RESEARCH TRIANGLE
ENVIRONMENTAL HEALTH
COLLABORATIVE

2010 Environmental Health Summit

Recommendations from the Research Triangle Environmental Health Collaborative

Representing a Compilation of Opinions

America's Healthcare Policy through the Lens of Environmental Health

Abstract

The 2010 North Carolina Environmental Health Summit convened more than 100 environmental and health experts as well as others from diverse backgrounds to discuss ways to increase the attention to environmental impacts on health in the ongoing debates over healthcare reform. Many of the participants represented organizations and interests (e.g., transportation, land development, housing/architecture, agriculture, utilities) ordinarily considered unrelated to environmental or public health, but their decisions and policies can nevertheless result in significant impacts and therefore are vital to the overall conversation on this topic.

The summit's desired outcomes were to:

- Increase clarity about the meaning of "environmentally related disease prevention" and how it relates to the national healthcare debate and cost savings.
- Recommend elements of an action plan for preventing adverse environmental health impacts while promoting beneficial environmental health impacts.

Much of the discussion focused on North Carolina as an example that can be generalized to other states. Promoting environmental health can reduce state budget deficits by preventing diseases that are triggered or exacerbated by environmental contamination and the substantial costs associated with managing these diseases. In total, medical care assistance programs accounted for more than $12 billion (26%) of North Carolina's $46 billion 2009-2010 budget. Exposure to environmental pollutants can initiate or aggravate many preventable chronic diseases, such as cardiovascular and cardiopulmonary diseases, that account for a substantial share of state healthcare spending.

Summit participants identified several major categories of actions that North Carolina could consider as elements of a plan to reduce environmental impacts on medical costs, including these top **recommendations**:

- Empowering minority and low-income communities to influence local planning decisions that affect local environmental quality and health.
- Developing North Carolina-specific case studies that strengthen the evidence base for the potential to reduce state medical care costs through environmental interventions.
- Developing "Environment Matters to Your Health" marketing campaigns to strengthen public engagement in environmental policy discussions and promote individual choices that reduce environmental risks to health.

This document describes these and many other recommendations North Carolina can pursue to reduce environmental impacts on medical care costs. As a next step, summit participants recommended that the Research Triangle Environmental Health Collaborative convene a work group to prioritize the recommended actions and determine how priority initiatives can be pursued without increasing the state budget in the short term, as well as how these priority actions can decrease the budget in the long term.

"Whoever wishes to investigate medicine properly should proceed thus: in the first place to consider the seasons of the year. … Then the winds …, especially such as are common to all countries, and then such as are peculiar to each locality. We must also consider the qualities of the waters, for as they differ from one another in taste and weight, so also do they differ much in their qualities."

– *Hippocrates*, On Airs, Waters and Places

"The connection between the health and the dwellings of the population is one of the most important that exists." [1]

– *Florence Nightingale*

"Diseases are 100 percent genetics and 100 percent environmental." [2]

– *Dr. Francis Sellers Collins, Human Genome Project*

Overview

As the above quotations illustrate, the association of environmental risk factors with preventable disease is a long-established concept in public health. The World Health Organization (WHO) estimated that in 2004, nearly a quarter of the global burden of disease was attributable to environmental risk factors.[3] Although developing countries bear the largest burden of environmentally related deaths and illnesses, the WHO found that 17% of deaths and diseases in developed countries could be attributed to environmental factors.

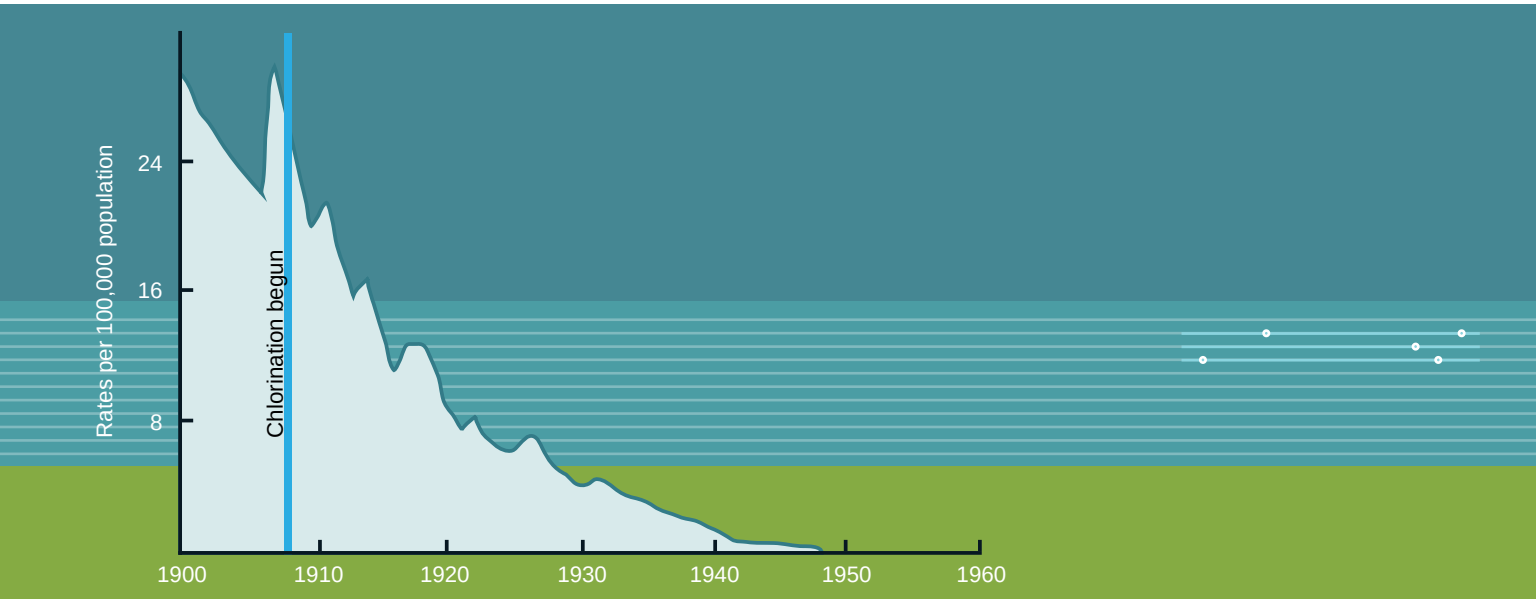
An increased disease burden due to environmental risks translates to significant economic implications for medical care systems. Landrigan et al. estimated the medical care costs in the United States associated with four environmentally mediated chronic health conditions in children: lead poisoning, asthma, cancer, and neurobehavioral disorders. The authors reported that these four disease categories alone were responsible for an annual average cost of $54.9 billion.[4] Several individual states have completed similar assessments on children, with state-specific total annual medical care costs for select diseases ranging from $1.57 billion to $5.8 billion.[5-8]

Several historic success stories in the United States highlight the public health benefits (and thus the potential to reduce medical care costs) of environmental improvements:

- The introduction of filtration and disinfection to municipal water systems led to substantial reductions in mortality in U.S. cities during the early twentieth century[9] (see, for example, the reduction in typhoid deaths illustrated in Figure 1).
- The federally mandated removal of lead from gasoline in 1976 reduced lead in ambient air and soil and, consequently, average blood lead levels in the population (Figure 2).
- From 1980 to 1982, as a result of the Clean Air Act of 1970, 2,500 fewer infants died in the United States than would have in the absence of this legislation, according to estimates by economists.[10]

These examples illustrate that programs to reduce population exposure to environmental pollutants (both chemical and microbial) can have dramatic impacts on public health. Yet, opportunities to prevent disease and reduce medical care costs through environmental interventions have received scant attention in the recent debates on the U.S. healthcare system. These debates primarily have emphasized disease treatment over prevention, despite ample evidence that prevention is a far more cost-effective approach to public health.

Opportunities to prevent disease through environmental interventions are especially relevant for the millions of U.S. residents who lack medical insurance coverage. Individuals without medical insurance are less likely to seek treatment for environmentally related diseases such as asthma than those with insurance and therefore may suffer disproportionately from the effects of environmental exposures. The U.S. Census Bureau reported that in 2009, more than 50 million people were uninsured, with almost a third of those reporting household income of less than $25,000. Especially troubling, the number of uninsured children under the age of 18 increased in 2009, with children in poverty having a higher uninsured rate (15%) than all other un-

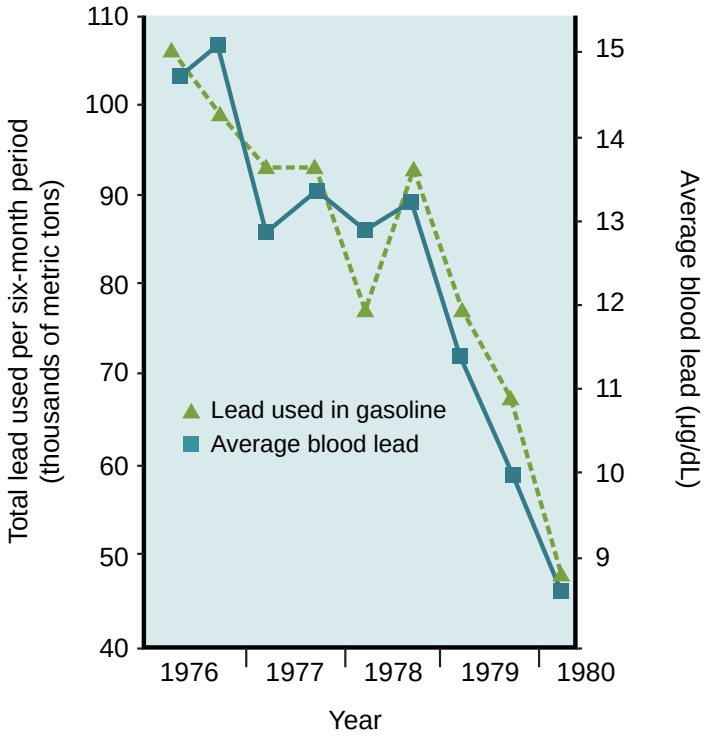


Death Rate for Typhoid Fever, United States 1900-1960

Figure 1. The death rate due to typhoid fever in the United States plummeted in the United States after the introduction of filtration systems in the late 19th century and chlorination in public water supplies. *Source: U.S. Centers for Disease Control and Prevention, Summary of Notifiable Diseases, 1997.*

insured children combined.[11] Although those with insurance coverage and adequate medical care also face environmental stressors that may place them at an increased risk of adverse health conditions, these census statistics on the uninsured population are significant due to the documented evidence that disadvantaged populations and those without access to adequate medical care are disproportionately affected by environmental pollution.[12] For example, the WHO has determined that medical care, in addition to environmental and socioeconomic stressors, is a key factor in understanding the differences in environmentally related disease burdens between developing and developed nations. In essence, the uninsured in the United States face circumstances similar to those faced by inhabitants of developing nations that lack sufficient medical facilities.

The dearth of national discussion on environmental interventions as health-promotion strategies in ongoing healthcare debates is partly a result of institutional structures that separate environmental management from public health and medical care management. In its report "The Future of Public Health," the U.S. Institute of Medicine concluded that "the removal of environmental health authority from public health agencies has led to fragmented responsibility, lack of coordination, and inadequate attention to the health dimensions of environmental problems."[13] By merging the body of science on



Lead Used in Gasoline Production and Average NHANES II Blood Lead (Feb. 1976 – Feb. 1980)

Figure 2. Beginning in 1973, the U.S. government required the use of lead in gasoline to be phased out. This figure shows that average blood lead levels in National Health and Nutrition Examination Survey (NHANES) participants dropped at a rate that paralleled the reduction. *Source: Jeffrey Engel, M.D., "Environmental Impacts on Public Health in North Carolina," presented at the North Carolina Environmental Health Summit, September 28-29, 2010, Research Triangle Park, North Carolina.*

environmental health risks into healthcare policy discussions, the United States can begin to develop cost-effective strategies aimed at reducing not only the disease burden at the population level but also the economic burden on our healthcare system.

In light of the current resurgence in the healthcare reform debate and the relationship between environmentally related diseases and medical care costs, introducing environmental issues into the ongoing healthcare discussions is prudent. As the discipline of environmental health identifies additional risk factors, designing effective measures to reduce contribution of those risk factors to the disease burden could help temper the anticipated continued rise in medical care costs. Substantial additional opportunities exist to reduce the U.S. environmental burden of disease, particularly for the noncommunicable and chronic diseases that represent an increasingly large share of U.S. medical care costs. For example, multiple epidemiologic studies have demonstrated links between exposure to air pollution and cardiovascular disease, which is the leading cause of death in the United States.[14]

With these considerations in mind, the Research Triangle Environmental Health Collaborative held the third annual Environmental Health Summit on September 28 and 29, 2010, in Research Triangle Park, North Carolina. This document summarizes the major themes and recommendations that emerged from the plenary sessions and three work groups at the summit.

2010 Environmental Health Summit: September 28-29, 2010

America's Healthcare Policy through the Lens of Environmental Health

The theme of the 2010 Environmental Health Summit was "America's Healthcare Policy through the Lens of Environmental Health." More than 100 invited participants and experts representing academia, government, private-sector organizations, and public-interest and advocacy groups contributed to the two-day summit. Participants were assigned to one of three interdisciplinary work groups with a specific focus:

Group 1: Policies to prevent or reduce environmental impacts on the disease burden and the healthcare system.

Group 2: Research and analytical tools to support existing and new policies to prevent and reduce environmental impacts on health and the healthcare system.

Group 3: Opportunities for outreach and education as well as mobilization of the public to reduce the impact of environmental quality on human health and the healthcare system.

During group breakout sessions, participants brainstormed recommendations on initiatives North Carolina could consider as steps toward reducing the state's environmental burden of disease and associated medical care costs. Some of these initiatives, if demonstrated in North Carolina, could then serve as national models. While each group focused on one of the three topics above, considerable overlap and synergy between the groups contributed to the overall charge of the summit: to view healthcare and healthcare policy through the lens of environmental health. To capture this synergy, all of the groups convened several times to solicit feedback on ideas from their peers.

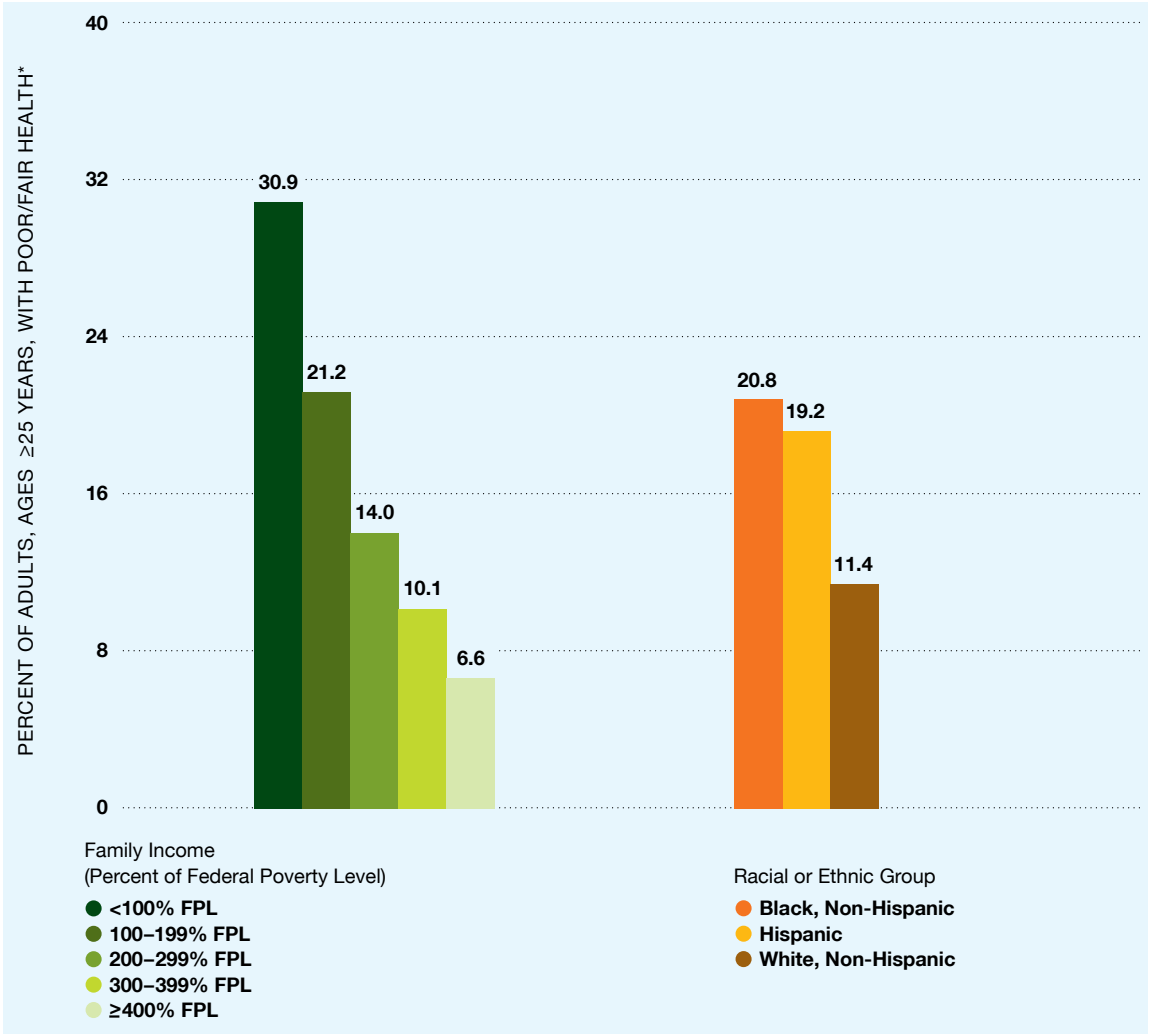
Common Themes

A number of common themes emerged among work groups, including recommendations to:

- Reduce disparities in exposure to environmental risks and in access to medical care that contribute to the individual and societal burden of illness among socioeconomic groups and geographic regions of North Carolina.
- Use education (of the public, medical professionals, and decision-makers) as a tool for democratizing environmental policy decisions.
- Coordinate environmental and public health data to evaluate environmental impacts on health.
- Conduct North Carolina case studies to demonstrate environmental impacts on medical care costs.

The disparities in exposures to environmental toxicants and access to medical care that many minority and low-income communities experience result in disparities in wellness and adverse health outcomes. Thus, the interrelationships among social position, environment, and health emerged as a prominent theme. Across the United States, low economic status and/or membership in a minority group have been consistently linked to poorer health. Those living below the federal poverty level are nearly five times as likely as high-income individuals to experience poor health (Figure 3). Blacks and Hispanics are nearly twice as likely as whites to experience poor health. Studies nationwide have demonstrated that low-income and minority communities are disproportionately affected by health outcomes associated with environmental pollution (Figure 4 provides an example). In addition, major geographic disparities in pollutant exposures exist, as illustrated by the substantial variation in fine particulate matter in North Carolina's air in 2003 (Figure 5).

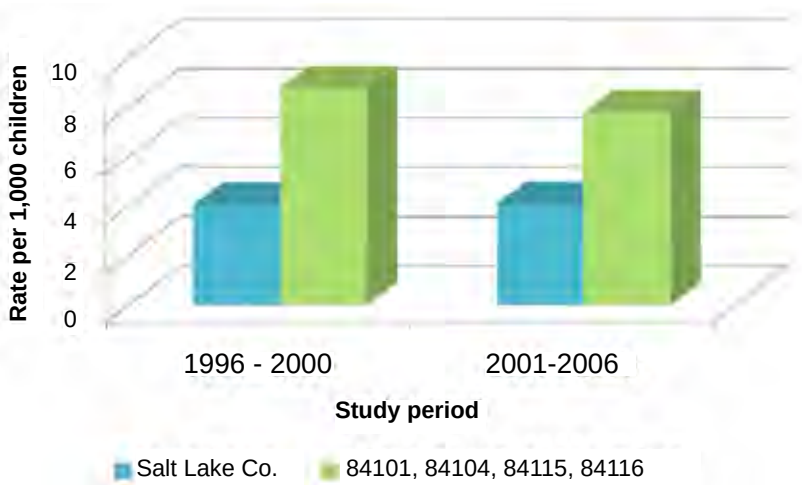
A major focus of the discussions during the conference was the need for the implementation of strategies to decrease these disparities and empower minority and low-income communities to have more control over their exposures to environmental contaminants. Participants stressed the need for broader access to medical care for all groups, regardless of socioeconomic status.



Prepared for the Robert Wood Johnson Foundation by the Center on Social Disparities in Health at the University of California, San Francisco.
Source: National Health Interview Survey, 2001–2005.
*Age-adjusted

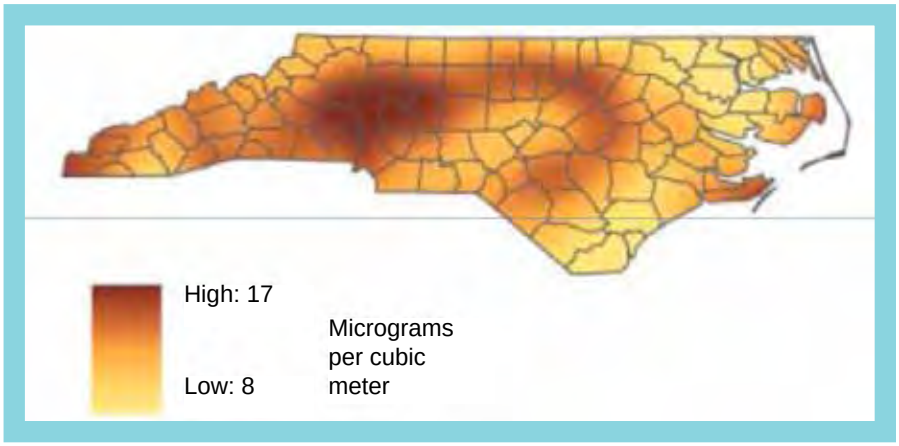
Health Varies by Income and across Racial or Ethnic Groups

Figure 3. Individuals living in poverty (far left of chart) have nearly five times the chance of experiencing poor health as those with incomes greater than four times the poverty rate. In addition, African-Americans and Hispanics have nearly twice the chance of suffering poor health as whites. *Source: Dr. J. Nadine Gracia, "Environmental Contribution to Health Disparities: Where the Health Burden Is," presented at the North Carolina Environmental Health Summit, September 28-29, 2010, Research Triangle Park, North Carolina.*



Children Hospitalized or Visiting an Emergency Department for Asthma

Figure 4. A study in Salt Lake County demonstrated that children in ZIP code areas predominantly composed of minority and low-income residents (the taller bars) have nearly twice the rate of hospital admissions for asthma as children in other parts of the county (the shorter bars). *Source: Dr. J. Nadine Gracia, "Environmental Contribution to Health Disparities: Where the Health Burden Is," presented at the North Carolina Environmental Health Summit, September 28-29, 2010, Research Triangle Park, North Carolina.*



Average Soot Levels in North Carolina, 2003 ($PM_{2.5}$)

Figure 5. Data from North Carolina's ambient air quality monitors show substantial spatial variation across the state in the risk of exposure to high levels of particulate matter. *Source: Dr. Jeffrey Engel, "Environmental Impacts on Public Health in North Carolina," presented at the North Carolina Environmental Health Summit, September 28-29, 2010, Research Triangle Park, North Carolina.*

Use Education

Improved education on the effect of environmental quality on health at all levels—from K-12 students to community residents and policy makers—was identified as a critical need. Participants highlighted the importance of education and access to information for democratic decision making, particularly valuable for empowering low-income and minority communities to have a stronger voice in public decisions affecting their health. Work groups emphasized the need for technical assistance grants to support education of communities affected by environmental contamination. They also recommended incorporating environmental health courses into training programs for doctors and nurses and developing training modules for local public health officials. Additional case studies that provide tangible evidence of the benefits of environmental quality improvements for public health are needed. The outreach, education, and mobilization group (Group 3) developed ideas for teaching environmental health concepts in K-12 schools, offering special environmental health training opportunities for decision makers, and developing marketing campaigns to educate the general public about the connections between health and environmental quality.

Coordinate Environmental and Public Health Data

Substantial discussion revolved around the uncertainties in predicting environmental impacts on health. Summit participants recommended making better use of existing environmental and health data by creating physical or virtual links among environmental and health databases maintained by various agencies and organizations throughout the state. For example, ambient air quality data that already are collected routinely could be linked with electronic medical records systems. With proper masking of personal information, such a linked data set could provide North Carolina-specific estimates of how air quality may impact health now and in the future. Further, establishing programs to link data sets would build new connections among the disparate agencies with roles in environmental protection and public health. The need for coordination amongst these agencies also was a frequent topic of conversation. Building joint data systems would be one way to foster interagency cooperation.

Conduct North Carolina Case Studies

Participants in all work groups stressed the need to gather tangible evidence that demonstrates the link between the quality of the environment and medical care costs. Such tangible evidence is needed to demonstrate to the public and policy makers the broader benefits of programs to improve environmental quality. Participants identified North Carolina as an ideal candidate for case studies designed to investigate these benefits. The diversity of the state's demographics, geography, and industry, as well as the presence of leading education and research institutions with missions related to environmental health, would contribute to the potential value of North Carolina case studies to inform our understanding of the connections between environment and health.

Participants discussed a variety of case studies that could be pursued, but two general types emerged as leading prospects. First, at the state or county level, North Carolina could carry out a comprehensive assessment of the environmental burden of disease, using guidelines from the WHO, to identify top environmental risks to public health. Results could then be used to help prioritize future environmental health interventions. Participants emphasized the need for a coordinated strategy for population health that emphasizes interventions with maximum potential health benefits and reduction in health disparities. The results of such a case study would be a powerful ingredient in planning for such a comprehensive strategy.

Second, North Carolina could conduct demonstrations of the health impact assessment approach for investigating unintended health consequences of new projects, plans, or policies (Figure 6). The Robert Wood Johnson Foundation, Pew Charitable Trusts, and other organizations are currently promoting the use of health impact assessments as a tool for preventing unintended negative consequences to health.

Examples of topics that might be suitable for health impact assessments include new highways, subdivisions, malls, and urban redevelopment projects that are currently in the planning stages; offshore wind energy projects currently under consideration; or potential programs to promote energy efficiency.

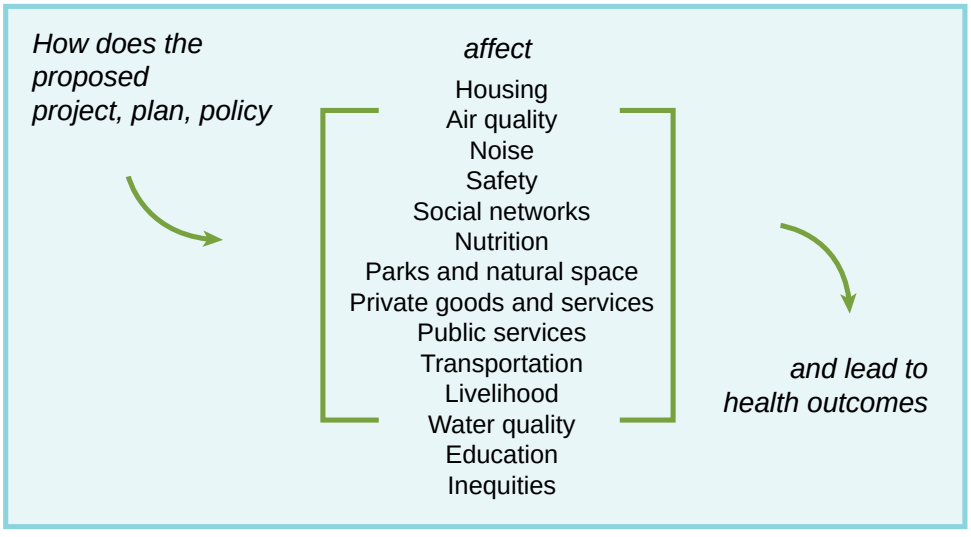


Figure 6. Assessments of health impact seek to estimate the unintended consequences for public health of proposed projects, plans, or policies. *Source: Kara Vonasek, "Health Impact Project," presented at the North Carolina Environmental Health Summit, September 28-29, 2010, Research Triangle Park, North Carolina. Slide courtesy of Human Impact Partners, Oakland, Calif.*

Recommendations

The remainder of this document presents more detailed information on specific recommendations from each group. These are not exhaustive but are instead intended to motivate further discussion of how environmental issues can be integrated into healthcare policy discussions at the state and national levels.

Each of the three work groups developed a separate set of recommendations for ways to integrate environmental factors into healthcare policy. The groups developed initial recommendations, presented them to a plenary session, and then revised the recommendations based on the plenary discussions. The final recommendations from the three groups follow.

Additionally, summit participants recognized that in an era of budget cutting, costly new state initiatives are unlikely to be pursued. Therefore, they recommended that the EHC convene a work group to prioritize recommended actions. It also could determine potential funding sources for initiatives in order to prevent short-term state budget increases while recognizing the potential for these initiatives to decrease the state budget over the long term.

Group 1: Policies to Prevent or Reduce Environmental Impacts on Health and the Healthcare System

The overarching theme emerging from Group 1 was the need to reduce health disparities in various populations that result from differences in environmental toxicant exposures. The group emphasized both the importance of eliminating disproportionate exposures to environmental risks among various segments of the population and of providing equal access to medical care for all community members.

To reduce disparities in environmental risks to health, Group 1 recommended a two-pronged approach that engages both policy makers and members of local communities.

Top-Down Policy Approaches

1.1. Promote community control over local land-use decisions that affect environmental quality and health and allow communities to adopt policies that are more protective of public health than federal or state policies.

1.2. Expand current county- and state-level public health planning processes to include formal assessments of environmental impacts on health. For example, counties and the state as a whole could conduct formal planning exercises to select environmental health priorities and identify interventions that will improve the health of the largest number of people and most severely affected communities. Community input and participation in the selection of both priorities and interventions could be required. These new planning programs could build on existing programs such as the Robert Wood Johnson Foundation Commission to Build a Healthier America.

To structure the planning processes, counties and the states could consider using the deliberative method for ranking risks[15-17] and the environmental burden of disease approach advocated by the WHO, which have been demonstrated as effective means for educating communities about the nature of environmental risks to their health and engaging them in planning to reduce those risks.[18-19] Counties in North Carolina conduct community health assessments every two years; environmental health assessments as suggested here could be incorporated in these ongoing assessments.

1.3. Promote the precautionary principle in developing new medical and environmental policies. For example, North Carolinians could support efforts currently under way to strengthen the Toxic Substances Control Act, which facilitates preventive approaches to public health by controlling the introduction into commerce of new chemicals that may have adverse health effects.

Bottom-Up Strategies

1.4. Promote community advocacy and empowerment through education and technical assistance, possibly using grant-funding mechanisms as a means of engagement.

1.5. Leverage the power of education as a strategy for democratization of policy decisions that affect environmental quality and public health.

1.5.1. Introduce concepts of environmental quality and its impacts on health into science education throughout North Carolina.

1.5.2. Integrate occupational and environmental health into training for medical providers.

1.5.3. Increase the resources available to public health agencies to educate community members about environmental health risks and prevention.

1.5.4. Leverage the EHC as a catalyst and facilitator in pairing universities with local public health offices to advance continuing education and training programs for local chapters of medical-care provider organizations.

Group 2: Research and Analytical Tools to Support Policies that Prevent or Reduce Environmental Impacts on Health and the Healthcare System

Group 2 emphasized the need for projects to test the hypothesis that environmental interventions can reduce medical care costs. Results of such projects could help state leaders and decision makers understand the potential for improved environmental protection to reduce medical costs for diseases of major importance. Although the group was assigned to assess research needs, the group emphasized that actions to reduce known environmental risks that have significant health consequences can be taken now, without waiting for more research. Research can strengthen the evidence base for future environmental interventions, but limitations in current knowledge should not be used as an excuse for delaying action. In fact, the case studies recommended by this group could be based on new or existing programs to improve environmental conditions in specific communities.

The group also emphasized the need to understand more fully individual variations in susceptibility to environmental risk factors. These may occur due to genetic differences and/or differences in individual behaviors and physical characteristics (e.g., body mass index). The discussion also included the need to predict how susceptibility to risk factors, at the population scale, may change in the future due to changes in the prevalence of obesity, diabetes, and lifestyles that lead to the development of disease. The group recognized that the physical environment can be an important risk factor for obesity and diabetes.

A third major theme in the group's discussions was that to date, many analyses of environmental impacts on health have relied on secondary data not collected expressly for the purpose of analyzing such connections. As an example, epidemiologic studies of the effects of air quality on health often have relied on air quality measurements collected for regulatory purposes using state and federal air quality monitoring networks with limited time and spatial resolution. Individual exposures are estimated based on these existing data. The group, while recognizing the value in using such data sets, also highlighted the need to collect environmental exposure and health data expressly for the purpose of understanding how environmental factors affect health and medical care utilization. Moreover, the group emphasized the need for better methods to integrate pre-existing data sets at different spatiotemporal scales.

A fourth major theme of the group was the need to identify environmental signals that may provide advance warning of impending health risks and associated demands on the healthcare system. The group identified spatial statistics as a particularly useful category of methods for detecting potential changes in such indicators, once the relevant indicators are identified.

A final high-priority theme of this group was the need to consider broadening the definition of "environment" to include the entire landscape in which populations operate, rather than just the specific concentrations of pollutants in air, water, or soil. The group suggested health impact assessment as a viable framework for analyzing environmental impacts on health, based on this broader definition.

The group's primary recommendation was the development of a series of case studies testing the hypothesis that improving environmental quality and/or the design of the built environment will decrease medical care costs. The group also developed secondary recommendations in three categories: data, methods and models, and fundamental knowledge.

Primary Recommendation: North Carolina Case Studies

2.1. Conduct a series of case studies in North Carolina to test hypotheses that improving environmental quality reduces medical care costs through decreases in treatment for chronic conditions such as asthma, diabetes, and cardiovascular disease; decreases in emergency room visits; and other benefits. Examples of types of case studies that could be conducted to test such hypotheses include comparing health status in counties (e.g., Duplin vs. Orange) with different environmental risk factors and analyzing health data before and after legislation to improve environmental quality (such as smoking bans or reductions in permissible air emissions).

2.2. Conduct case studies in North Carolina to quantify the local and regional burden of disease due to different environmental factors. Estimate the medical care cost savings that might accrue with decreased exposures to environmental risk factors. Quantify how social, economic, and demographic factors affect the environmental burden of disease in the case study communities.

2.3. Conduct case studies in North Carolina to demonstrate the health impact assessment approach for analyzing the effects of the built environment on human health and medical care costs.

2.4. Conduct a community-based comparative risk study to demonstrate methods for engaging communities in determining which environmental risk factors to health are most important in the study community. In identifying priority environmental risks to community health, use the deliberative method for ranking risks, which combines quantitative risk assessments with structured community engagement.[15-17]

Additional Recommendations: Data

2.5. Establish key metrics for monitoring environmental public health. Building on the WHO global burden of disease approach, in defining such metrics emphasize outcomes that pose high risks and contribute the most to medical care costs (while also including

sufficient metrics relevant to less common environmentally related illnesses). Example metrics might include concentrations of pollutants in air, water, and soil; number of people living in areas that have not attained required environmental quality standards (such as air and water quality standards); proportion of residents who the live near major roadways or in areas with high levels of vehicular traffic; the proportion of communities lacking municipal sewage systems; blood lead levels in children; and number of children exposed to secondhand smoke.

Collect baseline information on these indicators and then track the indicators over time to assess changes in the health status of the population in North Carolina. Compare the results across geographic areas of North Carolina, as well as to other states. Link data sets and evaluate health outcomes using analytical tools and methods provided by the Centers for Disease Control Environmental Public Health Tracking networks.

2.6. Identify which of the identified metrics should be recorded in patient health records. Examples would include risk of exposure to environmental tobacco smoke, pesticides, lead, and other contributors to environmentally related diseases.

2.7. Incorporate environmental health modules into the electronic health records systems being developed by health systems.

2.8. Establish a program to monitor medical care utilization data for indicators of elevated levels of diseases (for example, asthma, cardiovascular events, lead poisoning, and gastrointestinal illnesses) that may be triggered or exacerbated by environmental factors.

2.9. Establish a biological monitoring program in North Carolina that would track personal exposures to key environmental contaminants. Use the program as the basis for a state "report card" that can be tracked over time and compared with other states. Link data sets and evaluate health outcomes using analytical tools and methods provided by the Centers for Disease Control Environmental Public Health Tracking networks.

2.10. To the extent possible, use community-based, participatory approaches to collect data on environmental public health metrics. For example, cell phone cameras could be used to record data on the built environment.

2.11. Incorporate environmental health into doctor and nurse training programs.

Additional Recommendations: Methods and Models

2.12. Develop the spatial architectures needed to integrate existing data on environmental exposures, health, and pollutant concentrations. The new architectures should be able to combine spatially resolved environmental data with health records at the individual and population levels, while protecting the privacy of personal health data.

2.13. Develop a common set of formats for reporting and a spatial infrastructure for collecting future data relevant to environmental quality and public health.

2.14. Improve methods for scaling existing data sets to local levels to assess small-scale spatial differences in environmental quality and public health.

2.15. Further develop methods for leveraging multiple data sets (for example, small but rich; large but sparse) to identify important variables from imperfect or incomplete data sets pertinent to environmental effects on health.

2.16. Develop advanced models, such as land-use regression models, to understand how the physical environment and land-use factors affect levels of environmental pollutants.

Additional Recommendations: Fundamental Knowledge

2.17. Promote, through funding incentives, research on the relationships among environmental factors, health, and the healthcare system that incorporates interdisciplinary teams from the beginning of research design. Types of disciplines important in understanding environmental implications for health and the healthcare system include environmental engineering and science, epidemiology, toxicology, genetics, spatial statistics, anthropology, behavioral sciences, and economics.

2.18. Promote research on the links between measurements of biological responses and public health indicators that would be valuable in the context of medical care utilization.

2.19. Support research to understand health impacts resulting from indirect pathways of exposure to environmental risks (for example, through diet or lack of activity, which may increase the risk of obesity-related diseases and, as a result, susceptibility to health damage from environmental pollutant exposures).

2.20. Sponsor research on how the vulnerability to environmental exposures varies with social, economic, and demographic factors.

2.21. Support research to improve understanding of how cumulative exposure to environmental risks and exposures to multiple risk factors may interact to affect health.

2.22. Support research to understand the health effects of pollutants for which the available data are insufficient to predict how exposure affects health; examples include toxic air pollutants and certain pollutants common at hazardous waste sites.

2.23. Develop systematic reviews of environmental health interventions and their effectiveness. Compare the effectiveness of different interventions in terms of health improvement and reduced medical care costs. Routinely disseminate this information to the environmental and public health policymakers.

Group 3: Outreach, Education, and Mobilization to Reduce Environmental Impacts on Health and the Healthcare System

Group 3 discussed ways to strengthen public engagement in promoting individual choices and public policies that reduce environmental risks to health. Special emphasis should be placed on education and outreach to state elected officials and lawmakers in order to strengthen their commitment to comply with and enforce federal public health statutes at the state level (Clean Air Act, Safe Drinking Water Act, Clean Water Act, Toxic Substance Control Act, and others).

The group's primary recommendation was to enlist marketing experts to develop "Environment Matters to Your Health" campaigns, using North Carolina as a test case and local foundations to provide funding. The campaigns would be designed to educate and mobilize the public on pertinent environmental health issues. When an environmental health issue of concern is identified, each affected community includes individuals with different views of the problem. Some care passionately, possibly because they have been directly affected; others are indifferent; and others oppose action to protect the environment. In addition, some community members have more political influence than others. Messages need to be tailored differently to target groups with different viewpoints and levels of influence. The programs would target four different audiences, with a separate messaging strategy for each:

- Members of the public who care.
- People of influence.
- Communities affected by environmental risks.
- Other members of the public who do not hold strong views on environmental protection (the "neutral public").

The group developed recommendations concerning the process for creating these campaigns and the topics to be emphasized. In addition, the group recommends specific additional steps to educate and mobilize legislators on the need for action to address environmental health risks in low-income communities.

3.1. Use a six-step process to design and implement a series of "Environment Matters to Your Health" campaigns directed at the four audiences above. The six steps in the process are as follows:

Step 1. Identify the goals of the campaign (the primary environmental health issue for which change or action is desired).

Step 2. Identify and research the target populations (for example, members of specific organizations, residents of specific communities, opinion leaders). The research step includes gathering insights into the concerns of and motivators for each target population. For example, background research might include holding focus group discussions to identify message concepts that would help correct misconceptions among the members of the audience and prompt them to take action once these misconceptions are corrected. For messages aimed at people of influence, this background research might include finding out what the people of influence care about, who (including other influencers) might best be employed to approach each person of influence, and what the potential objections might be (along with how to address them).

Step 3. Develop the specific message. The message should include a pitch that sells the message and a "do" that identifies what the audience can do to effect change.

Step 4. Identify the delivery vehicles (Table 1).

Step 5. Use an integrated messaging approach that includes multiple delivery vehicles and multiple reinforcing messages.

Step 6. Define metrics that will be used to gauge success, and set benchmarks for the metrics. Example initial metrics for the members of the public who care might include the number of environmental organizations reached, the number of direct mail items sent, the number of individuals who sign a petition or attend a meeting, or the number of phone calls made. In the longer term, the key metric is whether the campaign effects change (in individual behaviors or public policies).

Table 1. Example Delivery Vehicles for "Environment Matters to Your Health" Campaigns

Type	Examples
Target Audience: Public that Cares	
Media outreach	Social marketing/media; reality show/public service announcements; mobile applications; YouTube video contest
Targeted outreach	Presentations at public meetings; field trips; public school curriculum enhancements; contests for high school students; service learning programs
Outreach to those who may influence the public	Activities for faith-based communities and sports teams; engagement of local celebrities, heroes, and teachers as advocates
Target Audience: People of influence	
Individual contact	Elevator speech; engagement of peers as advocates
Learning opportunities	Invite to summits and workshops; site visits
Other	Mobilize followers of the influencers; create events to engage the person of influence; employ social media to lobby influencers for support

3.2. In the short term, the "Environment Matters to Your Health" campaigns should focus on messages that concern policies and individual actions that are most readily implemented and feasible.

3.3. In the longer term, the campaigns should encompass policies and actions that will contribute the most to reducing environmental impacts on health.

3.4. Promote six steps to assess and reduce environmental risks to health in low-income communities:

Step 1. Establish local/state/federal collaborative partnerships[20] to ensure that the North Carolina General Assembly allocates suf-

ficient resources to comply with and enforce federal laws for the protection of North Carolina residents' health and quality of life.

Step 2. Educate the North Carolina State General Assembly and local governments about federal inter-agency policies to reduce environmental pollution and health disparities.

Step 3. Identify lawmakers who could sponsor a collaborative bill to assure compliance with and enforcement of federal environmental statutes, including the National Environmental Protection Act.

Step 4. Address states' rights issues as barriers to funding for corrective actions for low-income, minority, and Native American areas with adverse and disproportionate environmental impacts.

Step 5. Locate funds to sustain the West End Revitalization Association (WERA)[21,22] as a working national model and prototype of the U.S. Environmental Protection Agency's "Community Facilitated Strategies" related to environmental impacts and goods movement corridors in low-income minority communities and tribal areas.[23]

Step 6. Use case studies as models for assessing and taking steps to reduce environmental health disparities. Potential case study partners representing a diverse set of communities include WERA in Mebane (a small town); Rogers Road and Eubanks Road Neighborhood Association in Chapel Hill/Carrboro (a high-income university city area); and Rural Empowerment Association for Community Help (REACH) in Duplin County (a rural area impacted by the international agribusiness industry).

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The Research Triangle Environmental Health Collaborative supports a united environmental health resource that connects organizations and institutions; links research and policy; and joins government, academia, industry, and public interest groups to mutually consider, discuss, and debate the future of environmental health on a regional, national, and international level.

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