Comprehensive Environmental Public Health

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Typically, people thinking about environmental health focus on how the environment can affect the four key physiological factors: air, water, food, and shelter. However, the environment can have a much broader impact on human health through changes to security, and personal and endogenous factors, such as genes, age, and past medical history. Every change in an external environmental factor can affect a broad array of diseases and alter morbidity and mortality in a population, sometimes in unpredictable ways. Our nation's disease burden is due to numerous causes, and we must address the complexity of the environment in which we live in a comprehensive way if we are to make significant strides in reducing morbidity and mortality. Addressing single issues undoubtedly will help to reduce health risks, but not nearly as well as addressing a much broader range of exposures that can harm an individual.

The human body consists of a series of interconnected systems. At the highest level is the entire human, where our major concerns are overall morbidity and mortality and general health. As defined by the World Health Organization, health is not merely the absence of disease or infirmity; rather, a healthy human being is one in a state of complete physical, mental, and social well-being.[1] To achieve this state, our organ systems must function properly, doing their jobs to provide oxygen and nutrients to the body and to mount a comprehensive defense against environmental agents and pathogens that would otherwise overwhelm us. Paracrine, autocrine, and other signaling processes must function according to plan. Each cell contributes to this interplay, and for each cell to function properly, the intricate intercellular biochemistry that drives that function must be maintained and balanced. This happens through a complex array of organelles and intracellular components that form their own system, with each cell type in each different organ of the body maintaining its own special biochemistry. This cellular machinery comes about as a function of genetic and epigenetic controls during development and then functions throughout the life of that cell. Molecular control mechanisms under genetic control are subject to changes in nutrition and other environmental factors. Hence, from the molecular level to the functioning of the whole, humans are very complex biochemical reactors that have to be maintained throughout a lifetime.

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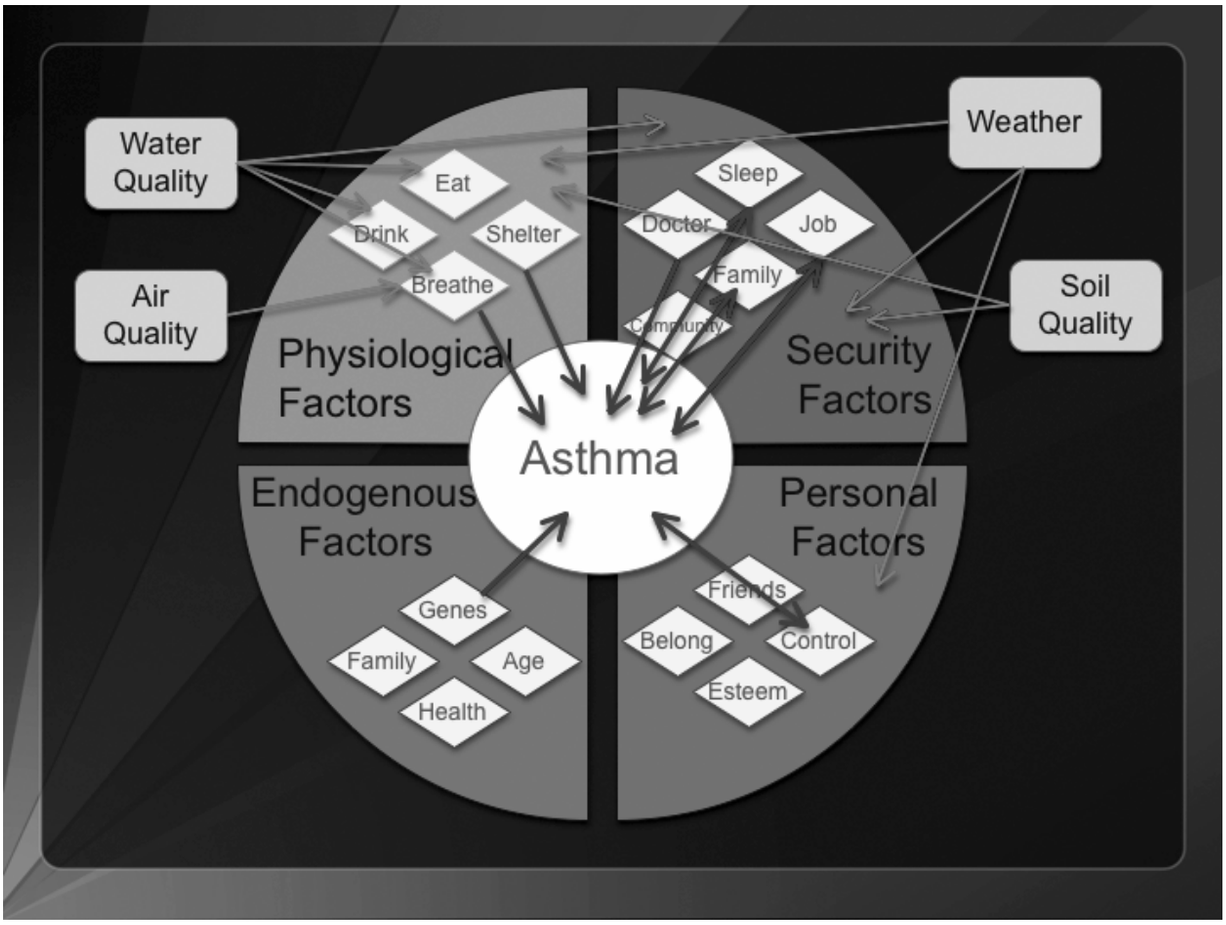
However, because humans do not fully control the environments in which they live, they cannot perfectly maintain the physical systems that support them. Our environment has four basic components that can interfere with and alter human systems and thus increase morbidity and mortality. Our basic physiological needs—air, water, food, and shelter—are key to maintaining health. Two other aspects of the physical environment also can play a key role in sustaining human life—global and local ecosystems and space-related ecosystems. Global and local ecosystems allow for nutritious food, clean air, clean water, and the ability to shelter when necessary, thus supporting our physiological environment. Space-related ecosystems refer to the sun, which provides energy as well as harmful radiation, and gravity, which we use to move about and function. A final component of the environment we live in that can play a crucial role in maintaining health in a modern society is the social environment. The social environment constitutes those elements of our built environment that allow us to work and play, maintain relationships, govern our behavior, and develop as the social animals that humans really are.

Let's consider an example of how complex the interplay between environmental components and disease can be. Asthma is a chronic inflammatory disease affecting the respiratory system. It is a recurring condition characterized by episodes of airflow obstruction and bronchospasms that lead to wheezing, coughing, chest tightness, and shortness of breath. The disease affects millions of children and adults in the U.S. and worldwide.

In children, we now know that the frequency of asthmatic episodes is not simply the result of genetic predisposition to asthma and pollen and dust in the air, but is linked to the interplay of environmental factors affecting the child (Figure). For example, the quality and the type of shelter in which the child lives can be

Figure. Childhood asthma provides an example of the interplay of environmental factors and their impact on human health. External forces in the physical environment can effect changes in physiological, security, and personal factors, which can also have a tremendous impact on a child with asthma.



associated with other exposures that have an impact on the quality of a child's life, affecting the immune system and the child's ability to fight exposures and avoid a prolonged attack. Access to health care has been shown to have a significant effect on the length and severity of asthma attacks. A child's ability to get sufficient sleep, support and care from family members, and sufficient financial resources are security factors that also can alter asthma prognosis. In addition, the asthma itself can have an effect on these security factors and leave the child vulnerable to asthma attacks. Finally, prolonged illness can significantly reduce personal factors such as self-esteem, leaving a child depressed, greatly stressed, and once again vulnerable to increased frequency and severity of illness. All of these factors interact either to improve or reduce a child's ability to fight the illness and live a healthy life.

External forces in the physical environment can effect changes in physiological, security, and personal factors, which can also have a tremendous impact on a child with asthma (Figure). Clearly, air quality is an important factor. Numerous studies have demonstrated the impact of air quality on the frequency and severity of asthma episodes. But water quality and availability, natural disasters, degradation of ecosystems, soil quality, and chemicals in the environment can also play a major role. For example, reduced availability of potable water can reduce the quality of the water we drink, food we eat, and even the air we breathe, thereby increasing a child's vulnerability to asthma. Soil quality can affect all of the physiological and security factors, and natural disasters can change everything for a child with asthma. Hence, asthma is a disease susceptible to environmental change in numerous interconnected ways that need to be understood and managed appropriately if we are to provide a child with asthma the ability to grow, develop, and overcome this disease.

Some, if not all, of these same factors are involved in other chronic diseases such as cancer, cardiovascular disease, diabetes, chronic obstructive pulmonary disease, and birth defects. Perhaps with the exception of cigarette smoking, no single environmental issue in the U.S. drives any specific disease risk. Instead, our rates of disease are due to numerous causes; thus, the effective practice of environmental public health calls upon us to address the environment in which a person lives in a comprehensive way if we are to make significant strides in reducing morbidity and mortality. This type of response requires three areas of emphasis:

1. Surveillance and tracking: The nation needs to do a better job of tracking disease incidence and outcomes, and link this to exposures at the local level. To truly understand the interplay between changes to our environment and human health, we need data collected continuously that monitors environmental factors (not just food, air, water, and housing, but the other environmental factors described previously), environmental exposures, and human disease rates. Such a system should be aimed at the local level, if not the individual home, and should include biomonitoring data to better characterize individual exposures. The Environmental Public Health Tracking Network at the Centers for Disease Control and Prevention's National Center for Environmental Health[2] is a good start, but it will need expansion if we are to really be able to use these data to understand complex interacting exposures.

2. Research: Having data is not enough. We also must extract knowledge from these data to take appropriate actions. This will require the analysis and interpretation of the surveillance and tracking data in ways that allow us to build models that can estimate disease risks in real time; predict trends in the data that can be used to optimize personal, local, state, and national strategies; and suggest hypotheses that can be followed up through additional scientific studies.

3. Implementation: Translating knowledge about environmental health risks into active strategies to reduce health risks is always a challenge. Regulations are useful and should be continued where appropriate. However, much of what protects and enhances our health happens at our kitchen tables. The everyday, personal choices we make about such factors as the quality of our indoor air, the types of food we eat, whether we smoke or drink alcohol, and whether we filter our water can have a profound effect on our health. Devising ways that empower people to create a healthy environment in which to live is a challenge that will need to be addressed.

In summary, comprehensive environmental public health uses comprehensive information on human environments linked to surveillance data on human diseases to better understand and control hazards, personal choices, and other factors and their interactions in ways that will improve public health. Creating such a comprehensive practice will require discontinuing activities that look at the environment through "stove pipes" and embarking on activities that build upon a

complex, interactive discipline that relies on science, economics, and common sense to improve public health. Only through approaching environmental public health in a comprehensive manner will we ever create sustainable healthy human environments.

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