
12. Donham K. Health effects from work in swine confinement buildings. *Am J Ind Med* 17:17-25 (1990).
13. Donham K. The impact of industrial swine production on human health. In: *Pigs, Profits, and Rural Communities* (Thu K, Durrenberger E, eds). Albany, NY:State University of New York Press, 1998.
14. Donham K. Respiratory disease hazards to workers in livestock and poultry confinement structures. *Sem Respir Med* 14:49-59 (1993).
15. Schiffman SS. Livestock odors: implications for human health and well-being. *J Anim Sci* 76:1343-1355 (1998).
16. Schiffman SS, Sattely Miller EA, Suggs MS, Graham, BG. Mood changes experienced by persons living near commercial swine operations. In: *Pigs, Profits, and Rural Communities* (Thu K, Durrenberger E, eds). Albany, NY:State University of New York Press, 1998.
17. Huffman, RL. Groundwater impacts of lagoons. 1999. Raleigh, NC:North Carolina State University. Available: <http://www3.bae.ncsu.edu/huffman/waste.html> [accessed 6 May 2000].
18. Huffman RL, Revels JE. Impact of older swine lagoons on shallow groundwater in North Carolina. 1998 ASAE Annual International Meeting. Paper Number 982032. Summary Report. Available: <http://www3.bae.ncsu.edu/huffman/waste.html> [accessed 6 May 2000].
19. Huffman RL, Westerman PW. Estimated seepage losses from established swine waste lagoons in the lower coastal plain of North Carolina. *Trans ASAE* 38:449-453 (1995).
20. Howell F, Tompkins PL, Wells JG, Ritchie JB. Social and economic characteristics of Mississippi counties, 1990. Report No. 95-1, Social Research Report Series. Starkville, MS:Mississippi State University, 1995.
21. Raine J. Environmental Justice Issues of the North Carolina Swine Industry [Masters thesis]. Durham, NC:Duke University, 1998.
22. Wing S, Grant G, Cole D. Environmental injustice in North Carolina's hog industry. *Environ Health Perspect* 108:225-231 (2000).
23. Edwards B, Ladd A. Environmental justice, swine production and farm loss in North Carolina. *Social Spectrum* 20:263-290 (2000).
24. Edwards B, Ladd A. Race, poverty, political capacity and the spatial distribution of swine waste in North Carolina, 1982-1997. *NC Geogr* 9:59-70 (2001).
25. Mississippi DEQ. Office of Pollution Control. Wastewater Regulations for National Pollution Discharge Elimination System (NPDES) Permits, Underground Injection Control

- (IUC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification, 1995.
26. U.S. EPA. National Pollution Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Confined Agricultural Feeding Operations. 40 CFR 122 and 412. Washington, DC:U.S. Environmental Protection Agency, 2001.
 27. U.S. EPA. Guidance Manual and Example NPDES Permit for Concentrated Animal Feeding Operations. Washington, DC:U.S. Environmental Protection Agency, 2000.
 28. ESRI, Inc. Getting to Know Arcview GIS: the Geographic Information Systems for Everyone. Version 3.1. Redlands, CA:ESRI, 1996.
 29. U.S. Census. 1990 Census Summary Tape File (STF3A). Suitland, MD:U.S. Census Bureau, 1990.
 30. Perlin SA, Sexton K, Wong DWS. An examination of race and poverty for populations living near industrial sources of air pollution. *J Expo Anal Environ Epidemiol* 9:29–48 (1999).
 31. U.S. Census Bureau. Current Population Survey (CPS)-Definitions and Explanations. Available: <http://www.census.gov/hhes/www/poverty.html> [accessed 28 December 2001].
 32. SAS Institute Inc. SAS OnlineDoc User's Guide, Version 8. Cary, NC:SAS Institute Inc., 1999. Available: <http://statweb.unc.edu/test1/onldoc.htm.html> [accessed 28 December 2001].
 33. Bullard R. *Dumping in Dixie: Race, Class, and Environmental Quality*. Boulder, CO:Westview Press, 1994.
 34. Bullard R. Environmental justice for all. In: *Unequal Protection: Environmental Justice & Communities of Color* (Bullard R, ed). San Francisco, CA:Sierra Club Books, 1994;3–22.
 35. Cecelski D, Kerr ML. Hog wild. *South Expos* 20:9–15 (1992).
 36. Center for Policy Alternatives. Toxic waste and race revisited. 1994. Available: <http://www.stateaction.org> [accessed 8 April 2000].
 37. Costner P, Thornton J. *Playing With Fire*. Washington, DC:Greenpeace, 1990.
 38. United Church of Christ Commission for Racial Justice. *Toxic Waste and Race: A National Report on the Racial and Socioeconomic Characteristics of Communities with Hazardous Waste Facilities*. New York:United Church of Christ, 1987.
 39. Wernette D, Nieves L. Breathing polluted air. *EPA J* 118:16–17 (1992).
 40. Ladd A, Edwards B. Swine before pearls: environmental justice and public opposition to corporate pork production in North Carolina. In: *Race, Gender, Class and Environmentalism* (Bullard R, Johnson G, Taylor D, Belkhir J, eds). New York:Roman and Littlefield, in press.
 41. Edwards B, Maiolo J. Assets and Threats to Quality of Life in Eastern North Carolina: Preliminary Results from the 1996 Annual Survey of Eastern North Carolina. Greenville, NC:East Carolina University, 1997.
 42. Lobao L. *Locality and Inequality: Farm and Industry Structure and Socioeconomic Conditions*. Albany, NY:State University of New York Press, 1990.
 43. Gomez M, Zhang L. Unpublished data, 2000.
 44. Jackson L. Large-scale swine production and water quality. In: *Pigs, Profits, and Rural Communities* (Thu K, Durrenberger E, eds). Albany, NY:State University of New York Press, 1998;103–119.
 45. Palmquist RB, Roka FM, Vukina T. Hog operations, environmental effects, and residential property values. *Land Econom* 73:114–124 (1997).
 46. Furuseth O. Restructuring of hog farming in North Carolina: explosion and implosion. *Prof Geogr* 49:391–403 (1997).
 47. Sewell T. Prestage farms bringing pork barrel to West Point. *Memphis Business J* (Memphis, TN), 15 August 1994;39.
 48. Copeland M. Personal communication.
 49. Thu K, Durrenberger E. Introduction. In: *Pigs, Profits, and Rural Communities* (Thu K, Durrenberger E, eds). Albany, NY:State University of New York Press, 1998;1–22.
 50. Senate Bill 2895. Mississippi Association of Supervisors. *Legislation Affecting Counties*. 1998 Legislative Session. Available: <http://ext.msstate.edu:80/mas/legis/reports/legis-summary98.html> [accessed 2 April 2000].
 51. Collins B. Personal communication.