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Abstract

Ecology pertains broadly to the relationships between organisms and their environments. The field of ecology and health examines the influence of conditions in the physical and sociocultural environment on the physiological, social, and emotional well-being of individuals and groups. The present article traces the development of research on ecology and health, beginning with the emergence of the ecological paradigm in the biological sciences and its subsequent development in other disciplines, including sociology, psychology, and public health. Recent interpretations of ecology as it applies to human health emphasize a perspective that acknowledges humans as an integral and interdependent part of the larger global ecosystem.

Ecology and Health

The term 'ecology' pertains broadly to the interrelations between organisms and their environments (Hawley, 1950). From its early roots in biology, the ecological paradigm has evolved within several disciplines (e.g., sociology, psychology, economics, and public health) to provide a general framework for understanding people's transactions with their physical and sociocultural surroundings (e.g., Barker, 1968; Bronfenbrenner, 1979; Park et al., 1925). The field of ecology and health examines the direct and interactive effects of conditions in the physical and sociocultural environment on the physiological, emotional, and social well-being of individuals and groups (cf Duhl, 1996; Moos, 1979; Stokols, 1996). Ecological analyses provide more integrative and comprehensive explanations for the joint influence of biogenetic, psychological, behavioral, sociocultural, and physical environmental factors on human well-being, than do narrowly gauged biomedical, behavioral, and environmental theories.

Emergence of Ecological Perspectives on Health and Illness

The emergence of an ecological paradigm for understanding the determinants of health and illness in human populations can be traced to research developments in several scientific fields. During the 1920s and 1930s, a series of correlational analyses were conducted by researchers in the Chicago School of Human Ecology, revealing systematic associations between community rates of illness and crime on the one hand and physical and social conditions of the urban environment (including poor-quality housing and high population densities within residences and neighborhoods) on the other hand (cf Faris and Dunham, 1939; Park et al., 1925). These correlational studies in the fields of human ecology and sociology suggested a strong link between conditions of the urban environment and residents' health, but did not provide an integrative theoretical account of the causal pathways connecting those variables.

An important theoretical analysis of the links between the social environment and illness etiology was provided by John Cassel in the field of public health. Cassel's (1964)

conceptualization of social epidemiology signaled a shift from 'germ-theory' accounts of health and illness (focusing on the health-impairing effects of specific pathogens once they invaded a human 'host'), toward a more ecologically oriented, contextual perspective emphasizing the effects of one's social environment (e.g., work overload, sources of interpersonal stress) on immune functioning and host resistance to pathogenic agents. Cassel's formulation of social epidemiology during the 1960s and his hypotheses concerning the impact of social and cultural factors on human health have been corroborated empirically in subsequent studies linking job strain, social isolation, and interpersonal stress to a variety of illness conditions and premature death (cf Berkman and Syme, 1979; Karasek and Theorell, 1990; Marmot et al., 1997).

Incorporation of the ecological perspective into areas of health promotion initially perceived as rooted in individual behavior and therefore best targeted by individual-focused behavior change strategies has led to an ecological approach to public health. Publication of the US Surgeon General's Reports in 1964 and 1979, documenting the deleterious effects of smoking on health, prompted the rapid growth of health promotion and disease prevention research during the 1980s (cf US Public Health Service, 1979). Much of the early research in this field was rooted in the concepts and methods of health education, and focused largely on behavior change strategies aimed at fostering healthier lifestyles and health habits among individuals (cf Belloc and Breslow, 1972). As appreciation for the salient role played by societal and environmental influences grew, efforts to encourage health-promoting behavior took a decidedly ecological turn, with programs such as ASSIST, an ambitious government-funded demonstration project undertaken in the 1990s to help states develop effective strategies to reduce smoking. Focusing on policy change, the goal of ASSIST was to alter states' social, cultural, economic, and environmental factors that promote smoking. Results of the evaluation of ASSIST supported the ecological hypothesis that policy-level changes can be effective for promoting changes in individual health behavior (Stillman et al., 2003).

Such targeted efforts to enhance individuals' health behaviors via an ecological approach have led to reduced use of tobacco products among adults, lower rates of alcohol-related automobile deaths, and reduced employee health costs at the

worksite (cf McGinnis and Lee, 1995; Pelletier, 1996; Schneider and Stokols, 2008). At the same time, however, the ecological approach to understanding health and disease has led to increased awareness of health risks that are strongly influenced by conditions outside of individual control, such as exposure to community violence, lack of medical insurance, environmental injustice, poverty, and unemployment. Critically, many of these health risks remain segmented in hard-to-reach 'pockets of heightened prevalence' (Fisher, 1995) – especially among low-income and minority groups in the population (cf Adler and Stewart, 2013; Bullard, 2005).

Growing recognition of the limitations associated with behavior change programs has prompted a paradigm shift in the health promotion field, away from individually focused interventions toward more comprehensive, ecological formulations that address interdependencies among socioeconomic, political, environmental, organizational, biological, and psychological determinants of health and illness (cf Kickbusch, 1989; Schneider and Stokols, 2000; Winett et al., 1989). These strategies include increased resources devoted to community policing as a method of preventing neighborhood violence (MacDonald, 2002), diversion of convicted drug users to treatment programs (Bull, 2005), and the Affordable Care Act, which utilizes a legislative approach to persuading individuals to purchase health insurance (Lavarreda et al., 2011). A common feature of these programs is that they incorporate multiple levels of analysis and intervention components – including political action, legislative reform, media advocacy, as well as behavioral change and environmental enhancement efforts – to address key contextual factors that substantially influence individual and population health.

Whereas the ecological approach to health has been informed and influenced by the principles of community health/community psychology, the former extends beyond the latter on both ends of the continuum from more proximal factors (e.g., biologic, genetic, and other intrapersonal factors) to more distal factors (e.g., global or national conditions). Community health, in which formal or informal social groupings form the unit of analysis or of intervention, may be viewed as a particular application of the ecological paradigm, which represents a "unique way of looking at the world" (Kelly, 2006). According to the ecological approach, health is "viewed as the consequence of reciprocal causation unfolding at multiple individual and environmental levels of influence" including, but not limited to, the community (cf Richard et al., 2012).

One other major development that has prompted greater interest in ecology and health in recent years is the discovery of adverse global environmental changes – for instance, the depletion of atmospheric ozone and the trend toward climate change – which have the capacity to elevate population morbidity and mortality rates at worldwide as well as regional and national levels (cf Folke, 2006; Stern et al., 1992; Stokols et al., 2009). Potential health impacts of these global changes include elevated skin cancer rates resulting from ozone depletion and individuals' heightened exposure to ultraviolet rays, and the food shortages, nutritional ailments, and respiratory illnesses associated with climate change (cf Leaf, 1989). The health consequences of extreme weather and disasters, expected to increase in both frequency and severity as the

climate shifts (IPCC, 2012), are becoming more evident as well. The discovery of these global environmental threats to population health has prompted greater international collaboration in the development of ecologically oriented health promotion programs through programs such as the World Health Organization (WHO) Healthy Cities Program (cf Ritsatakis, 2012) and the WHO work plan on climate change and health.

Core Principles of Ecology and Health Research

Research on ecology and health encompasses several disciplines, including medicine, public health, urban planning, environmental design, public policy, and the behavioral, social, and global ecology sciences. The scientific contours of this research are not easily delimited, owing to the interdisciplinary scope of the field (cf Stokols, 2000). The unique concerns of ecology and health can be better understood in terms of the overarching conceptual principles that underlie this field, rather than by searching for a clearly defined body of research organized around this topic. The core principles underlying ecology and health research are drawn largely from programmatic statements about the 'New Public Health' and the conceptual and methodological assumptions of systems theory and social ecology (cf Duhl, 1996).

Intellectual Antecedents: Systems Theory and the Ecological Paradigm

The 'New Public Health' outlined in the *Ottawa Charter for Health Promotion* (1986) called for the development of comprehensive, ecologically oriented approaches to the study and prevention of disease (cf Kickbusch, 1989). For instance, the Ottawa Charter gave explicit attention to social causes of illness, as well as the physical environmental health threats that exist in many communities. Subsequent analyses of ecology and health extended these programmatic ideas by providing a set of conceptual and methodological principles derived largely from systems and ecological theories, for organizing and evaluating community-based health promotion programs (cf Green and Ottoson, 1999; Sallis et al., 2006).

The field of ecology and health incorporates a number of concepts derived from systems theory (e.g., interdependence, homeostasis, negative feedback, deviation amplification; cf Emery and Trist, 1972; Maruyama, 1963) to understand the interrelations among people and their environments. Systems analyses suggest that the healthfulness of particular settings and the well-being of their participants are jointly influenced by multiple facets of the physical environment (e.g., geography, architecture, technology) and the social environment (e.g., culture, economics, politics). The health status of individuals and groups is further influenced by personal attributes such as genetic heritage, psychological dispositions, and behavioral patterns. From the vantage point of systems theory, efforts to promote well-being should be based on an understanding of the relationships among diverse environmental and personal factors, rather than on analyses that focus exclusively on environmental, biological, or behavioral factors (cf Moos, 1979).

Research Findings from Ecological Analyses of Health

The direct and interactive effects of environmental and personal attributes on health have been observed in several lines of research. For example, a substantial body of research highlights the ways in which poverty, inequality of income distribution, and minority status jointly undermine the health of individuals and vulnerable subgroups in the population (cf Adler and Stewart, 2013; Bullard, 2005; Kaplan et al., 1996). Other studies indicate that neighborhood socioeconomic status (percent of households in a geographic area receiving public assistance) is associated with poorer self-reports of health, above and beyond individual socioeconomic status (Malmstrom et al., 1999; Robert, 1998). Interactive effects of environmental and behavioral risk factors are exemplified by the findings that environmental exposure to asbestos exacerbates chronic smokers' risks of developing lung cancer (Grunberg, 1991), and that an individual's disposition toward exerting internal control over his/her environment buffers the potentially negative effects of low education and income on health status (Lachman and Weaver, 1998).

Systems theory also posits that people–environment transactions are characterized by cycles of mutual influence, whereby the physical and social features of settings directly affect occupants' health and, concurrently, the participants in settings modify the healthfulness of their surroundings through their individual and collective actions (or, alternatively, adopt an increasingly passive stance toward their environment). For example, individuals' routine exposure to community violence in some low-income neighborhoods can provoke feelings of disempowerment, helplessness, and depression, which in turn diminish their efforts to adopt health-promotive practices related to physical activity and dietary change (cf Sanders-Phillips, 2000). In contrast, local residents' struggles with asthma exacerbated by air pollution can motivate them to engage in community activism targeting policies that impact air quality (Garzón et al., 2012). On a societal level, economic forces have stimulated an accelerated process of urbanization and commensurate degradation of the natural environment – a change that may be associated with poorer health status and that some communities attempt to counteract with urban planning that preserves greenspace for parks (Maller et al., 2008). Accordingly, ecological analyses of health should take into account that persons and their environments are in a constant state of mutual adaptation.

Ecologically oriented studies of health also incorporate certain conceptual and methodological principles drawn from the field of social ecology (Stokols et al., 2013). For instance, ecological theory highlights the multidimensional nature of human environments. Environmental settings can be characterized in terms of their physical and social components, their objective (actual) or subjective (perceived) qualities, and their scale or immediacy to individuals and groups (proximal vs distal). Moreover, the participants in environmental settings can be studied at varying levels ranging from individuals, small groups, and organizations, to larger communities and populations. Rather than focusing solely on individuals or aggregates, the social ecological perspective incorporates multiple levels of analysis and diverse methodologies (e.g., medical exams, questionnaires, behavioral observations, environmental recordings, epidemiologic analyses) for assessing

the healthfulness of settings and the well-being of individuals and groups.

Social ecological analyses conceptualize human environments as complex systems in which local settings and organizations are nested within more complex and remote regions. Accordingly, efforts to promote human well-being must take into account the interdependencies that exist among immediate and more distant environments. The occupational health and safety of workplaces at the local level, for example, are directly influenced by state and national ordinances aimed at protecting environmental quality and public health (cf Stokols, 1992).

Another core theme of ecological theory is that physiological, emotional, and social well-being are influenced by the multiple, interrelated settings that comprise the daily activity systems of individuals and groups (cf Michelson, 1985). Bronfenbrenner's (1979) ecological model of human development highlights the joint influence of people's families, school, work, and recreational settings on their health and developmental outcomes. Rather than focusing exclusively on person–environment transactions that occur within single settings (microsystems, such as home or work environment), Bronfenbrenner's research emphasizes the ways in which functional linkages between two or more settings (i.e., the mesosystem, the exosystem, and the macrosystem) influence developmental processes and outcomes. Mesosystem units are comprised of two or more environmental settings (e.g., family and occupational environments) in which the individual is directly involved (e.g., a parent employed outside the home). Exosystems include an environment in which the developing person is directly involved (e.g., a child in his or her home environment) and one or more other settings in which that person does not participate directly (e.g., the workplaces of the child's parents), but that, nonetheless, affect his or her development and well-being (e.g., stressful experiences at work that impair the quality of parents' interactions with their children at home). Finally, the macrosystem level of analysis encompasses the belief systems, social norms, and institutions of the culture as a whole.

The joint influence of multiple life settings on individuals' health has been observed in several studies. Children's exposure to environmental stressors (such as high levels of spatial density and noise) in their home and elementary school environments, for instance, was associated with both additive and interactive effects of those conditions on their physiological health (e.g., systolic and diastolic blood pressure) and academic achievement (cf Cohen et al., 1986). In other studies, employees' perceived lack of flexibility in work hours for scheduling children's doctor visits was associated with their underutilization of employer-provided family health benefits (Fielding et al., 1994). Health outcomes associated with the work–family mesosystem have also been documented through studies of the adverse impacts of 'work–family conflict,' as well as the positive effects of spousal support in buffering work-related stressors (cf O'Neil and Greenberger, 1994).

The research findings noted earlier suggest the value of studying human health from an ecological systems perspective. By considering the joint influence of multiple life settings on individuals' well-being, a broader understanding of how

personal and situational factors contribute to health status can be achieved, than by focusing more narrowly on environmental conditions within single settings.

Directions and Challenges of Ecology and Health Research

The broad conceptual scope of ecology and health research is both an asset and a limitation. On the one hand, the breadth of ecological analyses affords a more comprehensive understanding of the multiple determinants of well-being. For instance, major political, economic, and environmental determinants of health that were neglected in earlier behavioral and medical studies yet have been targeted in more recent ecological analyses. On the other hand, so many disciplines and levels of analysis are combined in ecological research that it is difficult to achieve parsimonious explanations of health phenomena. Thus, an important challenge facing the field of ecology and health is to develop criteria for identifying the most influential determinants of wellness at particular levels of analysis (intrapersonal, social, organizational, institutional, community, global) and to give greatest priority to these high-leverage variables when designing scientific studies and community health promotion programs (see Health Education and Health Promotion).

A rapidly growing area of health research focuses on the impacts of individuals' virtual ecology on their physical, social, and emotional well-being (cf Stokols, 1999). Studies in this area have documented potential conflicts inherent in people's immersion in virtual settings and digital communications (e.g., chat rooms, multimedia multitasking, use of cell phones) while they are concurrently engaged in place-based relationships and behavior settings (cf Pea et al., 2012). For instance, the effects of perceived information overload from cybersources on individuals' self-reported levels of stress and health impairment (Misra and Stokols, 2012), and physical injuries resulting from multimedia multitasking while walking or driving, have been examined (Meyers, 2013; Strayer and Drews, 2007). At the same time, positive influences of the Internet on personal and community health, through telemedicine, telewellness, and the use of personalized mobile communications for health promotion and disease prevention have been identified (Stokols et al., 2009).

Developing High-Leverage Strategies for Effective Health Promotion

Examples of high-leverage variables and health promotion strategies include (1) the implementation of strategic corporate and public policies that can enhance population health on a broad scale (e.g., California's Proposition 99 which imposed a \$0.25 tax on each pack of cigarettes sold and thereby reduced statewide levels of smoking prevalence (cf Breslow and Johnson, 1993)); (2) the modification of 'other-directed' health behaviors enacted by corporate and public decision makers whose actions directly influence health outcomes among large numbers of their employees and constituents (cf Stokols, 1996); (3) the identification of key socioeconomic indicators (e.g., female participation in the work force,

unemployment, per capita government spending on health care) associated with rates of suicide (Milner et al., 2012); (4) the implementation of defensible space design guidelines to reduce the incidence of violence and crime in urban neighborhoods (cf Newman, 1972); and (5) the development of internet-based 'telewellness' programs designed to enhance health awareness and well-being among large segments of the population (cf Stokols, 1999).

Targeting Vulnerable Subgroups in Health Promotion Programs

An important direction for future ecological research is to incorporate the above leveraging strategies into the design of community health promotion programs aimed at improving the well-being of impoverished and underrepresented groups. Certain illness risk factors, including environmental racism, exposure to community violence, and lack of medical insurance, have proven to be highly resistant to earlier and more traditional health promotion programs (cf Bullard, 2005; Fisher, 1995). These interrelated community problems, borne disproportionately by low-income minority groups in the population, are highly complex and will be reversed only through the design and implementation of strategically leveraged, multilevel intervention programs (Winett et al., 1989), for example, the multisectoral Healthy Cities Programs sponsored by the World Health Organization (cf Ritsatakis, 2012).

Conclusions

The field of ecology and health, which grew rapidly during the last three decades, highlights the importance of developing integrative, broad-gauged strategies for promoting human wellness. As proponents of ecological analyses have noted aptly, improvements in individuals' health practices "usually require some combination of educational, organizational, economic, and environmental interventions in support of change in both behavior and conditions of living" (Green et al., 1997: p. 125). The principles of systems theory and social ecology outlined earlier provide a useful framework for establishing more integrative and effective approaches to wellness promotion in the coming decades.

See also: Environmental Health and Safety: Social Aspects; Environmental Stress and Health; Health Education and Health Promotion.

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- http://www.who.int/globalchange/health_policy/who_workplan/en/index.html – WHO work plan on climate change and health.