

Commitment of the National Institute of Environmental Health Sciences to Community-Based Participatory Research for Rural Health

Liam R. O'Fallon and Allen Deary

Division of Extramural Research and Training, National Institute of Environmental Health Sciences, National Institutes of Health, Research Triangle Park, North Carolina, USA

The National Institute of Environmental Health Sciences (NIEHS) is the leading biomedical research institution in the United States whose mission is to support research that seeks to understand how environmental exposures affect human health. NIEHS possesses a longstanding interest in the health effects of agrochemical and other environmental exposures in rural America, including pesticides, to farmers and their families and to migrant farmworkers and their families. In recent years, NIEHS has begun augmenting traditional basic science investigations with innovative programs that translate findings from the laboratory to affected populations. It is through community-based participatory research that NIEHS strives to advance the public health field by fostering the development of culturally relevant interventions that will reduce exposures to environmental contaminants and the risk of environmentally induced disease. In this article, we describe the translational research program at NIEHS as it relates to the NIEHS mission and highlight activities pertinent to the health of rural communities, especially underserved populations. We provide an overview of NIEHS-supported projects addressing health concerns of Native American and rural African-American communities in addition to farmworkers. We conclude with a discussion of future plans for community-based participatory research at NIEHS. *Key words:* community-based participatory research, livestock farming, migrant farmworkers, Native Americans, pesticide exposure, rural health, translational research. — *Environ Health Perspect* 109(suppl 3):469–473 (2001).

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All humans have the right to live in a safe, healthy environment. This right is becoming more difficult to realize, and underserved communities face the brunt of this challenge (1). Recent research demonstrates that people of higher socioeconomic status (SES) have better health than those of lower SES (e.g., migrant farmworkers, Native American communities, and some rural populations) (1–3). In this article, we describe the activities the National Institute of Environmental Health Sciences (NIEHS) has developed to address these growing disparities, in particular for rural communities, and its commitment to maintain these efforts.

Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biologic, social, and psychosocial factors in the environment (4). The mission of NIEHS is to reduce the burden of human illness and disorders that result from environmental exposures by advancing our understanding of the interrelationship among age, environmental factors, and genetic susceptibility (5). NIEHS achieves its mission through myriad multidisciplinary research programs, prevention and intervention efforts, and communication strategies that encompass training, education, technology transfer, and community outreach.

Pesticides and the health of farmers have been a major focus of NIEHS since its inception in 1966. Many of the early studies

concentrated on worker reentry into fields after pesticide application. Soon those efforts developed into mechanistic studies regarding pesticide metabolism in mammals (6–8). In 1992, the National Cancer Institute, in collaboration with NIEHS and the U.S. Environmental Protection Agency (U.S. EPA), initiated the Agricultural Health Study, a large 10-year epidemiologic study of risk associated with agrochemical exposures and cancer. A cohort of 90,000 licensed pesticide applicators from Iowa and North Carolina, their spouses ($n = 30,000$), and children ($n = 20,000$) have been enrolled. Given the selection criteria, the cohort is predominantly white (97%), and almost all minority applicators are African American (9–11).

Within the Agricultural Health Study, NIEHS leads research projects on noncancer health outcomes, such as reproductive effects, asthma, neurologic outcomes (e.g., Parkinson's disease) and child development (11). Findings from this study will have public health implications for more than only rural populations. Exposures to pesticides, nitrates, metals, mycotoxins, solvents, and silica extend beyond rural communities. As such, results may be relevant to other underserved populations.

At the same time the Agricultural Health Study was initiated, NIEHS began promoting new, innovative research methodologies that foster increased cooperation and collaboration between biomedical researchers and

underserved communities. The intent behind these approaches is to enhance our understanding of the complex interaction among diverse environmental exposures and their resultant health effects, and ultimately to transfer the scientific knowledge to the public. NIEHS introduced these efforts in response to the expressed desire of communities to better understand the effects and risks to human health from exposure to physical and chemical agents and to assure appropriate research outcomes and interventions.

Communities need help in preparing their members to face the daily challenges of making decisions to protect themselves from the risk of agents that permeate their environment. Community education, coupled with innovative research to develop effective and culturally appropriate solutions to complex public health problems, are essential to minimize and prevent adverse health effects from environmental exposures (12). Recognizing the critical need to establish sustainable mechanisms for educating the public about environmental health issues and for supporting individual and active community involvement in the identification and investigation of environmental health concerns, NIEHS develops and supports cutting-edge community-based research activities within its translational research program.

Translational Research

NIEHS defines translational research as the conversion of findings from basic, clinical, or epidemiologic environmental health science research into information, resources, or tools that can be applied by healthcare providers and community residents to improve public health outcomes in at-risk neighborhoods (13). In addition, the NIEHS emphasizes that the information be culturally relevant

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Address correspondence to L.R. O'Fallon, Program Analyst, Chemical Exposures and Molecular Biology Branch, NIEHS, PO Box 12233 EC-21, Research Triangle Park, NC 27709 USA. Telephone: (919) 541-7733. Fax: (919) 316-4606. E-mail: ofallon@niehs.nih.gov

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and understandable to the target community. As David O. Carpenter, former Dean of the School of Public Health, State University of New York at Albany, explains, "If the public either does not know or is not convinced to care about new insights into the origins and causes of disease, the research effort is wasted" (14). Thus, NIEHS vigorously promotes interaction between basic and translational research through many innovative programs such as those illustrated in Figure 1.

To demonstrate effectively that decreased exposure equals decreased risk, basic research findings must be converted into public health knowledge so that appropriate interventions can be implemented (Figure 1). Programs with an emphasis on basic research require a community outreach component to assure the greatest public health impact. Toxicologists, molecular biologists, and other basic scientists need to interact with community leaders, teachers, parents, and children to discuss their research and environmental health concerns. Historically, NIEHS has used the Core Centers Program as a vehicle to promote the translation of basic research findings to the general public. These efforts have changed over the years to include the following: environmental justice; Partnerships for Communication (effective communication strategies between researchers and communities); K–12 environmental health sciences education (educational outreach to students); Centers for Children's Environmental Health and Disease Prevention Research

(community-based intervention research); and Community-Based Prevention/Intervention Research (community-based intervention research).

A major facet of translational research at NIEHS is community participation. An increasing number of investigators use community-based participatory research (CBPR) because it advances their scientific knowledge of environmental health and improves the effectiveness of their intervention strategies (15). For researchers, CBPR assures greater recruitment, retention, and participation from the residents. Research findings will likely reflect more accurately the real issues, which in turn, will result in improved and more cost-effective public health interventions. Community members who work with researchers often gain insight into research methods and learn of educational opportunities in health sciences (16). Many residents acquire or strengthen their skills and abilities to lead, teach, and investigate. Community residents are empowered to redefine their role from subject to participant by working actively with investigators at every stage of the research process, from designing research and intervention strategies to evaluating the effectiveness of a given intervention (17).

A variety of unique research initiatives comprise the NIEHS translational research program and focus on an array of environmental health issues and populations. These activities are tied together by three objectives: to improve the understanding of how environmental factors affect human health; to develop better means of preventing environmentally related health problems; and to promote partnerships among scientists, healthcare providers, and community members.

Translational Research and Rural Health

Rural health is one of many environmental health issues addressed in the NIEHS Translational Research Program. Within the context of this program, rural health encompasses more than the health of farmworkers exposed to pesticides and other agrochemicals. In this section we describe some of the research initiatives subsumed under the umbrella of the Translational Research Program at NIEHS. In addition, we highlight research efforts that have a particular focus on the health of rural populations, notably migrant farmworkers, Native Americans, and African Americans.

Environmental Justice: Partnerships for Communication

Support of research aimed at achieving environmental justice (EJ) for all populations is a prominent goal of NIEHS (12,18).

Historically, research on the health effects of environmental pollution, as well as public health interventions and environmental regulations based on such research, were performed with little or no input from affected communities. NIEHS initiated the Environmental Justice: Partnerships for Communication Program in the early 1990s to institute and strengthen mechanisms to bridge this crucial communication gap so that affected communities could obtain a demonstrable role in identifying and defining problems and risks related to environmental health and in shaping future research approaches to such problems.

EJ projects address environmental health issues such as lead and pesticide exposures, water and air quality, hazardous waste, and the impact of the agricultural industry on the quality of life in rural communities. The primary objective of the EJ program is to develop new modes of communication and to ensure that community members actively participate with researchers and healthcare providers in developing responses and setting priorities for intervention strategies. By developing these relationships and enhancing the knowledge base, community leaders can define testable research projects that will benefit their community and can work with scientists to explore tangible risks in their neighborhoods.

The partnership among the University of North Carolina School of Public Health, the Concerned Citizens of Tillery, a community-based organization, and the North Carolina Student Rural Health Coalition exemplifies work performed within the EJ program as it relates to the health of rural populations. In collaboration with community residents, investigators are analyzing health risks associated with intensive livestock farming practices in a predominantly African-American region of rural eastern North Carolina (19,20). The study focuses on the impact such farming practices have on the quality of life of those communities. Results from this project demonstrate that this community more frequently reports symptoms such as headache, runny nose, sore throat, burning eyes, diarrhea, and excessive coughing than other rural communities that are not in close proximity to intensive livestock operations (20).

This partnership effectively raises the awareness of community members and policymakers regarding health and environmental impacts of these farming practices. A measure of this project's success can be observed in the way its results are being used locally and elsewhere in the United States to assist communities in obtaining increased access to healthcare and necessary public infrastructure, such as better water treatment facilities (21).

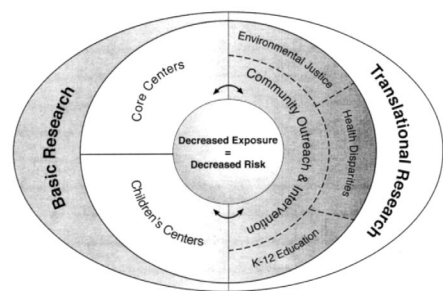


Figure 1. Interaction between NIEHS research foci (31). This graphic illustrates the strategy NIEHS embraces to demonstrate that decreased exposure is equivalent to decreased risk. It shows how basic research performed at NIEHS core centers and children's centers, which includes both mechanistic and population-based research, is being translated into public health knowledge through community outreach and/or community-based intervention activities. These activities may address such issues as environmental justice, health disparities, or environmental health science education. The arrows represent bidirectional nature of the interactions among basic scientists and community members. In some cases, research at these centers is influenced by the expressed concerns of the community it serves. The dashed lines indicate the fluid nature of translational research activities.

Community-Based Prevention/ Intervention Research (CBPIR)

Established in 1994, the programmatic aim of the CBPIR program is to implement culturally relevant prevention/intervention activities in economically disadvantaged or underserved populations adversely affected by an environmental contaminant. Investigators use CBPIR to expand our knowledge and understanding of the potential causes and remedies of environmental-related disorders, and at the same time to enhance the capacity of communities to participate in the processes that shape research approaches and intervention strategies.

Similar in their underpinnings, the EJ and CBPIR programs differ in their outcome emphasis. Where the EJ program focuses on communication and capacity building, the CBPIR program builds upon established relationships and fosters refinement of scientifically valid intervention methods. Community members play a lead role in CBPIR and EJ projects by participating in the design and implementation.

Fostering and maintaining communication and partnerships can ensure that relevant research findings reach affected individuals and communities. CBPIR projects are conducted in a manner that reinforces collaboration between community members and research institutions; results are disseminated to the community in clear, useful terms through a variety of mechanisms such as newsletters, health fairs, and educational curricula. Special attention is given to the unique social, economic, and cultural factors that influence health status in these populations to maximize the potential for change in knowledge, attitudes, and behavior. The benefits of community-based research are immense, often including increased acceptability, use, and adherence.

The projects discussed elsewhere in this issue by Arcury et al. (22), McCauley et al. (23), and Flocks et al. (24) provide three examples of the efforts supported by NIEHS that address farmworker health within the CBPIR program. Arcury et al. focus on pesticide exposure of migrant farmworkers in rural North Carolina. Working with growers and farmworkers, Arcury and Quandt are developing intervention strategies based upon existing resources and handling practices, as well as the knowledge, attitudes and beliefs of the farmworkers (25,26).

Flocks and her team of researchers (23) are working with the Farmworkers Association of Florida, a small community-based organization that represents 6,300 families of several ethnic backgrounds. Together they are developing a randomized intervention trial to minimize pesticide exposures. At the conclusion of the project, they will evaluate the effectiveness of the intervention.

The project led by McCauley (24) takes a different approach to pesticide exposure and the migrant farmworker. This project focuses on pediatric pesticide exposure in the home and the take-home pathway. In collaboration with a local community-based organization, investigators examined the amount of pesticide residue in the homes of migrant farmworkers to establish a baseline; conducted focus groups to ascertain the knowledge, attitudes, and beliefs of parents regarding pesticide exposure in the home and how to protect their children from harmful exposures; and developed an educational video and pamphlet to provide parents with appropriate information on how to minimize pesticide exposures. They will evaluate the effectiveness of this intervention by reexamining pesticide residues in the home.

NIEHS Core Centers—Community Outreach and Education Program (COEP)

The NIEHS Core Center Program is designed to facilitate outstanding, multidisciplinary research in environmental health science by promoting interaction among investigators with similar research interests. The program primarily supports core facilities or shared resources at research-intensive universities. These NIEHS-supported core centers are classified into one of three categories: environmental health sciences, marine and freshwater biomedical sciences, or developmental.

Despite their varying research foci, each center maintains a COEP to translate research results into culturally appropriate public health knowledge. Individual centers define the community or communities with which they will work. Serving as a bridge between researchers at the centers and community members, outreach activities are a direct extension of the research pursued by center investigators, while the investigators simultaneously address environmental health issues and problems of greatest concern to the community. COEP activities include continuing professional education, disease prevention programs; education at primary, secondary, and/or college levels; information dissemination; community issue programs; and public awareness seminars.

It is particularly important for COEPs to deal with community health issues when they arise in a population possibly more susceptible to environmental insults; such populations may include children, elderly, or socioeconomically disadvantaged communities. The centers at the University of California (UC) at Davis and the University of Iowa are two examples of COEPs that work effectively with rural communities to address their health concerns.

California is the major agricultural producer in the United States and more than

1,000,000 people in that state work in some aspect of the farming industry (27). Thus, at UC Davis, the center maintains a strong program in the toxicology of agrochemicals as they relate to human health. Researchers focus on the mechanistic aspects of toxicology, such as molecular neurotoxicology, reproductive and developmental toxicology, and respiratory toxicology. Shaped by this research emphasis, outreach efforts focus on the health effects of pesticides on the farmworker communities of northern California.

Using a variety of approaches, the UC Davis COEP has been successful at reaching out to the affected communities, predominantly migrant laborers. Through its Integrated Pest Management training program the COEP has been instrumental in developing programs to train pesticide handlers and agricultural field workers to identify and treat pesticide illnesses and injuries (28–30).

Working with the National Institute for Occupational Safety and Health-funded UC Agricultural Health and Safety Center, the COEP initiated a program to provide workers in migrant health centers with information about pesticides, pesticide poisoning, pesticide use, and pesticide illness and injury reporting. It is anticipated that this effort will more rapidly and effectively engage center researchers in working directly with agricultural healthcare providers. This program matches center investigators to migrant clinics on the basis of the interests of the researcher and the needs of the clinic.

The COEP reaches out to migrant farmworker families through *consejera* (lay health advisor) training. By tapping into the community network of *consejeras*, the COEP anticipates providing community members with more information about pesticides and actual environmental health hazards facing workers and their families.

In addition, the COEP, in coordination with the Public Health and Agricultural Commissioners' Offices and Cooperative Extension Offices, conducted a survey to assess farmworker family health. The COEP is also having *promotoras* (community advisors) at a migrant camp field-test the Spanish version of a questionnaire to ascertain family use and understanding of pesticides in the home.

Migrant farmworkers are not the only rural populations concerned about potentially hazardous environmental exposures. At the University of Iowa, research at the Environmental Health Sciences Center focuses on issues such as cancer and respiratory diseases as they relate to agricultural exposures. Rather than singling out a subset, outreach efforts are geared toward providing rural communities in general with information on environmental health science issues of interest to them. The COEP strives to imbue

rural youth with an interest in environmental health sciences and to increase their awareness of career opportunities. Through the Environmental Health Summer Institute for Rural Youth, students develop presentations on environmental health issues of interest to them. These presentations are being used to reach out to others throughout Iowa. Some participants have been asked to present their work at the Iowa Public Health Association-Iowa Environmental Health Association annual meeting.

In addition to reaching out to rural students, the Iowa COEP has a rural teacher training program. This effort introduces science teachers to curriculum materials developed by center investigators, provides access to a virtual library of internet resources, and encourages them to remain scientifically literate through hands-on research experiences at the center.

NIEHS Core Centers—Developmental Centers

Developmental centers are designed to ensure that the scientific, institutional, geographic, and demographic diversity of the NIEHS Core Center program is maintained by encouraging new research-oriented institutions to develop the research, leadership, and organizational capabilities expected of an NIEHS center. NIEHS currently supports a developmental center at the University of New Mexico (UNM) (Albuquerque, New Mexico, USA), where researchers address environmental health concerns (asthma and lung cancer) of Native American communities in collaboration with the Lovelace Respiratory Research Institute (LRRI) (Albuquerque).

The Laguna Pueblo community in New Mexico has been exposed to excessive amounts of environmental contaminants, as a result of a long history of mining in their region. High rates of asthma and radiation exposure led researchers at UNM and LRRI to seek and develop methods for determining whether Native American communities have unique genetic or other predispositions that render them sensitive to environmental insults or injury. Researchers are developing population-based studies to investigate the expressed environmental health concerns in concert with Native American residents. The researchers are also designing new outreach strategies to help them convey their findings to the community in a more effective manner.

Centers for Children's Environmental Health and Disease Prevention Research

Exposure to hazardous environmental conditions can be particularly detrimental to the health of children. NIEHS, the U.S. EPA, and the Centers for Disease Control and

Prevention developed the Centers for Children's Environmental Health and Disease Prevention Research Program in 1998 to promote translation of basic research findings into applied intervention and prevention methods. Each center is designed around a central scientific theme and conducts multidisciplinary basic and applied research in combination with CBPR projects to support studies on the causes and mechanisms of children's disorders that have an environmental etiology (31). Current centers focus primarily on respiratory and developmental disorders in children from underserved populations and the mechanisms by which household and ambient pollutants contribute to the development or exacerbation of these conditions. Researchers at children's centers seek to identify relevant environmental exposures; to reduce hazardous exposures and their adverse health effects through intervention; and to decrease the prevalence, morbidity, and mortality of environmental-related childhood diseases.

Integration of laboratory science with applied intervention strategies makes the children's centers unique. Researchers investigate the health effects of environmental exposures and develop and evaluate risk management strategies for disease prevention and health promotion within diverse groups of children. Community participation ensures the appropriateness of the intervention strategies and strengthens the capacity of community members to participate in processes that shape such efforts. Participation in public health research, a requisite of the program, facilitates outreach and education efforts of the centers. The improved communication between researchers and community members strengthens the knowledge base of communities, healthcare providers and decision makers regarding detection, treatment, and prevention of environmental-related diseases in children. The children's centers at the UC at Berkeley, the University of Washington, and the University of Iowa address the health of rural populations.

The UC at Berkeley Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS, a title that means "little children" in Spanish) addresses chronic, low-dose pesticide exposure to pregnant women and postnatal children and its potential impact on neurobehavior, growth, and respiratory health. Researchers hope to increase their understanding of more of the health outcomes for unborn children by examining the pathways and levels of pesticide exposure. Investigators are working with community members to develop and evaluate an intervention program that minimizes pesticide exposures in the home (31,32). Basic researchers at the University of Washington

Children's Center are investigating the neurodevelopmental health effects of pesticide exposure *in utero* and *in vitro*. The community intervention project seeks to identify and break the take-home pathway of pesticides. Using risk assessment methods, researchers are translating research findings into public health intervention and prevention strategies to minimize adverse health effects associated with pediatric pesticide exposure (31). At the University of Iowa, investigators are examining endotoxin exposure in rural families and the risk among family members for developing asthma. They hypothesize that managing asthma better and minimizing exposure to known environmental triggers will bring about a decrease in reported asthma cases. Researchers have devised a two-pronged approach for their community-based intervention project, focusing on healthcare providers and on parents of asthmatic children in rural communities.

Continuing Commitment

In this discussion we have provided an overview of activities currently supported by NIEHS to deal with real and perceived environmental health problems faced by rural communities. Projects address issues from livestock waste to radiation exposure, and utilize methods such as teacher training, community-based participatory research, and student education to begin improving the health of these exposed communities. Although NIEHS has achieved great success through these programs, it continues to encourage cutting-edge research for populations that face unequal environmental health burdens.

Most recently, NIEHS implemented a program to consider the mechanisms that lead to differences in health status among various populations. Titled "Health Disparities: Linking Biological and Behavioral Mechanisms with Social and Physical Environments," the research program seeks to clarify biologic, social, and behavioral processes that lead to health disparities stemming from the interaction of social and physical environments and SES as a basis for ultimately developing intervention strategies. Physical environment includes physical agents (e.g., radiation), chemical agents (e.g., pesticides), and biologic agents (e.g., pathogens, toxins from harmful algal blooms) to which individuals are exposed in a multitude of settings, including home, school, and workplace. The social environment includes individual and community-level characteristics, such as SES, education, coping resources and support systems, residential factors, cultural variables, institutional and political forces such as racism and classism, familial factors, and media influences.

Recent work emphasizes that individual lifestyle choices and access to and quality of

healthcare have less of an impact on an individual's health status than does the broader context or array of social and physical environmental factors, such as community cohesion, housing quality, and sense of trust (2). Consequently, NIEHS has adopted a more holistic approach to determining the contributions of social and physical exposures to disparities in health outcomes. NIEHS will encourage and strengthen collaborative efforts between social and behavioral scientists, biomedical scientists, and communities to facilitate this method. Each project will include a community outreach and education component to link researchers and residents and to ensure that research findings are translated into meaningful and culturally relevant public health knowledge.

NIEHS plans to expand its CBPIR by amplifying the scope of research pursued by communities and universities to include etiology and exposure assessment in addition to intervention. Creating more opportunities for investigators to participate in CBPR projects will enhance the overall status and recognition of this field. The implications for rural health research are clear. NIEHS anticipates that inclusion of exposure assessment research in this program will encourage more applications from investigators who work with rural communities to understand better the health risks associated with exposures to agrochemicals and other xenobiotics.

Conclusion

In many respects, the beginnings of NIEHS are rooted in the health of rural populations, specifically its desire to understand the health effects of pesticide exposures. Through time, the institute's dedication to rural health has evolved from basic research—which includes mechanistic and epidemiologic studies—to the incorporation of translational research. This trend demonstrates the commitment of NIEHS to continue its leadership role in developing and promoting innovative research methodologies that address the challenges facing underserved populations, including rural communities. NIEHS has found CBPR to be an effective methodology

to address environmental health concerns of underserved populations. Through the collaborative and cooperative relationships forged between researchers and communities, investigators are better able to recruit, retain, and transfer scientific and public health knowledge to residents of those communities. In addition, these partnerships may lead to more effective public health interventions. Through the array of research initiatives within the NIEHS Translational Research program, many opportunities exist for universities and communities to further the public health field by addressing the environmental health concerns of rural populations.

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