

# Environmental Equity and Health: Understanding Complexity and Moving Forward

The authors invoke a population health perspective to assess the distribution of environmental hazards according to race/ethnicity, social class, age, gender, and sexuality and the implications of these hazards for health.

The unequal burden of environmental hazards borne by African American, Native American, Latino, and Asian American/Pacific Islander communities and their relationship to well-documented racial/ethnic disparities in health have not been critically examined across all population groups, regions of the United States, and ages.

The determinants of existing environmental inequities also require critical research attention. To ensure inclusiveness and fill important gaps, scientific evidence is needed on the health effects of the built environment as well as the natural environment, cities and suburbs as well as rural areas, and indoor as well as outdoor pollutants. (*Am J Public Health*. 2003;93:209–214)

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## CREDIT FOR DRAWING

attention to the unequal burden of environmental exposures borne by communities of color and impoverished places goes to the grassroots activists—largely women—who first raised concerns about potential health effects.<sup>1</sup> In 1962, Rachel Carson helped mobilize mainstream environmentalism in the United States with the publicity surrounding the publication of her book *Silent Spring*, a salvo against the indiscriminate use of pesticides.<sup>2</sup> The environmental justice movement, however, developed from a civil rights tradition and is often dated to the 1982 protests staged by residents of Warren County, North Carolina, over a PCB (polychlorinated biphenyl) dump.<sup>3</sup> In 1994, as a result of the political activism of affected communities, President Bill Clinton signed Executive Order 12898, requiring federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on people of color and impoverished communities in the United States and its territories and possessions.<sup>4</sup>

Here we invoke a population health perspective in an attempt to provide a better understanding of the distribution of environmental hazards according to race/ethnicity, social class, age, gender, and sexuality, as well as their implications for health. While this framework has been applied more commonly in Can-

ada and Europe than in the United States, it is particularly useful “for thinking about why some people are healthier than others as well as the policy development, research agenda, and resource allocation that flow from it.”<sup>5</sup> We focus here on recent scientific evidence that addresses the complexities surrounding environmental equity and health issues, methodological advances, and research implications for population health in the United States. We end by identifying critical gaps in the understanding of the distribution and determinants of environmental hazards among population groups and the need for scientific research to elucidate the resulting health effects.

## UNDERSTANDING COMPLEXITY

One of the authors (G.N.S.) recently argued that the US civil rights struggles of the 1950s and 1960s that were based solely on race needed to expand in response to a fuller understanding of oppression and the complexities of jointly considering race, class, gender, and sexuality.<sup>6</sup> Toward the same goal of inclusion, we choose the language “environmental inequity” rather than “environmental racism” (the charge leveled by grassroots activists) or “environmental justice” (the movement resulting from their efforts) to carefully assess all undue prejudice in the distribution of environmental burdens across popu-

lation groups in the United States, along with any resulting health effects.<sup>7</sup> “Environmental equity,” therefore, is the goal toward which we are collectively striving.

In discussing environmental exposures that have the potential to harm or promote health, we include physical, chemical, and biological pollution of the air, water, soil, and biota. We take into account as well the built environment—notably, housing and other physical structures such as schools and workplaces but also parks, streets, and transportation systems. This means that cities and suburbs as well as rural areas are embraced, and indoor as well as outdoor pollution is part of the research agenda. We grapple here with only a few of the many salient environmental exposures, including lead poisoning, hazardous waste sites, and air pollution, because research has begun to address the unequal burdens borne across population groups. It is necessary to consider where different people live, work, play, and learn—and also why—to investigate the full range of environmental exposures borne by population groups. For instance, the “geographies of sexuality” are such that certain people are more likely to live in urban areas and to live in distinct neighborhoods within these areas,<sup>8,9</sup> but the data necessary to assess either exposures or health effects according to sexuality are woefully lacking.<sup>10</sup>

## LIMITED HEALTH RESEARCH

With the notable exception of lead poisoning, there has been a glaring lack of health research on environmental inequity.<sup>1</sup> Notwithstanding incontrovertible evidence of the health hazards of blood lead levels of 10 µg/dL or higher, poor children in both urban and rural regions of the United States continue to have blood lead levels that far exceed this standard. Using data from the third National Health and Nutrition Examination Survey (1988–1994), Pamuk et al. found that 12% of children living in poor families had elevated blood lead levels, in comparison with 2% of children in high-income families.<sup>11</sup> In each income group, Black children were more likely than children of other racial/ethnic groups to have elevated blood lead levels.

What is true nationally—in that most of the population lives in cities—may not hold true in poor rural areas with intense lead exposures from local sources. In a former mining region of northeastern Oklahoma, Malcoe et al. assessed lead sources and blood lead levels among both Native American and White children.<sup>12</sup> In a representative sample of 245 children aged 1 to 6 years, measured blood lead levels ranged from 1 to 24 µg/dL. No difference in blood lead levels by ethnicity was found ( $P=.48$ ), while interactions between soil lead and poverty ( $P=.005$ ) and between dust and soil sources ( $P=.02$ ) were strong and statistically significant. These results indicate that soil and dust lead derived largely from mining waste pose health hazards to both Native American and White children

and that current residential dust lead standards are insufficient to protect them.

Recent studies of the health effects of air pollution, especially particulate matter, by race/ethnicity and other factors have been reported with sufficient power to test for effects in population subgroups. Zanobetti and Schwartz examined the association between mortality and PM<sub>10</sub> (particulate matter less than 10 microns in diameter) by race, gender, and education in 4 cities that had in place daily monitoring systems during the period 1986 through 1993: Chicago, Detroit, Minneapolis–St. Paul, and Pittsburgh.<sup>13</sup> Regardless of significance level, the effects of PM<sub>10</sub> on daily deaths were modest. Significant effect modification was found in the case of gender, with the slope in female deaths one third larger than the slope in male deaths.

The effect of PM<sub>10</sub> on overall mortality tended to be higher among Whites than among Blacks (contrary to the original hypothesis) and higher among individuals with less than a high school education than among individuals at higher education levels, although these results were weak and failed to reach statistical significance. The authors posited instead that the association between mortality and particulate air pollution could depend more on preexisting medical conditions than on social factors or that the effects of race and class may be apparent only in the case of people with specific medical conditions. Teasing apart these relationships may be more complicated, however, because medical conditions are also related to race and class.

Linn et al. examined hospital admissions for cardiopulmonary

illnesses in metropolitan Los Angeles during 1992 through 1995 by race/ethnicity, gender, and age in relation to ambient CO (carbon monoxide), PM<sub>10</sub>, NO<sub>2</sub> (nitrogen dioxide), and O<sub>3</sub> (ozone) levels.<sup>14</sup> Overall, the authors found that day-to-day increases in the 3 primary pollutants (CO, PM<sub>10</sub>, and NO<sub>2</sub>), but not increases in O<sub>3</sub>, were associated with meaningful increases in cardiovascular illnesses. Subgroup analyses suggested increased cardiovascular effects among people with diabetes, among Whites and Blacks (relative to Hispanics and Asians), and among individuals 65 years or older. The authors concluded that the relatively nonspecific pattern of diagnoses suggests a reason for the excess number of patients admitted to hospitals on high pollution days in metropolitan Los Angeles: individuals with preexisting problems that make them highly vulnerable to additional stresses, including unfavorable changes in the air environment, are seeking treatment on such days.

## DISCRIMINATION IN THE HOUSING MARKET

While not new, the connections between poor housing and a wide range of health conditions are gaining new attention.<sup>15,16</sup> In the United States, Blacks have been found to face the greatest hostility of any racial/ethnic group in terms of the search for housing.<sup>17</sup> Impoverished older adults,<sup>18</sup> people with HIV/AIDS,<sup>19</sup> and individuals with serious and persistent psychiatric disabilities<sup>20</sup> also face significant challenges in the housing market. Affordable housing and social services are essential to improving health outcomes in popula-

tion groups with support needs.<sup>21</sup> The contribution of discrimination in the housing market to inequities in health across population groups is a vital research issue and warrants further study.

In a sample of 132 Dominican and African American households with young children in northern Manhattan, Rauh et al. found that indoor cockroach allergen levels were related to degree of household disrepair after adjusting for individual family attributes.<sup>22</sup> These results suggest that social–structural aspects of housing may be appropriate targets for interventions designed to reduce allergen exposures among young children with asthma. Indeed, rather than focusing solely on environmental hazards and untoward health effects, it may prove valuable to assess the health benefits of community-building strategies.

Two of the authors (M.E.N. and G.N.S.) are currently involved in an asthma initiative along with Harlem Children's Zone Inc, the Department of Pediatrics at Harlem Hospital Center, and the Harlem Health Promotion Center of Columbia University.<sup>23</sup> By using the existing infrastructure of Harlem Children's Zone Inc, it may be possible to evaluate the effectiveness of multiple programs designed to improve the health of children and their families, including efforts to improve the physical environment—especially housing—both indoors and outdoors.

## COMPLEXITIES OF ASSESSING LOCAL THREATS

Both qualitative and quantitative research techniques have been used to investigate environmental concerns among

population groups at the local level. Gerlak and Clarke designed a cross-cultural analysis to help determine whether certain racial/ethnic groups are environmentally worse off than the rest of the population in metropolitan Tucson, Ariz.<sup>24</sup> Data from several local sources were used, namely in-depth interviews with elected officials, newspaper articles and official documents pertaining to pollution impacts, and maps produced by the Pima County Department of Environmental Quality and Public Works. Results showed that Tucson's Hispanic community is convinced that environmental racism exists, even if Tucson's White majority does not (or could care less). Indeed, the research demonstrated that it was not so much the polluting activity itself that brought charges of racism to the fore, but rather the nature of the official responses.

This study highlights a very important yet underappreciated point: different ethnic groups often hold distinct views on what environmental threats are important, critical, and worth acting upon, even in the case of supposedly common resource issues such as clean water and air. The Hispanic community in Tucson mobilized around the siting of a garbage dump, which transformed local politics and yielded other gains, including a state-funded health clinic established to treat people with problems resulting from TCE (trichloroethylene) and other chemicals that were dumped—untreated—in desert arroyos for decades and contaminated part of the underground aquifer.

Working in 20 rural counties of the Mississippi Delta region, Preston conducted an environ-

mental awareness and behavior survey among 763 female heads of households with children aged 2 to 5 years participating in Head Start programs.<sup>25</sup> Most survey respondents (75%) were African American; 23% were White. Respondents who had an education beyond the high school level were consistently more likely to be familiar with government agencies responsible for health and the environment. Although the education level of survey participants did not seem to influence their sources of food or water, participants from counties with higher proportions of high school and college graduates were more likely to be connected to public water providers and less likely to obtain their food from a personal farm or use wild game as a food source. Respondents from counties with higher proportions of people of color were more likely to report living in homes constructed 25 or more years earlier and to report having insect and rodent infestation in their homes.

In addition, there was a significant correlation between the Black composition of counties and indicators of watershed quality, especially the number of violations resulting from exceeding permissible contaminant levels in drinking water or problems in monitoring contaminant levels or facility maintenance. Finally, Black respondents were more likely to report the presence of both landfills and chemical plants within their communities, suggesting that Black communities may have greater environmental burdens, concerns, or perceptions of injustice than White communities.

## METHODOLOGICAL ADVANCES IN ENVIRONMENTAL ASSESSMENT

Maantay reviewed the pitfalls and potentials of geographic information systems in assessing the disproportionate burden of environmental hazards borne by certain population groups.<sup>26</sup> She cited refinements in exposure indices, use of dispersion modeling and advanced proximity analysis, application of neighborhood-scale analysis, and consideration of other factors such as zoning and planning policies as keys to better understanding the spatial relationships between pollution and health. While documenting the distribution of noxious facilities is certainly of consequence, what has yet to be demonstrated conclusively is the correspondence between unequal environmental burdens and disparities in health outcomes within and across populations. The paucity and insufficiency of health data for most outcomes is a major limitation.

A community–academic collaboration in Southern California employed recent advances in air emissions inventories and air exposure modeling data to investigate reasons for the disproportionate burden of treatment, storage, and disposal facilities borne by communities of color.<sup>27</sup> Results of a longitudinal analysis showed that Toxic Release Inventory (TRI) facility siting, not market-based “minority move-in,” accounted for the disparities found across communities. This collaborative also investigated the health effects of outdoor air toxic exposures from mobile and stationary sources and found that race plays an explanatory role in predicting cancer risk distributions among

populations in the region, even after other socioeconomic and demographic factors have been controlled. Incorporation of actual health data, including cancer incidence rates by site, race/ethnicity, social class, age, gender, and sexuality, would allow more thorough investigations of the relationships between the siting of hazardous facilities and health effects at the population level.

Methodological advances have also been made in assessing the built environment to assist research investigating potential physical and mental health effects. For example, Weich et al. developed a 27-item observer-rated built environment site survey checklist for use in a prospective cohort study seeking to compare changes in mental health over 3 years among individuals residing in 2 electoral wards in the north of London.<sup>28</sup> Most of the checklist items exhibited at least moderate interrater reliability, although further work is needed to refine and validate the measures for the areas involved in that study as well as other urban settings. Nonetheless, preliminary findings showed that ratings on several of the built environment checklist items were meaningfully associated with depression prevalence rates and residents' dissatisfaction with their area as a place to live.

## WHICH CAME FIRST?

Given new evidence and advanced methods, it is worth revisiting an old debate, namely, “which came first”: host communities that are home to impoverished people and people of color or locally unwanted land uses (LULUs)?<sup>29</sup> Understanding the dynamics and causation of environmental inequity may assist in

the development of effective public policies to remedy identified problems.<sup>4</sup> That is, if the inequitable distribution of LULUs results from siting processes that are motivated by racial prejudice and discrimination, then the government can take legal action under the US Constitution and the Civil Rights Act of 1964 or design public policies to encourage more equitable distributions of LULU burdens.

Using a conceptual framework for the analysis of environmental equity and causation that includes presiting neighborhood dynamics and the characteristics of control neighborhoods, Liu re-analyzed a Houston case study that allegedly supported the hypothesis that LULUs result in host communities becoming home to more impoverished people and people of color.<sup>4</sup> Indeed, “frameworks matter,”<sup>30</sup> because they determine the research questions that are posed and investigated.

In this case, Liu found no significant differences in changes in Black population percentages and relative family incomes between the LULU and control neighborhoods. That is, the forces driving neighborhood change in Houston appeared to be similar for the neighborhoods with and without LULUs, and alternative hypotheses (invasion–succession and other push forces) offered better explanations than the market dynamics hypothesis for why the Houston host neighborhoods were home to more impoverished people and people of color. Of course, the conclusions in the Houston case do not mean that the market dynamics hypothesis should be summarily rejected in other cases or that solid waste facilities do not have

adverse health effects on the surrounding community.

### GRAPPLING WITH COMPLEXITY

Recent research has grappled with the complexities involved in attempting to assess whether or not socially disadvantaged groups bear a disproportionately high burden of environmental hazards. Consider the following environmental exposure study. In contrast to earlier research that was conducted under financial constraints and relied on overly aggregated data sources—including the landmark and influential 1987 report published by the United Church of Christ<sup>31</sup>—Anderton conducted a census-tract-level analysis of possible population group inequities in relation to uncontrolled toxic waste sites.<sup>32</sup> Such sites are regulated by the 1980 Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA).

An inventory of all discovered potentially hazardous sites is currently maintained through CERCLIS (the CERCLA/SARA Information System). More than 1400 of these sites have been ranked as especially dangerous and placed on the National Priorities List (NPL) for eventual cleanup; these sites are commonly referred to as Superfund sites. Hence, Superfund sites result from both the discovery of abandoned or closed CERCLIS sites and a subsequent review and prioritization process that places them on the NPL. Because placement on the NPL is biased toward sites that pose a threat<sup>31</sup> to drinking water, urban

sites are less likely than suburban or rural sites to become Superfund sites.

The census-tract-level analysis of Superfund sites conducted by Anderton demonstrated that CERCLIS neighborhoods were typically working class rather than poor, had lower percentages of Black or Hispanic residents and higher percentages of Native American residents, were less densely populated, and had more residents with industrial jobs than non-CERCLIS neighborhoods.<sup>32</sup> On the other hand, as the percentage of Blacks or Hispanics and socioeconomically disadvantaged households in a neighborhood increased, fewer CERCLIS sites were placed on the NPL, providing evidence for inequity in the prioritization process.

In a second study, Perlin et al. addressed the complexity of residential proximity to industrial sources of air pollution that are subject to the reporting requirements of the US Environmental Protection Agency for the TRI.<sup>33</sup> Specifically, they examined the interrelationships among race (African American or White), poverty (above or below the household poverty threshold), and age (birth to 5 years or 65 years or older) and living up to 3 mi (4.8 km) from TRI facilities in 3 study areas: the Kanawha Valley in West Virginia, the Baton Rouge–New Orleans corridor in Louisiana, and the greater Baltimore metropolitan area in Maryland. They found that, in comparison with White children, a substantially higher percentage of African American children aged 0 to 5 years lived in poor households that were located in relatively close proximity to one or more industrial sources of air pollution.

### ENVIRONMENTAL POLICIES FOR POPULATION HEALTH

Brown et al. investigated the effectiveness of housing policies in reducing children’s lead exposure during the period 1993 through 1998 in 2 adjacent northeastern US states, one where lead prevention statutes were strictly enforced (including criminal and civil penalties against property owners who failed to abate lead hazards and reporting of dangerous lead levels to the owner, all tenants at the address, and the state lead poisoning prevention program) and one where they were not (criminal and civil sanctions were *not* initiated against property owners, and tenants were *not* notified of the presence of lead hazards).<sup>34</sup> Results showed that the risk of identifying one or more children with blood lead levels of 10 µg/dL or above was 4.6 times higher in areas with limited enforcement. Because relocation of lead-poisoned children is frequently the goal of lead poisoning prevention programs that lack the capacity to enforce abatement, these findings also argue for the development of address-specific surveillance systems to track the blood lead levels of resident children.

Gilpin et al., using data derived from 5 population-based surveys conducted in 1990, 1992, 1993, 1996, and 1999, assessed progress in achieving smoke-free workplaces and homes in California between 1990 and 1999.<sup>35</sup> Results were reported by gender, age, race/ethnicity, and education level. Overall, the percentage of California indoor workers reporting smoke-free workplaces in-



creased from 35% in 1990 to 93% in 1999. Nonetheless, clean indoor working environments have not been established equally in all demographic groups. In general, men, younger workers, people of color (notably Hispanics and Asian/Pacific Islanders), and those with less education still have higher rates of work area exposure to environmental tobacco smoke.

The percentage of Californians reporting smoke-free homes was 74% in 1999, almost a 2-fold improvement since 1992, when the question was first asked on the survey. This increase in smoke-free homes has resulted in an increase in protection of children and adolescents from environmental tobacco smoke to more than 80% across all population groups, with Hispanic children and adolescents most protected (85%) and African American children and adolescents least protected (76%).

Finally, Solitaire and Greenberg evaluated the Environmental Protection Agency grant program designed to assist communities in redeveloping abandoned or underused former industrial sites, otherwise known as brownfields.<sup>36</sup> Using data from the 1990 US Census of Housing and Population, they compared the brownfields pilot cities with other communities in the United States. Results showed that, regardless of intent, the program was environmentally just in that it awarded grants to the most economically distressed cities, although cities receiving funding in the early years of the program were more economically distressed than cities receiving funding more recently.

## THE WAY FORWARD

To better guide the development of future public policies to advance environmental equity and improve population health, scientific and scholarly investigations that incorporate the complexities present across environmental exposures and population groups are urgently needed. Research priorities include a better understanding of the social determinants of the distribution of environmental exposures, the reasons for increased susceptibility to environmental hazards among certain population groups, and the health effects from multiple environmental insults as they accrue over the life course; careful assessment of the benefits and limitations of available remediation methods for known hazards; and comprehensive analyses of the health benefits that ensue from the enforcement of existing environmental regulations and neighborhood improvements, including improved mental health and well-being and decreased instances of injuries and violence.

Historically, closer integration of public health professionals with urban planning, environmental protection, and civil rights adherents has proved fruitful for articulating purposeful research questions and providing the necessary data to guide informed decision making.<sup>37–40</sup> Scientific research findings on the health effects of environmental equity may bolster societal commitments to sustainable development, safe and affordable housing, and reductions in greenhouse gases that may ultimately result in improved health among all population groups.

The most critical need at present is ongoing support for environmental and health surveil-

lance systems so as to ensure adequate data for local, regional, and national research into the determinants of environmental equity and health. These data need to be collected for particular and diverse racial/ethnic groups, for the United States as a whole and by region, and in relation to other qualities we embody simultaneously that make us complete and complex people, namely, social class, age, gender, and sexuality.<sup>41</sup> A first priority is the collaborative selection of apt and accessible indicators of social, economic, and environmental factors to better monitor progress and hold agencies and institutions accountable for moving forward toward the goal of environmental equity. ■

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