Environmental Health

Environmentally Related Disease

Our environment is made up of the surroundings in which we live. Environmental health is concerned with the ways that our environment can affect our health, from chemicals and microbiological organisms in the food we eat or the water we drink to particles in the air we breathe. Recently, new concerns have been raised about how our environment affects our lives, such as how climate change might change disease patterns, increase air pollution, and cause extreme weather events and how the way that neighborhoods and cities are laid out might affect our physical activity. These environmental problems have the potential to affect a very large number of people for a very long time. Environmental health practitioners are only beginning to address these problems.

Eventually, people can come into contact with these contaminants through the food or water they ingest, the air they breathe, or the objects they touch. The amount of a chemical or microorganism people are exposed to depends on the concentration of the contaminant in the environment and on how frequently and to what extent people come into contact with the contaminant during their daily activities. If people are exposed to enough of a chemical, this can affect the functioning of their bodies' cells or organs. If people are exposed to a sufficient number of pathogenic organisms, then they might become infected. If these biological effects are great enough, people can experience symptoms and/or develop a specific disease. All people respond to environmental exposures differently depending on their overall health, age, genetic makeup, and exposures they face.

Environmental Health Indicators

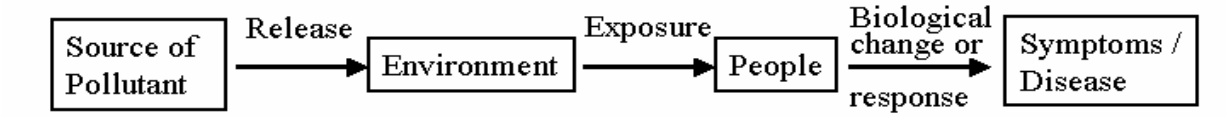

Figure 1. How the release of pollutants leads to environmentally-related disease in people.

Figure 1 is a simplified diagram showing how the release of a pollutant into the environment can lead to disease. These pollutants can come from many sources such as industrial facilities, wastewater treatment plants, auto emissions, insect and animal borne microorganisms, improperly prepared foods, and naturally occurring deposits that can release toxic substances, such as radon or arsenic. Cars and trucks release chemicals and particulates into the air, factories and wastewater treatment plants release chemicals or microorganisms into waterways, and on-site sewage systems can release microorganisms into groundwater if they are not working properly. Some pollutants move through the environment, perhaps evaporating from the soil into the air, washing into groundwater, or carried by rain out of the air into a lake. How a chemical or microorganism moves or degrades in the environment depends on its chemical structure and on environmental conditions.

An indicator is a simple measure that tells a story about how good or bad things are—that is, the "state of affairs." If the right data are available, we can use them to see whether conditions are getting better or worse and where the most serious problems are.

There are four types of indicators used in environmental health, and each measures a different part of the process from environmental contamination to environmentally related disease. Figure 2 shows where these four types of indicators fit into the environment-disease process.

Hazard indicators measure the release of hazards into the environment or the level of hazards already in the environment. These indicators include the types and/or amount of chemical released from a source such as factory, the concentration of a micro-organism in a river, or the level of particulates in the air. While these indicators do not directly measure the risk to individuals, they do measure the potential for current or future problems. Hazard indicators are the most common type of environmental health

indicator because these data are generally the easiest to collect and are often required by regulatory agencies.

Protective indicators measure the effectiveness of environmental and public health programs in controlling public exposures to environmental hazards. Examples of protective indicators include the number of restaurants without food safety violations or the percent of public water systems that have completed required water quality testing.

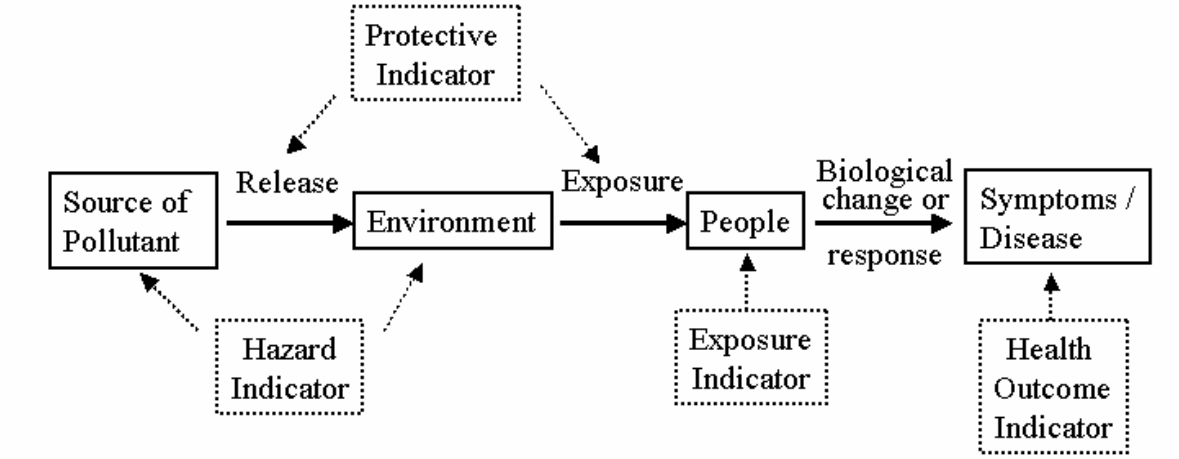

Figure 2. Environmental health indicators and the environment-disease process.

Exposure indicators directly measure the level of exposure of individuals to specific agents that cause disease. The level of lead in a child's blood is an exposure indicator.

Health outcome indicators measure the incidence or prevalence of a specific disease. For example, the number of people who get sick from eating contaminated shellfish is a health outcome indicator.

Accurate health outcome indicators are available for only a few environmental health problems because of the complexity of the relationship between contamination in the environment and health problems resulting from this contamination. This relationship is complex for three reasons. First, many environmental problems involve more than one pollutant. Air pollution from automobiles, for example, includes several different types of chemicals as well as fine particulates. Similarly, the water discharged from a septic system can contain several different types of pathogenic bacteria, viruses, and protozoa.

Second, there is rarely a one-to-one relationship between an exposure to a given pollutant and a specific disease. Particulates in air pollution can trigger episodes of asthma and worsen the condition of people with other lung or heart diseases. Some chemicals and microorganisms can have immediate toxic effects on a specific organ at high levels of exposure, or they can lead to cancer or other chronic conditions only after prolonged exposures at much lower levels.

Third, most diseases caused by environmental factors can also be caused by non-environmental factors. Birth defects, for example, can be linked to exposure to environmental chemicals, but they are also strongly associated with specific nutritional factors as well as genetic makeup. Statistical analyses have demonstrated that increases in outdoor air pollution are associated with substantial increases in deaths, but air pollution is never cited as the specific cause of death.

Interpretation of Environmental Health Indicators

Environmental health interventions focus on reducing exposures by reducing levels of hazards in the environment and by ensuring that those parts of the environment that people directly interact with (food, drinking water, outdoor and indoor air) meet public health standards. Because of this approach, it is important to track hazards and exposures. Tracking diseases that are affected by environmental contaminants is also important. But it can be difficult to use this information because, in many cases, environmentally related diseases such

as cancer do not appear until after decades of exposure.

Due to the complexity of the relationships between chemicals or microorganisms in the environment and any resulting illness, it is difficult to accurately assess the health risks from the levels of pollutants in the environment. Just because there are sources or releases of environmental pollutants doesn't mean that people are actually exposed to those pollutants. The movement and chemical changes of pollutants in the environment is often difficult to predict and varies substantially from place to place. Human behaviors, such as how much time people spend at a specific location, the exact foods they eat, and how often and how well they wash their hands, also varies from person to person and day to day. These variations in environmental processes and human behaviors make it virtually impossible to estimate accurately a specific person's level of exposure to a specific contaminant.

Actual exposure levels can be measured in individuals using bio-monitoring such as blood tests, but this can be very costly. Even in these cases, it can be difficult to know the risks associated with a specific exposure. For many contaminants, there is still little understanding of the precise relationship between exposure and disease. Most of the data describing the health effects of chemicals were generated using animal testing, not from observations made on people. Furthermore, the way that people are affected by chemicals and other hazards will vary from person to person due to differences in genetics, nutrition, and physiological processes. As a result, in most situations it is not possible to state precisely the extent to which a specific environmental hazard is affecting public health. Nevertheless, each type of indicator is useful for measuring potential risk to the public and the level and effectiveness of the efforts of environmental and public health agencies to reduce these risks. Having good indicators, and the data to measure them, is essential to improving our efforts to protect public health.

Section Overview

There is no consistently agreed-upon set of environmental indicators used by public health agencies. Several federal agencies and other states have developed environmental health indicators for use by public health systems.[1,2,3,4,5] In addition, some local health departments and community groups have developed environmental health indicators.[6,7] In the following chapters, indicators are presented for the following topic areas:

- Drinking Water Quality
- Foodborne Illnesses
- Shellfish Safety
- Pesticide-Related Illness and Injury
- Outdoor (Ambient) Air Quality
- Indoor Air Quality
- Other Issues in Environmental Health
- Children's Environmental Health

We focused on these topic areas because they are important environmental health issues for Washington, sufficient data are available to construct useful indicators, and the Department of Health has a role in addressing the issue. The chapter "Other Issues in Environmental Health" presents information on a number of other important environmental health topics for which there were limited data to construct indicators. Topics covered include Area-wide Soil Contamination, Environmental Radiation Assessment, Hazardous Waste Sites, Illegal Drug Manufacturing Sites, Persistent, Bioaccumulative and Toxic Chemicals, Recreational Waterborne Illness, and Zoonotic Disease.

Highlights

The field of environmental health is as old as public health itself, and the work of the early sanitarians more than 150 years ago remains the same today: ensuring clean air, water, and food. Highly developed environmental programs have been implemented to address these problems, and overall, these systems are working well. Of more than 4,000 public water systems, about 99% deliver safe, high-quality drinking water to five million Washington residents every day. There have been vast improvements in ambient (outdoor) air quality. In 1990, about half of the state's population lived in areas that did not meet the national air quality standards for carbon monoxide and ozone; today all areas of the state meet these primary air quality standards.

The number of reported foodborne illness outbreaks continues to drop, but a lack of reporting of such outbreaks may contribute to this trend. Just

maintaining a low number of outbreaks per year may be a sign of success, considering that most foodborne outbreaks result from poor food handling practices, and preventing such outbreaks depends on good training of the more than 150,000 food handlers and careful inspections of the more than 48,000 permanent and temporary food service establishments in Washington State. Preventing over-exposures to pesticides among workers also relies primarily on the actions of workers, from proper application techniques to the daily use of protective equipment. While there is always room to improve how consistently these practices are followed, the number of pesticide over-exposures among agricultural workers has remained relatively constant over the past five years, even though recent improvements to the way that such cases are tracked is thought to have reduced the number of cases that were missed.

There have also been significant ongoing improvements in the protection of shellfish beds. The number of beaches classified as "open" (with safe water quality) for recreational shellfish harvesting increased from 73 in 2000 to 114 in 2006. Similarly, over the past five years, water quality improved enough so that more than 7,700 acres of shellfish beds were allowed to re-open. This was three times more acreage than had to be closed due to deteriorating quality in the same period.

As with any system—whether mechanical or human—maintenance, monitoring, and ongoing training are essential to keep things working. In these areas of environmental health activities, there have also been improvements. For example, training and outreach programs targeted to water system operators have resulted in an increase in compliance with water quality testing for nitrates from 50% in 1997 to more than 92% today. Similarly, there have been marked improvements in the training of operators of small water systems. Today, 2,686 public systems are required to have a certified operator. Of those, 98% are in compliance.

Recently, there have been changes in both air quality and drinking water quality regulations as a result of years of research indicating that current regulations are not protective of public health. The level of arsenic allowed in drinking water was lowered based on several studies that found an unacceptable risk of cancer at the previous level. Based on historical sampling records, as many as 210 of Washington's public water systems may be required under the new standard to reduce the level of arsenic in the water they provide their customers. The U.S. Environmental Protection Agency also instituted the use of a measure of fine particulates (PM 2.5) from sources such as diesel exhaust or wood stoves as an air quality standard because research has shown a strong association between exposure to these particulates and lung and cardiovascular disease. Some areas of the state will need to take steps to reduce such emissions to come into compliance with this new standard. These changes will better protect public health, but they also create new challenges for environmental and public health agencies.

While drinking water quality from community water supplies and outdoor air quality are mostly managed by government programs, there are also hazards present in our homes that can only be addressed by people taking steps to protect themselves and their families. Many of these household hazards have existed for decades and continue to be problems. For example, the number of residential pesticide poisonings has increased each year since 2001. About half of these exposures occurred to persons when mixing or applying the pesticide; a third of the cases concerned people who were indoors and not involved in the pesticide application. Seventeen percent of those affected were children younger than ten.

Children are a particular concern, as their body size and behaviors often lead to greater exposures to contaminants than adults experience, and their physical and cognitive development can be permanently affected by even low exposures. Many of the hazards facing children are found in the home and preventable by simple actions. Injuries from acute poisoning is the second leading cause of injury requiring hospitalization for Washington children. In Washington, about 1 percent of young children who are tested have elevated blood lead levels. While this rate of lead poisoning is lower than many other states, it still represents more than 5,000 children younger than six who may be at risk of cognitive deficiencies from exposure to environmental sources. Many children and teens are routinely exposed to second-hand smoke. According to two surveys, 10% of adults allow smoking in their homes, and about half of 10th-graders surveyed had been exposed to second-hand smoke during the previous week.

The population of Washington, and its economy, continue to grow. By itself, this growth leads to increases in the amount of pollutants released into

the environment. The most striking example is emissions from vehicles. Exhaust from diesel engines is of particular concern because it contains both fine particulates and hazardous air pollutants. The amount of diesel sold in Washington has tripled since 1981. People who live near large urban highways—as nearly two of every three Washington residents do—are exposed to higher levels of diesel exhaust.

Long-term population pressures are also contributing to environmental health problems. Many researchers believe that emissions of carbon dioxide are leading to a general increase in global temperatures. Such changes can make existing problems worse. For example, an unusually warm summer in 2006 led to unhealthy levels of ozone in several communities and an increase in cases of illness due to *Vibrio parahaemolyticus (Vp),* a naturally occurring bacteria whose levels increase during warmer temperatures, both in the water and in oysters harvested from those waters. Contaminated water at inland lakes, where the water quality at bathing beaches is not monitored, can also cause waterborne illness outbreaks that typically affect young children.

Over the past five years, much work has been done to understand better the levels and sources of chemicals that persist in the environment. The Washington State Legislature passed legislation in 2007 to help reduce the amount of polybrominated diphenyl ethers (PBDEs), a flame retardant, in consumer products. Other persistent chemicals used in consumer products, such as perfluorooctanoate (PFOA), are under scrutiny. Important data gaps persist in the actual levels of exposure to such chemicals in people. Bio-monitoring is a powerful tool for understanding the levels of exposure, but it is costly and there are no programs for conducting these analyses. As shown in Figure 2, data on hazards, exposures, and health outcomes guide environmental health actions to protect public health and prevent problems before they occur.

Disparities

While it is difficult to assess racial, ethnic, or socioeconomic differences in environmentally caused illness, there are many situations where groups face greater exposures to environmental hazards or live in closer proximity to sites that release environmental pollutants. The term "environmental justice" was coined to describe such disparities.

The Washington State Board of Health defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[8] This definition focuses on the practices that assure all citizens are afforded equal protection from environmental risks.

The reasons underlying a lack of environmental justice are often complex and include differences in land use and land value patterns, overall differences in economic status, food consumption practices, and variations in other behaviors between groups from different racial or ethnic backgrounds or different income levels. While there are few data available for the indicators presented in the following chapters that can be used to assess environmental justice in Washington, we do have some information on environmental disparities for a few topics.

Farm workers, the vast majority of whom are Hispanic, face higher risks of pesticide-related illness than the rest of the population. American Indian and Alaska Native populations and some Asian and Pacific Islander communities face higher than average exposures to contaminants in fish and shellfish because their traditional diets are rich in these foods. Blacks and Asians and Pacific Islanders live predominantly in urban areas, and as a result, a higher proportion of these groups are exposed to higher levels of air pollution. Limitations in assessing such disparities lie in part in the lack of health outcome data for environmentally related diseases and the complex relationships described above, among release of pollutants into the environment, exposure to individuals, and subsequent health problems.

Interventions

Most people live in groups and share the same air, food, water, and physical space. If one person in a group is exposed to an environmental pollutant, then it is likely that other people will also be exposed. Environmental health problems are public health problems. Environmental and public health agencies protect public health by:

- Providing information to residents about the levels of environmental pollutants and what they can do to reduce their exposures

- Managing and regulating releases of contaminants in the environment
- Monitoring the level of contaminants in the environment
- Ensuring that products for human consumption (such as drinking water and shellfish) are safe
- Tracking personal behaviors that affect exposures (e.g., fish consumption patterns), exposure levels in people (e.g., bio-monitoring), and specific illnesses known to be related to environmental exposures (e.g., pesticide-related illness or foodborne outbreaks)
- Preventing harmful exposures by using toxicological, epidemiological, and clinical data, along with information about people's exposures (e.g., risk assessment), to support environmental regulations or other actions.

Historically, environmental health efforts have focused on controlling the release of contaminants into the environment, keeping contaminants out of food, water, and shellfish, and cleaning up contaminated sites. Today, many of the emerging issues are problems of "low-level" widespread contamination, such as arsenic and lead in soil and methyl-mercury in fish from the historical use of persistent chemicals. These problems are extremely difficult to clean up using traditional approaches.

New strategies focus on the best ways to minimize exposure to these contaminants through simple, low-cost management practices and/or changing people's behaviors. While this approach might be the only feasible means of reducing the risk of health problems, it shifts the responsibility for action from the government to the individual. To make this approach work, environmental health practitioners need a better understanding of how to elicit long-term behavioral changes to reduce potential hazards that cannot be resolved through government regulations or oversight. At the same time, governmental agencies must continue to work on programs and legislation to reduce the release of contaminants over the long-term. Issues such as climate change and the effects of our "built environment" pose even more difficult challenges for environmental public health, as actions, or the lack thereof, in places far from our state pose risks to our health and the health of our children. Addressing these risks will require environmental and public health workers to find creative ways to raise awareness and translate scientific evidence into actions that protect the public's health.

Endnotes

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