

Can disease ecology account for non-infectious diseases?

Disease ecology takes into consideration a broad spectrum of factors comprising the tapestry of a human being's day-to-day life experience. A disease ecology perspective is one that places human health within the context of a human being's interactions within a wide array of environments. These include the physical environment that surrounds us as well as the social and cultural environments all humans are influenced by and participate in. If we were to think of each of these environments as vast planes, then the life of a human being can be represented by the line formed at the simultaneous intersection of these environmental planes. With this image, we are able to better illustrate the idea that a human's state of health and well being is determined by the collective influence of all environments he or she is a part of. Thus, no one environment can be singled out and no one neglected if we are to paint a fair and balanced picture of health and disease propagation.

Environmental influences do not solely determine health. One must not forget that humans have agency and personal responsibility in their health outcomes. The disease ecology perspective emphasizes the role that human behavior plays in continually shaping environmental conditions which in turn affect human health, for better or for worse. For example, human behavior is responsible for technological interventions into the physical environment, allowing for the continued growth and persistence of human civilization in even the harshest of climates. But, on the other hand, these same technological interventions have allowed for the creation of unsanitary and overcrowded urban environments that have multiplied disease prevalence. Another example is the health of populations in sub-Saharan Africa where masses of displaced people are continually forced to migrate into sparsely inhabited areas as a result of war and strife. These migratory populations are besieged by increasingly virulent outbreaks of malaria and trypanosomiasis from their exposure to disease from remote animal population reservoirs spread by large mosquito and tsetse fly populations serving as vectors for new disease strains for which the human populations possess no natural or inherited immunity. Older disease ecology models that focus primarily on human-habitat interactions are quite successful in understanding how phenomena such as human migrations into remote landscapes and overcrowding in poorly-sanitized urban settings spread disease. These earlier disease ecology perspectives focused primarily on explaining the rise, fall, and distribution of infectious diseases such as influenza, malaria, yellow fever, plague, smallpox, and similar diseases transmitted by vectors or through the spread of microbes in a given area over a period of time. As such, traditional disease ecology has primarily been concerned with the transmission and spread of infectious diseases. But what we are interested in knowing here is whether or not a broader disease ecology perspective is capable of explaining the occurrence and prevalence of *non-infectious* diseases as well.

Meade and Erickson have formalized such an expanded disease ecology idea by modeling the collection of environments humans are exposed to as the "triangle of human ecology." In this model, habitat, population, and behavior each occupy one of the three vertices of a triangle, with a human being's state of health located somewhere within the enclosed space. Meade and Erickson take these three categories as broad, elastic characterizations of the various aspects of human life. I will look at each of these categories in turn and discuss the human's role in each.

A most basic starting place is to consider the surrounding habitat of a human, the first vertex on the triangle of human ecology. Three distinct habitat spaces fall under this heading: the natural environment, which consists of surrounding topography, water, plants, animals, and climate conditions; the built environment, which consists of the urban and residential landscapes in which people live and work; and finally the social environment, which consists of the groups, relations, and societies within which people live. All humans are constantly interacting with each of these habitats, each to varying degrees.

The second vertex on the human ecology triangle is population. This is concerned mainly with the genetic influences that are passed on from generation to generation within a given population. Here are where factors such as gender, age, race, etc. can be incorporated. Unlike the other two categories of disease ecology, humans are not able to exert any control over the factors considered under the population category. This is for the simple reason that each of us are born with a certain set of genes that, aside from possible gene therapy interventions, we cannot change. With these genes come predispositions to developing certain diseases and resistances to others.

The third vertex on the human ecology triangle is behavior. This is one of the important features of the disease ecology perspective because human beings are seen not as passively relating with their environment but rather as actively exerting influence over their natural, built, and social environments. Under this heading is also incorporated the uniquely human trait of cultural expression. From culture, belief systems, values, and perceptions arise—all of which help to shape the way in which human beings choose to interact with their environment.

All three aspects—habitat, population, and behavior—interact together and shape one another. This expanded disease ecology model has significant advantages over the older models that looked primarily at human-landscape interactions responsible for the spread of infectious diseases. Yet, the question remains: is this broad disease ecology perspective flexible and comprehensive enough to be able to explain the origins and prevalence of non-infectious diseases? The answer, I believe, is yes. Disease ecology accomplishes this in several ways. First, a disease ecology perspective takes into account many of the slow, perpetual aggravating assaults from the environment that threaten health. These assailants (such as pollutants and toxins) can accumulate in the air we breathe, the water we drink, and the food we eat. Second, a disease ecology perspective can account for dietary-induced diseases such as malnutrition and obesity that arise from nutritionally deficient or unbalanced food consumption. A political ecology perspective, which will be defined later, can provide greater insight into the causes of these and other diseases. Finally, disease ecology can help us to better understand the range of factors implicated in cardiovascular disease, which continues to be the highest cause of mortality in the developed world.

The disease ecological perspective takes into account assaults from the surrounding environment that pose a major threat to human health. Pollutants and toxins come in all forms and exist in both the indoor and outdoor environments of our habitat. Examples include everything from lead-based paints, asbestos fibers, and second-hand cigarette smoke to automobile engine NO_x emissions, industrial smoke stack exhaust, and radioactive waste. Basic science and epidemiological research has demonstrated strong links between the pollutants and toxins to which human populations are exposed and the increased incidence and prevalence of many non-infectious diseases within those populations. According to studies conducted in U.S. metropolitan areas by Dockery et. al., fine-particulate pollutants such as dust, soot, smoke, and tiny droplets of acid cost tens of thousands of lives annually in the United States. These and other inhaled pollutants have been linked to increased risk for developing lung cancer, cardiopulmonary disease, and respiratory ailments such as bronchitis, asthma, and emphysema. Those living in the developing world are exposed to an even greater range of pollutants and are facing great health risks from environmental degradation due to industrialization. For example, dirty, polluted, and unsanitary water in many poor countries is to blame for the deaths of 2.2 million people a year. As countries in the developing world move to greater levels of industrialization and petroleum consumption, they would do well to learn from the pollution mistakes that the developed world has made in the past.

In addition to pollution, dietary habits significantly affect the health outcomes of a society. What foods enter into a regional diet is dependent both on cultivation conditions of the local landscape (habitat) and how the cultivated food is cooked and prepared (behavior). A particularly telling example of how unfortunate consequences in both local landscape and food preparation practices combined to produce extremely high rates of esophageal cancer comes from the people who live in the valley of Lin Shen in China. At one time in the late 20th century, the incidence of esophageal cancer in this region of northeast China was higher than anywhere else in the world. Approximately one out of every four people would contract cancer of the esophagus, and many others had esophageal hyperplasia. When a team of Chinese scientists was sent in to investigate what might be causing this epidemic, they identified a combination of dietary and landscape factors. They discovered that several components in the regional diet, when combined together in the stomach, created conditions that allowed the production of endogenous nitrosamines. Nitrosamines are a family of known carcinogenic compounds that are the end products of reactions between three types of chemicals—nitrates $R_x(NO_3^-)_y$, nitrites $R_x(NO_2^-)_y$, and amines RNH_2 . These chemicals were found in various components of the Lin Shen diet and gradually accumulated in abnormally high quantities in the people's digestive systems over the course of their lives. Three of the main dietary sources of these chemicals were identified as high levels of nitrates in the local well water, high levels of nitrites in the cultivated plants due to low levels of molybdenum in the topsoil, and finally high levels of amines produced by fungi grown on moldy bread (a local delicacy) as well as other fungal sources that were part of the local diet. From this example, it is clear how regional diet when viewed from a disease ecological perspective can lead to dramatic health outcomes.

Other examples of non-infectious diseases that are a result of poor diet are malnutrition and obesity. In order to fully understand these diet-based diseases, we must expand the notion of disease ecology that we have used thus far. From the examples we have discussed, the goal of disease ecology can be simply understood as the building of an explanatory and dynamic set of models that collectively reveal the intricate web of factors involved in disease incidence, proliferation, and distribution. Disease ecological thinking can further advance toward this goal through the inclusion of a political ecology model of health and disease. A political ecology perspective takes into consideration how local, regional, and global economies interrelate and how the political forces that drive economies affect the social distribution of wealth, goods, and access to services. A population's access to health care and ability to create health care infrastructure are economically and politically driven phenomena because they both entail the exercise of labor in exchange for the flow of capital to compensate for goods and services rendered. When investment capital and collective surplus wealth resources are inadequate within a geographic region or a socioeconomic subgroup, population health suffers and the levels of both infectious and non-infectious diseases rise. Thus, an unequal distribution of wealth results in a large fraction of the world's population receiving far less health care and treatment when compared to a much smaller fraction that receives a far greater level of treatment and care.

Before returning to our topic of non-infectious diseases, it would be helpful to illustrate the power of a political ecology perspective in the realm of infectious diseases. An all-too-clear example of the maldistribution of health care as a function of social and economic inequality can be seen in the case of the massive spread of the HIV/AIDS epidemic, a topic that Paul Farmer has written on extensively, most notably in *Infections and Inequalities* where Farmer chronicles his personal experiences with the emergence and mass proliferation of HIV in Haiti from his perspective as both a physician and a medical anthropologist. When looking at the catastrophic pandemic of HIV, the traditional disease ecology models fall miserably short. Even while accounting for landscape, lifestyle, and habitat conditions conducive to the spreading of the viral agent, these ecological models only give limited insight into the reasons behind HIV's spread and distribution which, in Farmer's words, "tracks along steep gradients of power" (91). In other words, traditional disease ecology's greatest deficit lies in its sheer inability to explain the radically unbalanced distribution of HIV incidence and prevalence across socioeconomic and politico-geographic lines. HIV seropositive cases are found far more frequently in the human populations that lie on the poverty-stricken and underdeveloped sides of these lines, with the hardest hit groups being those at the lowest end of the spectrum. By and large, the unaffected populations do not possess any kind of heightened immunity to infection by the HIV virus. No matter how many new anti-retroviral cocktails or chemotherapies are developed for HIV and AIDS, these precious products of the academic arena and the pharmaceutical industry will do no good if they are unable to reach the populations most afflicted. Millions in the developing world simply do not have economic accessibility to these life-extending products of scientific research.

With this politico-economic perspective on health and disease in place, much can be understood about the distribution and prevalence of many of the devastating infectious diseases of our modern day like HIV and TB. Similarly, this same politico-economic knowledge is able to inform investigations into the occurrence and distribution of many non-infectious disease patterns. Excellent examples of this are the dietary-influenced diseases of malnutrition and obesity, the former a disease of scarcity and the latter one of excess. At the most basic level, extreme malnutrition has a clear political ecological interpretation because those suffering from severe hunger and starvation simply do not possess the social and economic capital necessary to obtain or produce food. Food sources that are available in a region are dependent upon what local cultivation conditions allow and what can be obtained from regional, national, and international trade. When local cultivation is crippled by drought or imported food supplies are blocked by an external political trade embargo (as the people of Iraq have suffered from since August 1990), a severe humanitarian crisis can arise. There is simply an insufficient amount of food surplus present to handle the waves of drought and famine that periodically arise. In the 1960's, a World Bank backed program known as the Green Revolution was initiated. Its mission was to distribute high-yielding genetically modified seeds for poor rural farmers to plant in developing countries. The program initially distributed seeds of staple grains such as wheat and rice with corn, coffee, and sorghum added later. While this allowed temporary relief from famine for many populations, the program led to increased malnutrition in the long run. Due to their status as high yielding cash crops, the distributed seeds were grown in large monocultures that filled thousands of acres of previously diversely planted soil. This displaced cultivation of local food so that regional millets and vegetables were no longer grown. In addition, the loss of agricultural diversity meant that the

monoculture crop fields were far more susceptible to insect attack and so more and more pesticides and insecticides were sprayed as crop-attacking pests became resistant to chemicals. What surplus money that did come from the cash cropping was often quickly spent on alcohol, sweets, or consumer goods by these people who were unaccustomed to working within a money economy. This resulted ultimately in a severely unbalanced diet that led to malnutrition and other problems down the road. These are the politics of malnutrition and starvation.

An altogether different set of food and dietary problems is found in the populations of the developed world. The major epidemic is obesity, a disease that puts afflicted individuals at much greater risk for developing other diseases including diabetes, hypertension, arthritis, sleep apnea, and asthma. In 1999, 61% of Americans adults and 13% of children in America between the ages of six and eleven were obese. Since then, these numbers have only risen. A disease ecology picture of this epidemic would focus on the cultural and social behavior patterns of excessive, unbalanced food consumption and the lack of physical activity that have contributed to this situation. A politico-economically informed disease ecology perspective reveals other contributing factors when certain questions are asked. For example, we could ask the question: an increase in what kind of food consumption has accompanied the growing obesity epidemic? Answer: fast food. Fast food is served by highly successful, large multinational corporations with franchises in nearly every American city and town. In 2000, Americans spent \$110 billion on fast food; that's more than we spend annually on higher education and more than we spend on movies, books, magazines, newspapers, videos and recorded music—combined (statistics from Eric Schlosser's *Fast Food Nation: What the All-American Meal is Doing to the World*). A follow-up question could then be posed: are there groups in society that consume more fast food than others, and if so, are they more obese? These kinds of questions are indeed answerable. Studies have shown that there is a higher density of fast food chains in geographic regions of lower overall socioeconomic status when compared to regions of higher SES. Such inquiries as have been posed here will undoubtedly reveal much needed new insight into the American obesity epidemic.

Closely related to the obesity epidemic in the U.S. is the high rate of cardiovascular disease which ranks as this country's number one cause of mortality. Here is a disease epidemic for which risk factors are many, causal forces subtle, and impacts gradually accumulating. Here is also an epidemic for which disease ecology can be valuable in better understanding. This is due to disease ecology's strength in viewing the instigating elements arising from several aspects of life all at once, integrating them together, and finding overall environmentally-influenced patterns of behavior to account for disease. In the case of cardiovascular disease, the variety of factors that place one at risk for developing CVD in middle to late adulthood include psychological stress, a diet high in cholesterol and lipids, and a sedentary lifestyle. Already we have seen what factors lead to poor diet and exercise. Let's examine the origins of stress more closely. The psychological stress generally arises from the 8-12 hours every day of the week that most Americans spend in an often stressful work environment. This continues almost year round because of the lack of vacation or holiday time that Americans take. A recent statistic published in *Business Week* showed that America ranks behind Italy, France, Germany, Brazil, Britain, Canada, South Korea, and Japan in average annual holiday time. In many instances, even the small amount of vacation time allotted is left unused. The work environment can be particularly stressful when one feels unable to exert any control over one's working conditions. Guidelines such as the number of hours that must be put in, what rules must be followed, and what quotas must be reached are all externally determined. In these types of situations, one feels devoid of any kind of internal locus of control, and psychological stress levels are high. Even the lack of space that an employee is given (and here I am thinking of the cubicle-dwellers from the *Dilbert* comic) can be source of stress. Another source of stress that must be mentioned is the constant struggle simply to earn enough money to survive that the chronically poor and destitute face. It should certainly come as no surprise then that CVD affects the ranks of the poor in greater numbers than it does the wealthy. This increased incidence of CVD in socially marginalized groups also has much to do with their lack of access to quality health care.¹

¹ Of course, stress is not the only culprit for CVD. American culture is the great culture of consumerism. And cardiovascular disease is a disease of consumerism. We are driven to the accumulation of consumer and material goods for which we have little free time to enjoy because we are consumed by work. All this consumption leaves little time to enjoy and relax, and a preoccupation with a mass media leaves little time for attention to be paid to improving exercise patterns and eating well.

Disease ecological thinking is indeed a powerful paradigm. I have attempted to show here that disease ecological thinking can help us to better understand the ensemble of factors that contribute to non-infectious disease propagation, and why certain groups over others are affected by these diseases. Disease ecology can also be an avenue by which we can understand how health can be maintained and improved. Indeed, eating a balanced diet and taking more free time from work to relax can be positive, health improving interventions. Disease ecology helps us become aware of these sorts of interventions, and ultimately it helps us remain conscious of the larger web of factors continually shaping our lives.

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And basically all my readings I have done and videos I have watched so far...