

Environmental Health Sciences Education— A Tool for Achieving Environmental Equity and Protecting Children

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Children are highly susceptible to deleterious effects of environmental toxins. Those who live in underserved communities may be particularly at risk because environmental pollution has been found to be disproportionately distributed among communities. Mounting evidence suggests that asthma rates are rising and that this disease can be caused or aggravated by air pollution. Although ambient air quality has generally improved, these improvements have not reached minority communities in equal proportions. This and other data has fueled the concept of environmental justice or environmental equity, which has led to community activism and government actions. One possible example of environmental inequity and its consequences is the Hunt's Point community, in the South Bronx, New York. This community experiences a high pollution burden with the siting of facilities that emit hazardous wastes into the air. Our approach to this problem has been the formation of mechanisms for bidirectional communication between community residents, government entities, and academic institutions such as Mount Sinai Medical Center. As a result of this experience, we believe that the key to achieving environmental health, especially in communities of color where many children are at risk, is to empower residents to take charge of their environment by providing relevant educational opportunities. Strategies for environmental health education include multitiered training approaches that include community residents, parent education, direct children education, and community education through professional counselors and train-the-trainer approaches. We propose that academic researchers must use community residents not just as subjects of our studies, but to increase our mutual understanding of environmental health, resulting in active participation of community members in research design, data collection, analysis, and dissemination of results in order to make intervention strategies more effective. — *Environ Health Perspect* 106(Suppl 3):849–855 (1998). <http://ehpnet1.niehs.nih.gov/docs/1998/Suppl-3/849-855claudio/abstract.html>

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Introduction

It has been well recognized that children, because of their physiologic characteristics, are particularly susceptible to the toxic effects of environmental pollutants. Furthermore, there is evidence to show that poor and minority children are in the segment of the population that is most

affected by environmental exposures (1,2). In this paper we explore the evidence that suggests that there are disparities in the distribution of environmental pollution among communities. We also explore asthma as a possible health outcome of environmental exposures in children, and

discuss some useful community-based approaches to alleviate these problems. We conclude that community empowerment through education in partnership with scientists and health care providers will result in better environmental health for children and the communities where they live.

Disproportionate Distribution of Environmental Pollution among Communities

A number of studies have suggested that socioeconomically disadvantaged and minority communities suffer disproportionately from environmental pollution in the United States. These findings have sparked the environmental justice movement. One of the first studies to be published, completed by the U.S. General Accounting Office (3), studied the racial and socioeconomic status of neighborhoods near four landfills in the U.S. Environmental Protection Agency (U.S. EPA) Region IV and found that in these neighborhoods most residents were African Americans (3). Another study assessed the location of incinerators and landfills in Houston, Texas, and found that four out of five of these sites were located in neighborhoods where a majority of the residents were African Americans and Latinos (4). One of the most frequently cited studies on environmental equity was authored by the United Church of Christ Commission for Racial Justice, first published in 1987 and updated in 1994 (5). It found that people of color were 47% more likely than whites to live in ZIP codes that contain one or more hazardous waste facilities. These and other studies have fueled the environmental equity movement which has resulted in legislative actions and is the basis of socio-political activism in many communities throughout the United States (6).

Various points of controversy have arisen regarding these studies, however. It has been argued that economics, not racial discrimination, has led to disparities in environmental burdens. It is possible that at least in some communities, many minorities may tend to move into areas near hazardous waste sites and polluting industries because these areas may have more affordable property values (7). However, a study by the Agency for Toxic Substances and Disease Registry has shown that even when controlling for family income, African-American children under the age of five are nearly twice as likely to

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Abbreviation used: U.S. EPA, U.S. Environmental Protection Agency.

have elevated blood lead levels than white children (8). A more recent study has also confirmed this finding (9). It seems likely that the relationship between environmental health outcomes and social variables is multifactorial. Education, race, income, occupation, political power, and other measures of social status can influence the extent of exposure to environmental pollutants (10).

Regardless of the mechanisms that cause disproportionate burdens to environmental pollution among communities, it is clear that particular attention must be given to those communities that are most at risk. To address this need, the federal government has considered various actions to promote an environmental equity agenda. In February 1994, President Clinton signed Executive Order 12898 titled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." This executive order mandates federal agencies to work together and individually to issue an environmental equity strategy and to conduct those programs, policies, and activities that affect environmental or public health so that they do not disproportionately affect populations on the basis of race. Furthermore, the executive order requires federal regulatory agencies to consider the racial, ethnic, and socioeconomic characteristics of a community and include community participation in the decision-making process to site any toxic waste dump or hazardous industrial facility. In addition to the federal efforts, at least 15 different environmental equity bills were introduced for consideration in various state houses between 1993 and 1994 alone (11). Other segments of the federal government have instituted policies to address issues of disparities in health outcomes and environmental exposures among underserved populations. Notably, the National Institute of Environmental Health Sciences has required its environmental health sciences centers to include community outreach and education programs within their organizations (12). This encourages the academic institutions receiving federal funds for environmental health sciences centers to become more responsive to the needs of the communities they serve. The objective of the program is to promote the translation of research results in the environmental health sciences into knowledge that can be applied to human health and thus benefit the communities directly.

Asthma in Children as an Environmental Health Problem

Although by most accounts air pollution has declined in most of the United States because of regulations imposed by the Clean Air Act, there is also no doubt that asthma is on the rise. Asthma and other respiratory diseases are among the most common chronic diseases of childhood. It accounts for 2.2 million pediatrician visits each year and 10 million school days missed (13). Asthma morbidity and mortality have increased in recent years, despite advances in therapy and general improvements in ambient air quality. Hospital discharge rates for asthma for children increased 4.5% annually between 1979 and 1987, and mortality has also increased (14,15).

It may be possible to explain some of the increases in asthma rates by looking at the disparities of air pollution burdens that exist among communities (16,17). An analysis of the U.S. EPA's nonattainment regions for national ambient air quality standards found that Latinos and African Americans are more likely than whites to live in areas that exceed federal standards for many toxic pollutants such as lead, ozone, carbon monoxide, and particulates (18). The disparities that these authors found are significant. For example, the percentage of the population who lives in areas of nonattainment air quality standards for ozone is 52% for whites, 62% for African Americans, and 71% for Latinos. The pattern is similar for a variety of other air pollutants (18). This is an important finding for children's environmental health, as levels of ambient air pollution such as particulate matter and ozone have been shown to correlate with morbidity from respiratory illness (19). It is possible that although the overall quality of ambient air has improved, there is an uneven distribution of air pollution that may contribute to some of the increased rates of respiratory disease found especially among minority and poor children (1,16,17). A study by the American Lung Association found that 61% of pediatric asthma cases occur in children who live in areas of nonattainment for air quality standards as defined by the U.S. EPA (20). Another study conducted in Canada showed that a low socioeconomic status is an important risk factor for respiratory symptoms suggestive of asthma (21). This finding is important because it suggests that differential access to health care is not a significant

factor in the increase of asthma among the poor and among minorities, as Canada provides universal access to health care. The authors of that study conclude that environmental factors associated with social and economic disadvantage may explain the high rates of asthma among this segment of the population.

Exposure of children to ambient air pollution has been clearly associated with acute and subacute respiratory effects in epidemiologic investigations and controlled exposure studies in inhalation chambers. For example, ozone causes airway inflammation and hyperactivity, bronchial epithelial permeability, decrements in pulmonary function, cough, chest tightness, pain on inspiration, and upper respiratory tract irritation (22-28). Epidemiologic studies link increased ozone concentrations with exacerbations of asthmatic symptoms (29,30). Controlled exposures to ozone concentrations at and below the current federal standard of 0.12 ppm, combined with moderate levels of exercise for several hours have resulted not only in pulmonary function changes and respiratory symptoms, but also in dramatic increases in inflammatory markers in bronchoalveolar lavage fluid (22,23,25). Epidemiologic studies suggest that repeated exposures to ozone and other photochemical oxidants and particulates are associated with an accelerated decline in lung function and with symptoms of chronic respiratory disease (31,32). One recent study links oxidants (primarily ozone) and other air pollutants in Los Angeles, California, with daily mortality (33).

Epidemiologic studies undertaken in a variety of locations indicate a relationship between outdoor air pollution and adverse respiratory effects in children. The pollutants most frequently implicated in these studies have been respirable particles (notably acidic sulfates) and ozone. Examples of health outcomes found to be correlated with air pollution levels include increased prevalence of chronic cough, chest illness, and bronchitis, hospital admissions for various respiratory conditions, and decrements in lung function (34-39). The prevalence of respiratory symptoms appears to be markedly increased among children with a history of asthma or wheezing (40).

The indoor environment can also be an important source of allergens, specifically, house dust mite, cockroaches, animal dander, and molds. There is a strong correlation between the development of dust mite

sensitivity and development of symptomatic asthma (41). Sensitization and the development of asthma are more likely to occur among individuals exposed to greater than 2 µg/g of house dust (42). Modifying homes and avoiding allergens has resulted in the reduction of asthma symptoms and bronchial hyperactivity (43).

Combustion effluents from residential gas stoves, especially oxides of nitrogen (NO₂) have been associated with respiratory symptoms and reduced lung function in populations of both healthy and asthmatic children (44). There is also significant exposure to environmental tobacco smoke in inner city populations. In a recent study, investigators at Mount Sinai Medical Center (New York, NY) found that almost half the acute asthmatics in the emergency room come from households with smokers (45). Cross-sectional studies have documented an association between passive cigarette smoke exposure and asthma symptoms (46,47). Martinez and co-workers found a relationship between passive cigarette smoke exposure and airway responsiveness in a population sample of 9-year-old children (48). These data suggest that asthma and other respiratory symptoms can be reduced or ameliorated by taking actions that reduce population exposures to indoor as well as ambient air pollutants (17,49).

Respiratory Disease in Minority Communities in New York City

Respiratory disease, particularly asthma, is highly prevalent in the impoverished urban communities of New York City. Rates are especially high among Latino and African-American children, and asthma has become the leading cause of hospital admissions for urban children. A recent study conducted by Mount Sinai Medical Center examined New York City rates of hospital admission for asthma by ethnicity (50). Asthma admission rates were found to have increased by 12.7% in 3 years, and mortality has also increased. Asthma hospitalization rates were 7.5 times higher for minorities than for whites. This same study found that the Bronx and Upper Manhattan (Harlem) had the highest asthma admission rates in all of New York City. Another study of pediatric asthma in the Bronx has estimated a prevalence of 8.6%, which is twice the national average (51). Moreover, this is likely to be an underestimate of the true rate as episodes of wheezing without a diagnosis

of asthma totaled 4.2%, raising the total of possible asthma cases in the Bronx to 12.8% among children younger than 17 years of age.

One particular community located in the South Bronx of New York can be examined as an example of the possible relationship between environmental pollution, high asthma rates among children of color, and how the perception of this possible link has led to community mobilization around environmental equity issues. Hunt's Point is an isolated, economically poor, environmentally burdened, predominantly minority community. It is situated on a peninsula of approximately 4 mi², bordered by the Bronx River to the east and northeast, the East River to the south, and the Bruckner Expressway to the north and northwest. The Hunt's Point community was recently the subject of the best-selling book *Amazing Grace: The Lives of Children and the Conscience of a Nation* by Jonathan Kozol, in which the author records the everyday lives of children in the area (52). In this community, it is very common to see schools, various types of factories, playgrounds, single family housing, waste transfer stations and other waste facilities, and large apartment buildings, all within a few city blocks. This type of zoning is uncommon in New York City, and the Hunt's Point community is one of the few remaining mixed-use zones in the city.

The population of Hunt's Point, according to the 1990 U. S. census, is 39,443. Over 98% of the population are members of minority groups—79% Latino, 19% African American, and less than 2% Caucasian. Perhaps the most striking demographic characteristic is the pervasive poverty. Over 60% of residents live in households with incomes below the poverty level. The median household income is only \$10,167, and 49% of the population receive public assistance. There are no physicians, nor are there any primary care facilities in the Hunt's Point peninsula; residents must leave the community to obtain basic medical care.

The South Bronx, and Hunt's Point in particular, is highly environmentally burdened. This has led the neighbors to question "what is in the air that is causing us to suffer respiratory problems and high asthma rate" (53). According to municipal data, the Bronx generates approximately 5% of New York City commercial waste yet it processes 21% of the municipal total; it generates 29% of city sludge yet treats 70% of this waste. The community also

has many toxic release inventory facilities listed by the U.S. EPA, several solid waste processing stations, facilities reporting hazardous substances, and municipal sewage treatment facilities—a sewage treatment plant, a sewage sludge dewatering facility, a sewage sludge thermal drying facility, and a sludge marine transfer station. The sludge drying facility handles over 70% of New York City's sludge and burns this sludge in an incinerator, whose odor and residue are prevalent throughout Hunt's Point. Nearby there is also a mass burn medical waste incinerator, a facility that violated federal emission standards 86 times in a period of 6 months, and that repeatedly exceeded legal limits for carbon monoxide emissions (53,54). The facility has now been closed, at least temporarily, due in large degree to community activism.

The concentration of polluting facilities in the South Bronx and particularly in Hunt's Point is illustrative of the burden of environmental contamination that many communities bear. Many residents of Hunt's Point see their community as an example of environmental injustice (12,53). The burden of pollution concentrated in Hunt's Point may have had a negative effect on the health of residents. Lincoln Hospital, the closest major health facility to the community, has documented a tripling in asthma-related deaths since the opening of the medical waste incinerator (53). These factors have led to increased community involvement and collaboration with the U.S. EPA Region II, the local department of health, and academic institutions such as Mount Sinai Medical Center and Hostos Community College (New York, NY). There is a need to respond to the interests of communities such as Hunt's Point by conducting research studies, designing effective intervention activities, and promoting community-based programs on environmental pollution and respiratory illness.

Role of Education in Environmental Health Outcomes

By definition, environmentally caused diseases are preventable events. This implies that approaches for the reduction of exposure, through the lowering of pollution outputs, reduction of personal exposures, or increased monitoring and treatment, may all lead to a decrease in environmental disease. An integrated approach towards improving environmental health education of community residents, scientists, health

care providers, and policy makers is key for addressing the problem. For example, the Mount Sinai Division of Environmental and Occupational Medicine uses a multi-tiered mentoring system to address the individual educational levels of a diverse student population that includes community residents. This approach entails having students of various abilities perform tasks appropriate to their level of training within a research team. All the students are valuable for the team, whether they are community residents with limited formal training in environmental sciences or post-doctoral fellows. This approach motivates advanced students to serve as mentors and promotes a collaborative atmosphere among participants. Also important is that community residents are able to participate in the research process alongside students and faculty members which helps them learn important concepts in environmental health sciences and understand the limitations of science in solving environmental justice problems (12,55). As a result of this type of collaborative interaction between residents of communities that suffer environmental injustice, students, and academic faculty, we have found that community residents are empowered to become more vocal in the environmental regulatory process because they can understand scientific concepts and have gained access to information that may have previously hindered their participation. In addition, this interaction fosters the ability of scientists to gain access to the community in order to design studies that can have a positive impact on real community problems.

Another effective strategy in improving health outcomes for children is addressing parent education in environmental health. It has been shown that parent education is a stronger predictor than family income, single parenthood, or family size for ensuring the health of children (56). As nearly 25% of children in the United States are born to a mother who is not a high school graduate (56), it is important that educational strategies be targeted to address issues that can directly impact preventable disease in communities at risk. Various approaches have been utilized in order to reach and educate parents, ranging from direct counseling to providing information via recorded telephone messages (57). The Centers for Disease Control and Prevention (Atlanta, GA), for example, has recommended that parents be educated about sources of lead during well-child visits. However, this

educational program for parents has met with limited success because only 12% of parents of children found to have elevated blood lead levels had received preventive counseling prior to detection (58). Clearly, more needs to be done to implement such parent education strategies.

Direct education of children can also reduce exposure to risk factors (59). For this reason, various school-based approaches have been designed to specifically address the need of children to take control of their environmental health. For instance, the Open Airways for Schools asthma management curriculum designed by the American Lung Association is specifically geared toward helping children manage their asthma symptoms (60). This educational program teaches asthma management strategies in a child-friendly manner, thus demystifying the disease by allowing children to understand the disease process, identify asthma triggers, and take some control of their own symptoms. It has been shown quite clearly that patient education improves compliance and is an important part of the control and treatment of asthma (49,61).

Other approaches involve providing environmental education opportunities for the community as a whole using various strategies. Among these approaches is the use of specially trained social workers (62) and nurses (63) who go out into the community and provide a series of services and information. A problem with this approach is that it still relies on highly trained personnel to provide educational services. Very often this personnel comes from outside the community and will leave when funds for the research or intervention project are expended. To alleviate this problem, innovative approaches utilize indigenous outreach workers who are members of the target community and are specially trained to educate their peers (64,65). These train-the-trainer approaches may be better received by some communities because the special abilities and street smarts of the outreach workers are respected, acknowledged, and utilized to reach the populations at risk. Also, to effectively reach the population of interest, it may be important to tap into the wealth of community organizations, churches, and other residents of the community such as teachers and business owners who have day-to-day contact with the population at risk (12,66).

Regardless of the approach utilized, community outreach and education strategies must cope with a general lack of

public knowledge of science, the inherent complexity of scientific data, and disagreements among scientists, making the communication of risk difficult. Another obstacle to the effective communication of risk to communities is the fact that environmental health issues may not be viewed as an immediate priority in an otherwise disadvantaged community (67). Many communities that are affected by environmental hazards are also plagued by economic and social distress that may be more acute or more visible. However, even with these obstacles, communities generally welcome outreach efforts and are interested in learning about how environmental pollution affects their health and the health of their families (67). For this reason, it is important that attempts to address environmental health issues give a community a real sense of empowerment and participation (68). This can be done by emphasizing that communities and individuals can do something to improve their environmental conditions (53). The goals of community activities may include increased community participation in research protocols from their design to their implementation, organization of forums and community-based symposia for the dissemination of study results, and community participation in public hearings and policy meetings with regulatory officials. In turn, academic scientists must learn to respect and value the knowledge and expertise that community residents bring to the design and implementation of solutions to environmental problems. This distinction of lay and professional ways of knowing has been described previously for epidemiologic assessments (69) and can be very valuable for formulating intervention strategies to environmental problems.

Communities and at-risk populations are not the only sector in need of more training in the environmental health sciences. The American College of Physicians and the Institute of Medicine have recommended that physicians be more knowledgeable about environmental and occupational medicine. A survey of family practice residency programs has shown that two thirds of the programs have a minimal emphasis on environmental medicine but that the directors of the programs would like to increase training in this area (70). A study of nurses yielded a similar result (71). Compounding this lack of preparation of family practitioners, a majority of environmental and occupational health specialists feel that they need to increase their knowledge of environmental

laws and that given the opportunity, they would do this through continuing medical education courses (72). This data underscores the need for a strategy of bidirectional communication between scientists and medical providers with community residents. It has been proposed that community-based patient-physician alliances would serve to enhance mutual education (73). This model appears to be especially applicable to environmental health education, as both the medical providers and community leaders may benefit from increased knowledge of environmental causes of disease.

Conclusions

Strategies for reducing respiratory disease morbidity in children have traditionally relied heavily on education. Most of this education has focused on control of dust and allergens in the indoor environment. There has, however, been a paucity of information available on the long-term success of educational interventions because of the multifaceted nature of this disease. Some studies have shown a small but beneficial impact on emergency room visits and hospitalizations for wheezing (74,75). Others have pointed to methodological problems in self-management research (76,77) and in reaching the segment of the population that is most at risk (78). Nevertheless, a number of community education approaches have been utilized in asthma intervention strategies with some degree of success. These include specialized training for health care providers (79), education of environmental health officers (80), and grass-roots community organizing (81).

We argue that the disparities in the pollution burden in minority communities can begin to be alleviated by the empowerment of these communities, particularly the children, through education (55,82). There is evidence to suggest that partnerships between scientists and community organizations can spark effective activism for environmental equity. It has been documented that environmental health education that leads to community involvement is most effective when community leaders and scientists work together to influence the regulatory process and to design disease prevention strategies (83). Because this approach is integrated into the fabric of the community it would be expected to become part of the everyday lives of community residents. This type of interaction has arisen sporadically, usually in response to acute, highly visible environmental threats.

We propose that a broader approach is needed in which community residents are involved in the design, implementation, intervention, and dissemination of research strategies to reduce diseases of possible environmental origin. The objective of increased community participation in the research process is to empower community residents to become active in the regulation of environmental pollutants in their neighborhoods by participating in the regulatory process and by the modification of behaviors that may reduce exposures. These activities will spark popular support for research, which may help in the allocation of funds for needed intervention efforts. This interaction will also

foment a collaborative relationship between academic scientists and affected community residents so that these residents do not merely represent subjects in a study but are active participants and beneficiaries of the research endeavors. In addition, active participation of community residents will improve the effectiveness of intervention strategies to alleviate disease caused by environmental exposures.

Although much research has been undertaken to understand the contributions of ambient and indoor air pollution to childhood respiratory disease, efforts to translate research results into intervention are only beginning. The steadily increasing prevalence and mortality rates for asthma, particularly in inner-city communities, bear stark witness to this need. Several specific problems must be addressed. First, intervention efforts need to encompass outdoor as well as indoor air pollution; virtually all efforts to date have focused almost exclusively on the indoor environment. Second, future interventions must extend beyond academic health centers and become truly community based. Third, there is a need for more research in environmental inequity and its role in producing illness in segments of the population, and these research efforts must be subject to close evaluation and peer review. We anticipate that the inclusion of community outreach and education goals within academic settings will contribute to a unified effort for the application of advances in environmental health research to the needs of underserved populations and vulnerable children.

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