

Integrating Epidemiology, Education, and Organizing for Environmental Justice: Community Health Effects of Industrial Hog Operations

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The environmental justice movement has stimulated community-driven research about the living and working conditions of people of color and low-income communities. We describe an epidemiological study designed to link research with community education and organizing for social justice. In eastern North Carolina, high-density industrial swine production occurs in communities of low-income people and people of color. We investigated relationships between the resulting pollution and the health and quality of life of the hog operations' neighbors. A repeat-measures longitudinal design, community involvement in data collection, and integration of qualitative and quantitative research methods helped promote data quality while providing opportunities for community education and organizing. Research could affect policy through its findings and its mobilization of communities. (*Am J Public Health*. 2008;98:1390–1397. doi:10.2105/AJPH.2007.110486)

There is growing interest in public health research that addresses the concerns of communities exposed to environmental hazards through research partnerships between scientists and community-based organizations.^{1–10} This interest is generated in part by public demands for accountability from scientific institutions that are increasingly dependent on funding from industries and research grants.^{11,12} Interest in community-driven research has also been stimulated by the environmental justice movement, which developed from grassroots efforts to oppose disproportionate placement of waste sites and polluting industries in communities that lack political power.^{13–15} Low-income communities and those composed predominantly of people of color not only have little influence on land-use decisions that bring pollution and disincentives for safe and sustainable development, they also lack resources for conducting research into relationships between land use, pollution, race, and class, or for investigating the impacts of land use and pollution on the health and quality of life. Such research could help to increase understanding of the scope, magnitude, and effects of environmental injustice, raise community awareness, educate policymakers, inform legal disputes, and contribute to the knowledge base for improving public health.^{1,2,16–18}

Several barriers limit community-driven environmental health research. First, its small share of environmental and health research funding is disproportionate to its needs. Second, people of color and low-income people often distrust researchers who visit their communities only when their research interests are piqued, come from institutions that foster and benefit from economic and racial inequalities, or are from professions with a history of discriminatory practices.^{19–21} This distrust creates further disincentives for researchers because, in the context of funding shortages, they must take the time and effort to build trust, learn about community situations and perspectives, and learn how to communicate with nonresearchers about technical topics.²² Third, researchers and community members may fear harassment, litigation, or loss of funding if they find evidence of discrimination or harm caused by industry practices and choose to bring them into the public arena.²³ These challenges highlight the need for refinement of study designs and methods for community-driven public health research.

We describe the design and methods of an epidemiological investigation of the impact of air pollution from industrial swine production facilities on the health and quality of life of neighboring communities as an example of (1) how community-driven environmental

health research can connect research, education, and organizing for change and (2) how community participation in research can improve the validity of the data collected. Community Health Effects of Industrial Hog Operations (CHEIHO) grew out of a collaboration between academic researchers and the Concerned Citizens of Tillery (CCT),²⁴ a community-based organization that promotes social justice and self-determination for rural African American communities. Our hypotheses and methods were based on community experiences and previous research. The study enrolled 102 people in 16 communities who collected data twice a day for 2 weeks. It was designed to integrate ethnographic and epidemiological research^{25,26} on acute exposures and their relationships to both health-related outcomes and quality-of-life concerns, while providing environmental health education and promoting community participation in environmental and social justice movements.

SELECTION OF RESEARCH QUESTIONS

From the time of its founding in 1978 through the 1980s, CCT worked to preserve a local public school, stop the loss of African American-owned land, and provide economic opportunity, medical care, and health promotion in an underdeveloped region of the South. CCT became more involved in environmental issues in the early 1990s when Tillery, a predominantly African American rural community in eastern North Carolina, was selected as a location for the construction of several industrial hog operations. These operations emit malodorous compounds from confinement barns, fecal waste pits, and fields on which waste is applied; waste pits and spray fields can contaminate ground and surface water. Industrial hog operations in North Carolina are disproportionately

located in communities of low-income people and people of color, where inadequate housing, poor nutrition, lack of access to medical care, and simultaneous exposure to other environmental and occupational hazards may exacerbate their impact.^{27–29} CCT viewed this situation as an example of environmental racism.

Rural residents who routinely experience unpredictable and uncontrollable malodor from hog dander, feed, feces, urine, and carcasses in and around their homes may view research into their exposures and experiences as unnecessary; they simply want the practices that lead to these exposures to end. Residents who petitioned appointed and elected officials for relief, however, received skeptical responses. Noting that industrial hog operations' permits required protection of the environment, public officials asked for research that documented problems, placing the burden of proof on the public and the communities themselves.³⁰ Most community members did not have experience conducting research; therefore, a collaboration with academics was established to provide documentation of whether industry practices affect local populations and, if such evidence was found, to provide evidence-based policy solutions.

Neighbors of industrial hog operations are concerned that water and air pollution could cause a host of health problems ranging from impaired quality of life to cancer. We focused on the acute effects of air pollution caused by industrial hog operations, for several reasons: (1) the centrality of transient malodors as a quality-of-life problem; (2) case reports of acute respiratory problems; (3) evidence of excess occurrence of respiratory and gastrointestinal symptoms among neighbors of industrial hog operations^{31–37}; (4) previous documentation of local air pollutants from the operations, including respirable particulate matter, ammonia, and hydrogen sulfide³⁸; and (5) evidence of short-term psychophysiological impacts of odor as a stressor.³⁶ A few other studies have compared the self-reported physical and psychological states of neighbors of industrial hog operations with those of the residents of other rural communities^{33,35,39}; however, they did not include measurements of environmental exposures. Our primary research questions were as follows:

- What was the frequency, magnitude, and duration of swine odors experienced by the operations' neighbors?
- What were the levels of particulate matter less than 10 μm in aerodynamic diameter, hydrogen sulfide, and endotoxin in communities near industrial hog operations, and were these pollutants associated with residents' reports of odor?
- How were pollution levels and malodors related to lung function, blood pressure, symptoms, mood, and quality of life of neighbors?
- How were odors related to stress reported by residents?
- How were odors or reported stress related to levels of salivary immunoglobulin A (IgA)?
- How were the cultural and social contexts of rural life related to experiences of environmental exposures and quality of life?

In addition to these research questions concerning quantifiable covariation of pollution levels with health-related outcomes, we used semistructured, in-depth interviews to explore and assess the social and cultural effects of local hog operations on their neighbors' well-being and quality of life. Twenty-six people were interviewed prior to the start of the longitudinal study to help design the quantitative instruments. An additional 49 people were interviewed later, 42 of whom had completed participation in the longitudinal study. These interviews explored the impact of hog odor on quality of life and beneficial use of property and evaluated the extent to which participation affected awareness of environmental injustice issues and attitudes toward community organizing.

EPIDEMIOLOGICAL DESIGN

Most epidemiological studies involve comparisons of groups of people classified according to degrees of exposure or simply as exposed or unexposed. The validity of such comparisons rests on the assumption that exposed and unexposed groups are comparable, similar, or exchangeable with respect to factors other than the exposure. If the exposed and unexposed groups are alike in all respects except exposure, and if the outcomes of interest can be assessed in equivalent ways in the 2 groups, differences in the occurrence

of outcomes of interest cannot be explained by factors other than the exposure. However, such comparability with respect to factors other than exposure can never be completely achieved. If neighbors of industrial hog operations, for example, are compared with residents of other rural areas, differences in symptoms could be due to either exposures from the operations or other factors such as medical histories, lifestyle, or environmental exposures that might differ between the 2 groups. Although it is possible to measure and control for some of these confounding factors, it is not possible to measure all such factors.

Rather than compare exposed and unexposed groups, CHEIHO was designed to compare time periods during which individuals were exposed or unexposed. This design was appropriate because air pollution from industrial hog operations comes and goes depending on facilities' operations and the weather, and because health-related outcomes such as excessive coughing, depressed mood, and physiological functioning vary over the course of hours or days and may relate to short-term changes in exposure.⁴⁰ Our goals were to evaluate at any given time (1) participants' exposures to hog operation pollution, (2) participants' health-related states, and (3) the relationship between exposure, health-related states, and quality of life. Answers to the study questions were obtained by determining whether health varied according to the degree of current or recent exposure.

The major advantage of this design over a design that compares exposed and unexposed groups is that, for a particular individual, the potential confounding factors are those conditions that are different at exposed and unexposed time periods. Differences in nutrition, medical history, occupation, personality, or prior exposures that could confound a study comparing neighbors of hog operations with an unexposed group were relatively constant for any one person during the 2-week data collection period. Although odors could affect participants' responses to questions and therefore bias measures of association between odor and self-reported symptoms, reporting bias would not affect outcomes measured with instruments, such as lung function, blood pressure, and the IgA concentration of saliva.

This design, however, is not appropriate for examining chronic conditions.

The choice of research questions allowed us to conduct a study composed entirely of participants who live near industrial hog operations. This has several advantages. People who live near these operations have more reason to be interested in participating in a study of exposures from them than those who do not, which promotes persistence in maintaining data collection efforts, reduces participant attrition, and helps reduce the potential for bias introduced when participation and completeness of response are related to exposure status. Participants' interest in the study topic, combined with a participatory approach to documenting their experiences, helps increase trust in the research and confidence in the data collection process. In addition, the shared concerns of neighbors participating together helps build solidarity, improves knowledge about environmental health and justice, and promotes organizing for better public health conditions.

OVERVIEW OF DATA COLLECTION

CHEIHO enrolled 102 volunteers from 16 communities in eastern North Carolina between September 2003 and September 2005. To be eligible, participants had to live within 1.5 miles of at least 1 industrial hog operation and be nonsmokers older than 18 years. An 8- by 12-foot trailer was set up in each neighborhood in a central location near participants' homes. Several continuous monitors were mounted on the trailer: a Tapered Element Oscillating Microbalance Series 1400a Ambient Particulate Monitor with a Series 8500 FDMS Filter Dynamics Measurement System (Rupprecht and Patashnick Co Inc, East Greenbush, NY) for monitoring particulate matter less than 10 μm in aerodynamic diameter (PM_{10}) and semivolatile PM_{10} ; a Dichotomous Partisol-Plus 2025-D Sequential Air Sampler (Rupprecht and Patashnick) for separate collection of coarse and fine particulate matter ($\text{PM}_{2.5-10}$ and $\text{PM}_{2.5}$) on filters to be assayed for endotoxin; an MDA Scientific Single Point Monitor (Zellweger Analytics Inc, Lincolnshire, IL) for measuring hydrogen sulfide; and a Vantage Pro (Davis Instruments, Hayward, CA) and

Young Model 05103VM-42 Wind Monitor (R.M. Young Co, Traverse City, MI) weather station for recording temperature, humidity, barometric pressure, rainfall, wind speed, and wind direction. Real-time data from each instrument were electronically recorded and downloaded once a week to a laptop computer. While environmental data were being recorded, participants used a diary and instruments to collect data on odor, mood, blood pressure, symptoms, and immune and lung function twice a day for 2 weeks. The times of day for the twice-daily data collection were chosen by each participant at a training session held prior to the beginning of the study.

Qualitative interviews conducted before the longitudinal study helped to identify relevant questions for the daily diaries and culturally relevant language. They also facilitated interpretation of quantitative results in the context of the participants' daily lives and the role that rural upbringing plays in shaping responses to pollution from industrial hog operations. In addition to providing a context for interpreting quantitative data, interviews conducted after completion of the longitudinal study provided data that permitted corroboration of quantitative observations and evidence about the impact of the study experience on participants.

Recruitment

Participants in CHEIHO were volunteers who learned about the study through community-based organizations. Community organizers from CCT initiated contact with interested individuals, usually in their homes, to discuss the project, provide a copy of the study brochure, and answer questions. If community members expressed interest, the organizer arranged a meeting with a University of North Carolina researcher, who provided additional information about the data collection process. People who wanted to participate provided the research team with their names and phone numbers, and a member of the team administered an eligibility questionnaire that included basic demographic and household information, smoking status, and availability of a freezer in the home for storage of saliva samples.

In each neighborhood, a central location for the air pollution monitoring trailer was

chosen (mean and median distance from participants' homes was 0.2 and 0.1 miles, respectively). The trailer was positioned in an area relatively unfettered by such physical barriers as tall trees and buildings. The team then identified a community member, often a study participant, who was willing to regularly check the equipment to ensure its proper functioning. Malfunctions were reported to the University of North Carolina research office so they could be quickly resolved.

Training Sessions, Informed Consent, and Protection of Confidentiality

After determining eligibility, the field team scheduled a 3-hour training session in the community, in which participants learned about the purpose and design of the research and how to collect data. After initial introductions, a member of the field team read the consent form aloud, answered any questions, and informed participants that they could withdraw from the study at any time. Included in the consent form was information about efforts taken by the research team to keep all identifying information confidential, information for contacting the University of North Carolina institutional review board, and a description of protections offered by the certificate of confidentiality that we obtained from the US Department of Health and Human Services to help protect identifying information even under court order or subpoena. We considered this necessary because the University of North Carolina had required us to turn over de-identified participant records from a previous study to attorneys representing the pork industry.²³

Members of the field team then led study participants in a step-by-step process through the data collection tasks that they were to complete twice a day for 14 days. Participants practiced filling out pages in the daily data collection diary and practiced each study activity until they felt comfortable with it. They were given phone numbers of the members of the research team to call if problems arose at any point during their participation.

The training sessions were more than formal tutorials or data collection exercises. They were carried out in homes, churches, or other local venues that provided a natural and comfortable community setting for

potential participants, and refreshments were provided. In addition to conveying methodological knowledge, the sessions fostered rapport and trust between researchers, community organizers, and participants and helped bridge a cultural divide by translating technical data collection concepts into meaningful local language.

Quantitative Data Collection

During the 2-week data collection period, environmental monitoring equipment ran 24 hours a day, 7 days a week. Each morning and evening, participants completed the following set of activities. They went outside their homes for 10 minutes at preselected times. While outside, they noted the intensity of hog odor, and whether and how it interfered with any of their usual activities. They then returned indoors and rated the hog odor for the 10 minutes spent outside on a 9-point scale. Study participants recorded in diaries whether or not they experienced any irritation of the eyes, nose, or throat or a cough while outside and then answered written questions about their mood at that time. They took their blood pressure twice with an automatic blood pressure monitor, recorded physical health symptoms they had experienced in the previous 12 hours, took a 2-minute unstimulated saliva sample to be analyzed for IgA content, and blew 3 times into a lung function monitor.

At the end of the first week of data collection, members of the research team returned to the community to download data from the monitoring equipment and to check in with the person monitoring the equipment. They also visited study participants to review their progress in completing the required data collection activities, conducted preliminary data quality checks, and answered questions. In addition to weekly visits from the research team, participants in 11 of the 16 communities had access to additional assistance from a community member who was able to visit participants in their homes when questions or problems arose. Study participants completed a questionnaire providing background information on their homes, occupations, existing health problems, and regular medication use; they also completed the Pearlin mastery scale^{41,42} and John Henryism active coping

scale.⁴³ At the end of the 2-week study period, they filled out a brief exit questionnaire in which they reported any problems they had had with the data collection protocol and whether or not they had been sick at any point during data collection.

Participant enrollment and data collection occurred sequentially in 16 communities. The order of data collection was based on the readiness of communities and the desirability of limiting movement of the trailer and equipment.

Qualitative Interviews

Semistructured, open-ended, in-depth interviews were conducted with 75 people.⁴⁴ The first 26 interviews provided information used to develop the instruments for the longitudinal study. Interviews were conducted later with 49 additional people, including 42 who had completed participation in the longitudinal study. The interviews, conducted in the homes of participants, lasted from 30 minutes to 2 hours. Informed consent was obtained separately from consent for the 2-week follow-up portion of the research. All participants provided consent for audio recordings of the interviews. All interviews were conducted by 2 interviewers: an African American community organizer and a non-African American researcher.

In the qualitative interviews, participants described their life histories, with particular attention to quality of life growing up in North Carolina and memorable aspects of rural life prior to the introduction of industrial hog operations. In addition, they were asked to describe in their own words how the arrival of the hog operations affected their quality of life, if at all. We used semistructured data elicitation approaches⁴⁵ and person-centered interviewing,⁴⁶ a process of open-ended information exchange in which responses from the participant trigger questions from the interviewer.

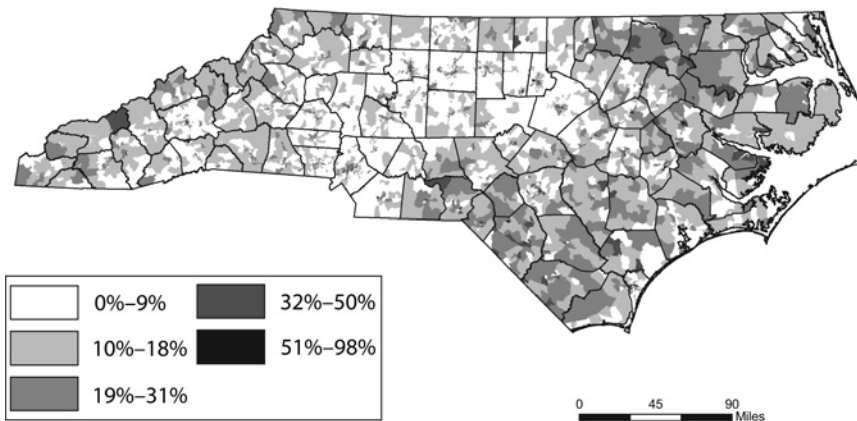
To discourage interviewers from imposing their own perspectives, responses to questions were open ended. When, for example, the impact of hog odor on “use of property and quiet enjoyment of life” was being explored, the question “What are some activities you enjoy doing the most?” allowed the participants to describe a range of activities both inside

and outside of their homes, which were then followed by probing questions about how often they engaged in such activities and what helped or hindered them. This allowed the participants, rather than the interviewers, to introduce the topic of hog odor and its impact on both outdoor and indoor activities. Multiple responses to similarly structured open-ended questions can be analyzed to identify thematic similarities and contrasts, which can then be assembled to create a better understanding of participants’ worldviews. In the CHEIHO study, we were able to develop a meaningful cultural framework that teaches us how neighbors interpret and respond to exposures from industrial hog operations; thus, quantitative relationships between exposures and health status can be “unpacked” to reveal how community members understand and deal with exposures in their lives.

Interviewees who had participated in the longitudinal study were also asked about their experiences and perceptions before, during, and after the 2-week period of data collection. This part of the interview explored how, if at all, participation in the training session and follow-up study had affected people’s understanding of their environmental health conditions and their sense of possibilities for improving those conditions.

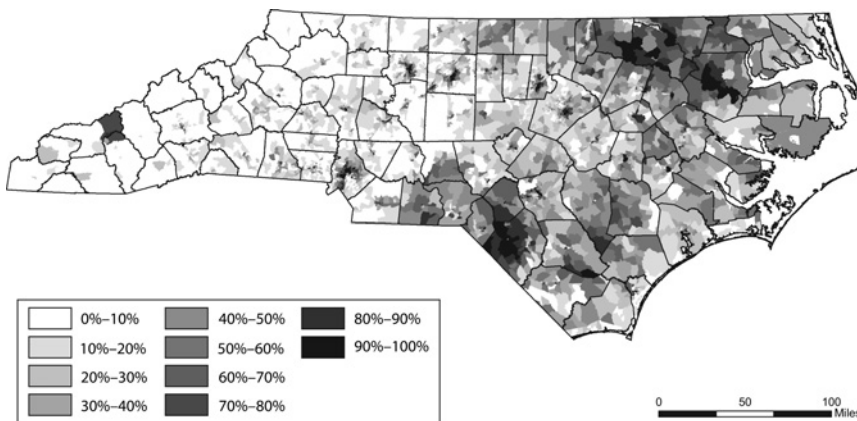
COMMUNITY EDUCATION AND ORGANIZING

Information about environmental health and environmental justice was offered to participants throughout the project—during recruitment, training sessions, and data collection. During initial meetings, the research team shared information about pollutants produced by industrial hog operations and the social and economic consequences of vertically integrated agriculture. Choropleth and dot maps (for examples, see Figures 1–3) were used to communicate official data showing the disproportionate location of industrial hog operations in low-income communities of color in eastern North Carolina.²⁹ This background information was intended to establish links between research results and the daily life experiences of communities living near hog operations, and also to build connections



Source. US Bureau of the Census.⁴⁷

FIGURE 1—Percentage of people in North Carolina living below the federal poverty line in 2000.



Note. "People of color" includes the following subgroups: African Americans, American Indians and Alaska Natives, Native Hawaiians and other Pacific Islanders, and Hispanics.

Source. US Bureau of the Census.⁴⁷

FIGURE 2—Percentage of people of color in North Carolina in 2000.

between neighbors. During these exchanges, the research team learned from participants about the impact of the industry on their lives.

Soon after data collection was completed, the research team returned to each community with a preliminary report on environmental measurements and odor ratings specific to that community. Satellite photographs of the neighborhoods were taken to show the locations of the monitoring trailer, participants' homes, and local hog operations.

Averages and bar graphs were used to summarize environmental measurements and odor reports. Presentation of the study measurements often led to discussion of environmental injustice and community action.

Mean outdoor odor ratings and hydrogen sulfide readings for each hour of the day are shown in Figure 4. Because records for one participant who had difficulty with several aspects of the study protocol were excluded, the figure includes data for 101 participants.

A similar bimodal pattern for both variables is evident, with highest odor ratings and hydrogen sulfide levels in the early morning and evening hours and lowest levels at midday and evening.

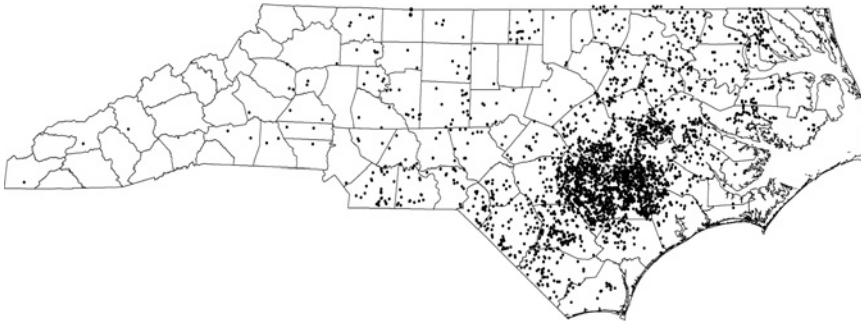
DISCUSSION

In many areas of science, the act of measurement can produce an unwanted alteration in the phenomenon being studied. For example, because patients in medical experiments may show improved symptoms or physiological functioning as a consequence of participation, patients in the intervention group may be compared with patients who receive a placebo. The effect of study participation is an unwanted consequence of the study procedure, and the placebo is used to reduce bias in the estimate of the effect of the experimental intervention.

By contrast, rather than treating all effects of the research process on participants as nuisance factors to be controlled, we hoped that, in addition to measuring health-related phenomena, CHEIHO would also encourage community organizing that could contribute to policy change and improved health. This was possible only because the research involved a partnership between researchers and a social change organization, CCT, that had roots in communities affected by industrial hog production. The temporal scale of the exposures and outcomes under study is short, occurring within a 2-week period, whereas the temporal scale of community organizing that might affect exposures from industrialized agriculture is long. The difference between these time scales helped to reduce the potential of the intended changes in participants' community involvement to create bias in the measures of short-term effects under investigation.

Community Participation and Data Quality

In several important respects, the participation of community members in the residential setting was essential to data collection for the CHEIHO project. Traditional experimental designs emphasize control by the researcher and, consequently, noninvolvement of passive participants. However, it is not feasible to study transient exposures in rural locations



Source. North Carolina Department of Environment and Natural Resources.⁴⁸

FIGURE 3—Distribution of industrial hog operations (black dots) in North Carolina.

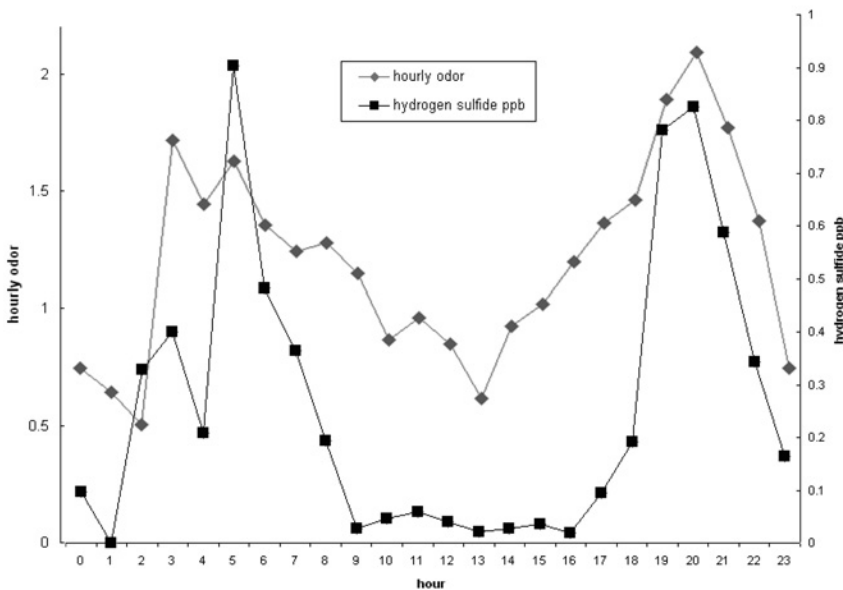


FIGURE 4—Mean hourly hog odor and hydrogen sulfide levels (parts per billion [ppb]) in 16 communities in eastern North Carolina.

without the involvement of local residents. For example, some community members had reported strong malodors to air quality officials in the past, but the odors had diminished or disappeared by the time the officials came to observe and measure. Participant involvement in CHEIHO allowed the collection of real-time data on malodors that would not otherwise be possible.

Furthermore, the context in which exposures occur—community or laboratory, for example—may change the meaning of the

exposure, its physiological impact, or both. Malodor from industrial hog operations means something different to people who live near the operations³⁶ than to research participants exposed to hog odor in an experimental chamber connected to a hog-confinement building.⁴⁷ People living near hog operations report that odors invade their homes and property, are unpredictable, diminish home value, interfere with daily activities, and cause embarrassment and shame. Conversely, laboratory research participants are

not threatened by odors in their homes, know when the exposure will begin and end, are paid to sit in an odor chamber, and do not experience diminished property value or quality of life. In contrast to a study of salivary IgA involving participants in their own homes, which detected lower concentrations and secretion rates following exposure to strong swine odor,³⁶ the chamber study found no such effect.⁴⁹ This may simply be because of the different context of exposure.

The participation of community organizations in the CHEIHO project was particularly important in the recruitment of study participants. In a number of counties in eastern North Carolina, the pork industry is a major employer and has political influence through county commissions, boards of health, sheriff's departments, and other public institutions. Members of communities near industrial hog operations may depend on the industry for their jobs, rent homes or land from owners or operators, and fear reprisal if they participate in research into the health effects of the industry.²³ For example, at a meeting held to inform community members about the study, one man said that he lived very close to waste spray fields. Although he expressed concern about the potential impact of the waste on the health of his young children, he said that he could not be associated with the research for fear of losing his job. Previous evidence of intimidation and fear in areas where the pork industry is very powerful led us to obtain a certificate of confidentiality from the National Institutes of Health to help protect participants. CCT and other community organizations played essential roles in participant recruitment; university researchers alone would have had little success. Community organizers were able to assure residents that CHEIHO researchers had previously fought to protect the identities of participants and communities.²³

Information provided by study participants via the semistructured interviews documented an unanticipated phenomenon. Some CHEIHO participants reported that odors from industrial hog operations waned at the very time the monitoring trailer was moved into the community. Perceived changes in odor could be explained by normal variability in off-site migration of hog operation

pollutants, changes in participants' perceptions of odor as a function of study participation, or participants' hopes that odor would be strong during the study. Another possibility is that hog growers suspected that an environmental health study was occurring and changed their management practices to reduce emissions. After the equipment was removed, many participants reported increased odor and, in some cases, an immediate resumption of regular spraying that had ceased during the study.

Ethnographic interviews were conducted to enhance scientific robustness and add humanistic clarity to epidemiological research results.^{25,26} The strengths of the epidemiological design include large sample sizes; quantification of statistical associations between variables, with control for possible confounders; specification of possible causal pathways between exposures and health outcomes; and the potential for replication of studies across multiple settings and populations. However, social, cultural, and even environmental conditions are reduced to discrete data parameters. Qualitative data can not only provide the daily culture and context for understanding the meaning of epidemiological variables, they can also help explain how and why such associations between variables exist. Intense investment in rich local data, however, implies a limited sample size, difficulty in making comparisons across populations, and reduced generalizability. Consequently, the strengths of one approach tend to address the deficits in the other.

Community Mobilization and Organizing

Community-based participatory research can promote action-oriented responses to research findings. Study participants gain confidence and a greater sense of legitimacy by seeing their experiences and views embedded in a scientific process in which they participated. Voiced experiences that may have been considered marginalized or idiosyncratic may become contextualized in scientifically observable patterns, empowering communities through connections with a privileged and previously inaccessible professional research realm.

CHEIHO was conducted mostly in relatively isolated rural areas. As a result of the research, people made new connections with

neighbors and organizations. Because groups working to advance environmental justice were not widely known, participating communities learned about their existence and successes. Participation in research broadened some participants' perspectives on community involvement and environmental injustice and awakened awareness about the potential for change. For example, during the qualitative interview following the quantitative data collection, a participant stated, "I never thought about it [the concentration of hog houses]. . . . The day after we did the class [CHEIHO training], I rode around and counted how many hog houses. I counted 22. I never knew there were that many hog houses . . . [or] how in the world they got here."

CHEIHO could not have been conducted without the participation of community members in identifying research questions, documenting odors, permitting collection of data in the natural context in which exposures occur, and recruiting study participants. Although active participation of exposed communities in the research process itself is typically viewed as a threat to the validity of results, we have demonstrated here how community participation can improve the validity of research, from the formation of hypotheses to the interpretation of results. We further note that, although community participation in research is frequently challenged, the participation of industries and government agencies that produce or regulate exposures is routine and unchallenged in many areas of science.

Environmental epidemiology is an applied field that typically addresses research questions pertinent to identifying and controlling hazards. Research usually addresses the needs of governments or industries that produce, permit, and regulate hazards. By contrast, CHEIHO is designed to respond most directly to the concerns of exposed communities, using community-based participatory research to simultaneously investigate causes of disease and promote social and environmental justice. Although one aim of the study was to provide evidence relevant to government and industry, CHEIHO was also intended to create change by involving communities that are most directly exposed. In this way, epidemiological research could encourage people "to become involved in collective efforts

to improve the structural determinants of health, such as reducing the social inequalities in our societies or eliminating the conditions of oppression, discrimination, exploitation, or marginalization that produce disease."^{50(p2)}

Achieving these aims requires the establishment of partnerships between researchers and community organizers and an emphasis on both data collection and community education for change. Engaging exposed populations in research could increase the likelihood that research findings will affect public health by creating a constituency that is prepared to use those findings in policy settings.¹⁶ ■

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Contributors

S. Wing had overall responsibility for design and management of the research, participated in recruitment and education, and wrote the first draft. R. Avery Horton had primary responsibility for quantitative data collection and participant training. N. Muhammad was primary community organizer and conducted participant training and interviews. G.R. Grant directed community organizing and conducted interviews. M. Tajik participated in field work, recruitment, training, and interviewing and initiated assessment of the impact of the research on participants. K. Thu initiated quality-of-life investigations and integration of qualitative and quantitative methods and conducted interviews.

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Note. The views expressed are those of the authors and do not necessarily reflect those of the US Environmental Protection Agency.

Human Participant Protection

This study was approved by the institutional review board at the University of North Carolina at Chapel Hill.

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