

CHAPTER

20

ECOLOGICAL MODELS OF HEALTH BEHAVIOR

James F. Sallis

Neville Owen

Edwin B. Fisher

KEY POINTS

This chapter will

- Provide a brief history of ecological models as applied to health promotion.
- Propose four core principles of ecological models of health behavior: (1) there are multiple levels of influence on specific health behaviors; (2) influences on behaviors interact across these different levels; (3) ecological models should be behavior-specific; and (4) multi-level interventions should be most effective in changing behavior.
- Describe applications of ecological models for health behavior research related to understanding influences on physical activity behavior and to comprehensive, multi-level interventions for tobacco control and diabetes self-management.
- Review strengths and limitations of ecological models, along with the challenges of applying them.

Ecological models of health behavior emphasize the environmental and policy contexts of behavior, while incorporating social and psychological influences. Ecological models lead to the explicit consideration of multiple levels of influence, thereby guiding the development of more comprehensive interventions.

In the past two decades, there has been a dramatic increase in interest in, and application of, ecological models in research and practice, due in part to their promise for guiding comprehensive populationwide approaches to changing behaviors that will reduce serious and prevalent health problems. The combination of environmental, policy, social, and individual intervention strategies is credited with the major reductions in tobacco use in the United States since the 1960s (Institute of Medicine, 2001), and this experience has stimulated the application of multi-level models and interventions to many health problems.

The core concept of an ecological model is that behavior has multiple levels of influences, often including intrapersonal (biological, psychological), interpersonal (social, cultural), organizational, community, physical environmental, and policy. Ecological models are believed to provide comprehensive frameworks for understanding the multiple and interacting determinants of health behaviors. More important, ecological models can be used to develop comprehensive intervention approaches that systematically target mechanisms of change at each level of influence.

Four core principles of ecological models of health behavior are proposed:

1. There are multiple influences on specific health behaviors, including factors at the intrapersonal, interpersonal, organizational, community, and public policy levels.
2. Influences on behaviors interact across these different levels.
3. Ecological models should be behavior-specific, identifying the most relevant potential influences at each level.
4. Multi-level interventions should be most effective in changing behavior.

The ultimate purpose of ecological models of health behavior is to inform the development of comprehensive intervention approaches that can systematically target mechanisms of change at several levels of influence. Behavior change is expected to be maximized when environments and policies support healthful choices, when social norms and social support for healthful choices are strong, and when individuals are motivated and educated to make those choices.

BACKGROUND, HISTORY, AND PRINCIPLES OF ECOLOGICAL MODELS

The term *ecology* is derived from biological science and refers to the interrelations between organisms and their environments. Ecological models, as they have evolved in behavioral sciences and public health, focus on the nature of people's transactions with their physical and sociocultural surroundings, that is, environments (Stokols, 1992). The environmental levels of influence distinguish ecological models from behavioral models and theories that emphasize individual characteristics, skills, and proximal social influences such as family and friends, but do not explicitly consider the broader community, organizational, and policy influences on health behaviors. Ecological models can incorporate constructs from models that focus on psychological, social, and organizational levels of influence to provide a comprehensive frame-

work for integrating multiple theories, along with consideration of environments and policy in the broader community.

Healthy behaviors are thought to be maximized when environments and policies support healthful choices, and individuals are motivated and educated to make those choices (Ottawa Charter for Health Promotion, 1986). Educating people to make healthful choices when environments are not supportive can produce weak and short-term effects, which are common. Yet just providing plentiful vegetables, sidewalks, or accessible condoms is no guarantee that people will make use of those resources. Thus, a central conclusion of ecological models is that it usually takes the combination of *both* individual-level and environmental/policy-level interventions to achieve substantial changes in health behaviors.

A general acceptance of, and enthusiasm for, ecological models as applied to health behavior is reflected in authoritative documents that guide public health programs nationally and internationally. These documents include *Healthy People 2010* (U.S. Department of Health and Human Services, 2000a), Institute of Medicine (IOM) reports on health behaviors (Institute of Medicine, 2001) and childhood obesity prevention (Koplan, Liverman and Kraak, 2005), the World Health Organization's (WHO) strategy for diet, physical activity, and obesity (World Health Organization, 2004), and the WHO Framework Convention on Tobacco Control (World Health Organization, 2003).

Historical and Conceptual Background of Ecological Models

The proliferation of contemporary ecological models is based on a rich conceptual tradition in the behavioral and social sciences. The contributions of many of these authors were described in a previous version of the present chapter (Sallis and Owen, 2002), and they are summarized in Table 20.1. Early on, there was a progression from the concept that only *perceptions* of environments were important (Lewin and Cartwright, 1951) to an emphasis on *direct effects* of environments on behavior (Barker, 1968). Many models were meant to apply broadly to behaviors, but more recent models were created for application to health behaviors and health promotion, such as those proposed by McLeroy and others (1988), Stokols and others (1992, 2003), Flay and Petraitis (1994), Cohen, Scribner, and Farley (2000), Fisher and others (2005), Glanz and others (2005), and Glass and McAtee (2006). Categories and hierarchies of behavioral influences have been described in numerous ways, from Bronfenbrenner's (1979) micro, meso, and exo environment approach to McLeroy and others' (1988) five sources of influence: intrapersonal, interpersonal, institutional, community, and policy. The first part of Table 20.1 describes models mainly designed to help explain behavior, and the second part contains models primarily intended to guide interventions. Some of the newer models are designed to be applicable to many health behaviors (Cohen, Scribner, and Farley, 2000; Glass and McAtee, 2006; Stokols, 1992; Stokols, Grzywacz, McMahan, and Phillips, 2003), while others are tailor-made for specific categories of behaviors (Flay and Petraitis, 1994; Fisher and others, 2005; Glanz, Sallis, Saelens, and Frank, 2005). This diversity illustrates the adaptability and robustness of ecological models.

TABLE 20.1. Historical and Contemporary Ecological Models.

Author, Citation, Model	Key Concepts
<i>Models designed mainly to explain behavior</i>	
Kurt Lewin (1951) Ecological Psychology	"Ecological psychology" is the study of the influence of the outside environment on the person.
Roger Barker (1968) Environmental Psychology	"Behavior settings" are the social and physical situations in which behaviors take place; concludes that behaviors could be predicted more accurately from the situations people are in than from their individual characteristics.
Rudolph Moos (1980) Social Ecology	Four categories of environmental factors: (1) physical settings—features of the natural (weather) and built environment (building); (2) organizational settings—size and function of worksites and schools; (3) the "human aggregate"—sociocultural characteristics of the people in an environment; and (4) "social climate"—supportiveness of a social setting for a particular behavior.
Urie Bronfenbrenner (1979) Systems Theory	Three levels of environmental influences: (1) "microsystem" is interactions among family members and work groups; (2) "mesosystem" is physical family, school, and work settings; and (3) "exosystem" is the larger social system of economics, culture, and politics.
Thomas Glass and Matthew McAtee (2006) Ecosocial Model	Conceptualizes hierarchies of influences on behavior within biology and society, which has social and physical environment dimensions. Structural contingencies provide opportunities and constraints, and biological processes regulate expression of behavior.
<i>Models designed mainly to guide behavioral interventions</i>	
B. F. Skinner (1953) Operant Learning Theory	Primary model is Environment→Behavior. Reinforcers and cues in the environment directly control behavior. Recently, Hovell and colleagues (2002) proposed a behavioral ecological model that draws heavily on Skinner.
Albert Bandura (1986) Social Learning and Social Cognitive Theories	Proposes environmental and personal influences on behavior. Bandura referred mainly to social environments and rarely addressed the role of physical, community, or organizational environments. (See Chapter Eight.)

TABLE 20.1. Historical and Contemporary Ecological Models, Cont'd.

Author, Citation, Model	Key Concepts
<i>Models designed mainly to guide behavioral interventions, Cont'd.</i>	
Kenneth McLeroy and others (1988) Ecological Model of Health Behavior	Five sources of influence on health behaviors: intrapersonal factors, interpersonal processes and primary groups, institutional factors, community factors, and public policy.
Daniel Stokols (1992, 2003) Social Ecology Model for Health Promotion	Four assumptions: (1) health behavior is influenced by physical environments, social environments, and personal attributes; (2) environments are multidimensional, such as social or physical, actual or perceived, discrete attributes (spatial arrangements) or constructs (social climate); (3) human-environment interactions occur at varying levels of aggregation (individuals, families, cultural groups, whole populations); and (4) people influence their settings, and the changed settings then influence health behaviors.
Deborah Cohen and others (2000) Structural-Ecological Model	Four categories of structural influences: (1) availability of protective or harmful consumer products, (2) physical structures (or physical characteristics of products), (3) social structures and policies, and (4) media and cultural messages.
Brian Flay and J. Petraitis (1994) Theory of Triadic Influence	Genes and environment are assumed to affect all behaviors, and the three streams of influence on behavior are intrapersonal, social, and sociocultural.
Karen Glanz and others (2005) Model of Community Food Environments	Proposes key constructs that affect eating behaviors: availability, price, placement, and promotion of foods, as well as nutrition information. Applies to restaurants and food stores.
Edwin Fisher and others (2005) Resources and Skills for Self-Management Model	Based on integration of individuals' skills and choices with support they receive from the social environment, as well as physical and policy environments of communities.

Principles of Ecological Perspectives on Health Behavior Change

Four core principles of ecological perspectives are proposed.

1. *Multiple levels of factors influence health behaviors.* Ecological models specify that factors at multiple levels, often including intrapersonal, interpersonal, organizational, community, and public policy, can influence health behaviors. Concepts that cut across these levels include sociocultural factors and physical environments, which may apply to more than one level. Inclusion of all these levels of influence distinguishes ecological models from theories that primarily focus on one or two levels.

2. *Influences interact across levels.* The interaction of influences means that variables work together. For example, individuals with high motivation to avoid weight gain may react differently than those with lower motivation to driving past a strip of fast-food restaurants. Education to be physically active may work better when policies support physician counseling and insurance discounts for engaging in regular activity. Because ecological models specify multiple levels of influence, and there are likely to be multiple variables at each level, it may be difficult to discern which of the possible interactions are most important. Thus, a challenge for research is to expand understanding of these interactions across levels.

3. *Multi-level interventions should be most effective in changing behavior.* A direct implication of ecological models is that single-level interventions are unlikely to have powerful or sustained populationwide effects. Many examples of interventions targeting individuals have shown short-term effects. Educational interventions designed to change beliefs and behavioral skills are likely to work better when policies and environments support the targeted behavior changes. Similarly, environmental changes by themselves may be insufficient to change behavior. Putting more fruits and vegetables in all convenience stores may have little impact unless the environmental change is supported by communication, education, and motivational campaigns.

4. *Ecological models are most powerful when they are behavior-specific.* Ecological models appear most useful to guide research and intervention when they are tailored to specific health behaviors. Often, environmental and policy variables are behavior-specific. The availability of condoms in nightclubs has little relevance to dietary behaviors, the presence of cycling trails in suburban neighborhoods is unlikely to affect alcohol intake, and policies related to food subsidies have little relevance to sun protection behaviors. The need to identify environmental and policy variables that are specific to each behavior is a challenge in the use of ecological models, because lessons learned with one behavior, for example, promoting jogging, may not translate to an apparently similar behavior, for example, promoting walking to work. Of course, some lessons learned in one can apply to others. General ecological models can be used as the basis of behavior-specific models that are needed for application to research and interventions.

APPLICATION OF ECOLOGICAL MODELS TO HEALTH BEHAVIOR

The following sections describe examples of ecological models applied to understanding influences on health behavior and guiding interventions for health behavior change.

The first example describes the recent emergence of ecological models to understand physical activity. The second and third applications illustrate the impact of multi-level interventions for tobacco control and diabetes management that were guided by ecological models.

Application to Understanding Influences on Physical Activity

Physical inactivity is one of the most significant health challenges, because of its effects on risk of major chronic diseases, mental health, quality of life, and early mortality (U.S. Department of Health and Human Services, 1996). The physical activity field has advanced from a broad recognition of the importance of environmental influences to development and testing of specific multi-level ecological models. For example, Giles-Corti and colleagues (2005) and Saelens and colleagues (2003) proposed models to highlight the different influences on recreational versus transportation physical activity, while Owen and others' (2004) model was specific to walking for different purposes. Matsudo and colleagues (2004) developed an ecological model to guide community interventions in a Latin American context.

Sallis and coauthors (2006) synthesized findings and concepts from the fields of health, behavioral science, transportation and city planning, policy studies and economics, and leisure sciences to create the ecological model shown in Figure 20.1. The model has a commonly used layered or "onion" structure to represent the multiple levels of influence, but with three distinguishing features. First, the model is organized around four domains of physical activity, reflecting the principle that behavior-specific ecological models are useful. Second, some types of relevant influences are not tied to settings where the behavior takes place. For example, information environments are ubiquitous, and counseling in health care settings can influence physical activity done elsewhere. A third key feature is that social and cultural environments operate at multiple levels. Other ecological models can be developed for specific physical activity behaviors (for example, walking to school, use of parks) and population subgroups (for example, racial-ethnic minority groups, rural residents).

It is important to test empirically the principles of ecological models and the propositions and hypotheses derived from these principles. Studies based on ecological models have recently addressed a major gap in understanding community environmental attributes. In the health and behavioral sciences field, a review by Humpel, Owen, and Leslie (2002) identified that access to physical activity facilities, and the aesthetic qualities of those places were consistently related to recreational physical activity. Saelens, Sallis, and Frank (2003) reviewed studies from the transportation and urban planning fields and found consistent evidence of more walking (and possibly cycling) for transportation among adults living in "walkable neighborhoods." In walkable neighborhoods, land uses are mixed, with homes near commercial and institutional destinations, and streets are highly connected, providing direct routes from place to place.

Most studies of environmental correlates of physical activity have not distinguished the relative importance of personal, social, and environmental influences on physical activity (Biddle and Mutrie, 2001). A few studies have examined correlates

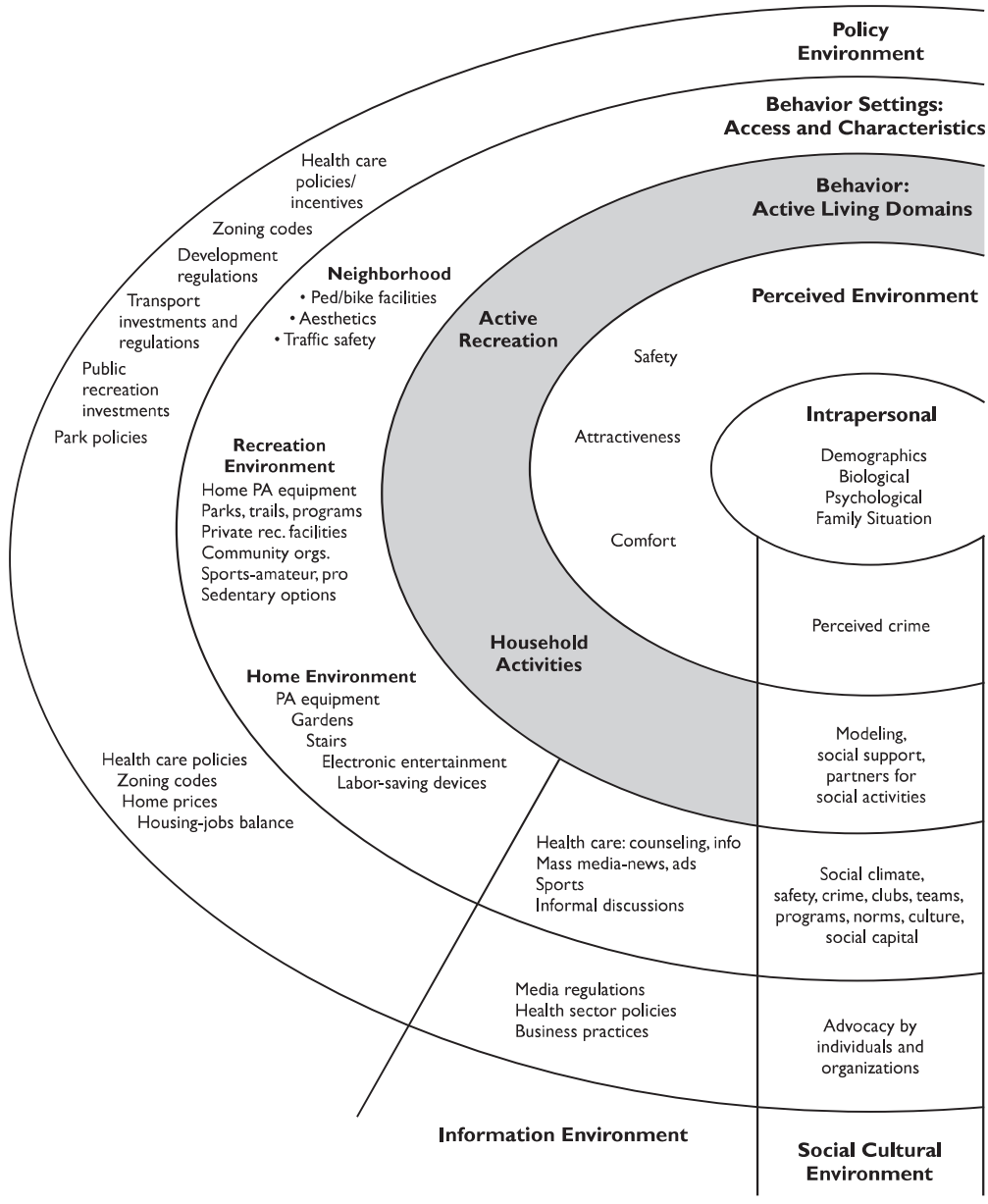
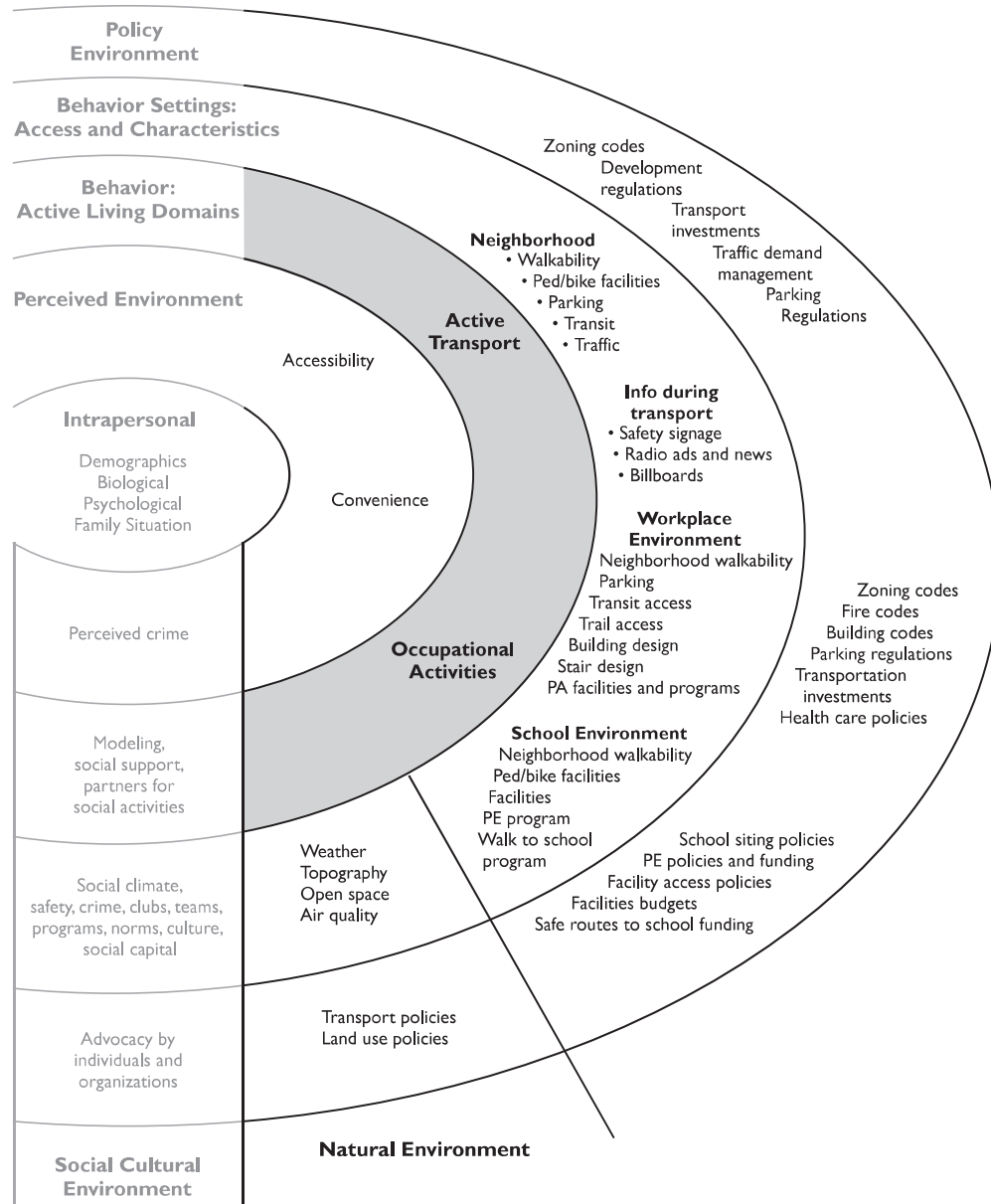


FIGURE 20.1. Ecological Model of Four Domains of Active Living.

Source: Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., and Kerr, J. (2006). "An Ecological Approach to Creating More Physically Active Communities." *Annual Review of Public Health*, 27, 297–322. Reprinted, with permission, from the *Annual Review of Public Health*, Volume 27, ©2006 by Annual Reviews (www.annualreviews.org).



of physical activity at multiple levels and found that built environment variables, such as the presence of sidewalks and nearby destinations, accounted for the least variance (De Bourdeaudhuij, Sallis, and Saelens, 2003; Burton, Turrell, Oldenburg, and Sallis, 2005; Giles-Corti and Donovan, 2002). An Australian study showed that built environment factors accounted for a modest amount of variation in walking for transport, and that such environmental factors (that is, objectively assessed neighborhood walkability) remained significant after controlling for personal attributes, such as individuals' reasons for choosing to live in their neighborhoods (Owen and others, 2007). Although recent physical activity studies appropriately focused on previously understudied built environment attributes, it is now time to examine correlates and interactions across multiple levels.

Testing hypotheses derived from ecological models presents particular study design challenges. A central problem is that there may be too little variation in social, environmental, and policy variables across units of study (Giles-Corti and Donovan, 2002). For example, a random sample from a U.S. city might yield few adults who value active transport (walking and bicycling), limited social support for walking for transportation, and few high-walkable neighborhoods. A random sample in many European cities would likely produce few participants with negative attitudes, widespread social support for active transportation, and few low-walkable neighborhoods. Within a study region, there may be no variation at all in policies related to park resources or zoning laws. Lack of variation leads to underestimation of effect sizes and inability to test some hypotheses. Thus, studies that include assessments of environmental and policy variables must be designed to ensure variation in those factors.

In summary, the rapidly growing literature on built environment correlates of physical activity complements a large literature on intrapersonal and interpersonal correlates. The next priority is to improve understanding of multi-level correlates and interactions across levels of influence, then use the findings to guide development of more effective interventions.

Application to Health Behavior Interventions: Tobacco Control

Ecological Models and Cigarette Smoking. Influences on smoking range from the brain physiology of nicotine addiction to peer pressure to smoke, household smoking restrictions, and taxation policy. At the individual level, addiction to nicotine and genetic factors contribute to persistence of smoking. These add to the effects of substantial psychological conditioning—the average smoker of a pack a day for twenty years has inhaled over a million times, establishing conditioned associations of smoking with work, relaxation, drinking coffee, and moods like anxiety and depression (Fisher and others, 2004). At the social level, parents' and peers' smoking are predictors of youth smoking (U.S. Department of Health and Human Services, 1994). Cigarettes are one of the most heavily marketed products in the United States. In 2005, tobacco companies spent \$13.1 billion in advertising and marketing—over \$35 million a day (American Lung Association, 2007). Youth with greatest exposure to tobacco marketing are more likely to start smoking and to become frequent smokers (Pierce and others, 1998).

Influences at different ecological levels can interact with each other. For example, the genetics of nicotine metabolism and the addictive nature of smoking create strong markets for cigarettes. Profitability of selling cigarettes drives advertising and marketing campaigns that promote the mood-elevating benefits of tobacco, as well as political contributions by companies that oppose restrictions on tobacco products. The cycle continues as success in attracting new smokers and keeping them addicted ensures the profitability of the cigarette business.

Individual-Level Interventions for Smoking Cessation. Parallel to the many levels of influences on smoking are the levels of interventions. Brief advice to quit in individual medical encounters is effective in promoting cessation (U.S. Department of Health and Human Services, 2000b). Ample evidence supports the helpfulness of nicotine replacement and other pharmacological quitting aids (U.S. Department of Health and Human Services, 2000b). Telephone counseling (Task Force on Community Preventive Services, 2005), self-help pamphlets, books, videotapes, and Web resources (Fisher and others, 2004) also work at an individual level but can more readily reach large numbers of smokers.

Organizational, Community, and Policy Approaches At the organizational level, reductions in smoking have been documented through programs restricting smoking at the workplace (Brownson, Hopkins, and Wakefield, 2002). Programs that emphasize community participation in program development have been successful in several settings, including low-income neighborhoods (Fisher and others, 2004).

Policy interventions—for example, promoting smoke-free environments, limiting access, and increasing tobacco prices through excise taxes—were the focus of the American Stop Smoking Intervention Study (ASSIST) program. ASSIST was implemented in seventeen states through grants to state departments of health and local steering committees. Policies promoting not smoking (for example, proportion of smoke-free workplaces) increased more in ASSIST states than in other states, and smoking prevalence fell from 25.2 percent to 22.2 percent, significantly more than the decline from 24.4 percent to 22.3 percent in the non-ASSIST states (Stillman and others, 2003). The strength of local coalitions and extent of focus on policy change predicted statewide improvements. Internationally, tobacco policy initiatives include the World Health Organization's (2003) Tobacco Free Initiative and Framework Convention on Tobacco Control. Tobacco control policies play an especially important role in prevention. In the United States, states with the most extensive array of tobacco control policies have significantly lower youth smoking prevalence (U.S. Department of Health and Human Services, 1994).

Importance of Multiple Intervention Approaches. Research on smoking cessation is consistent with ecological models' emphasis on the interplay among influences on health behaviors. At the individual level, the likelihood of success of an intervention is not as strongly influenced by the specific form of treatment (for example, self-help, individual counseling) as by the *number of different forms* of treatment used (U.S. Department of Health and Human Services, 2000b). This importance of combining interventions is also reflected in benefits of simultaneously educating health

care workers about smoking cessation and creating systems to remind them to counsel patients about quitting or combining telephone counseling with mass media (Task Force on Community Preventive Services, 2005).

At the state level, comprehensive multi-level programs have created substantial reductions in smoking. Multicomponent campaigns of public education, including “counter-marketing” TV advertisements and billboards, increased taxes on cigarettes, support services for cessation, smoking prevention programs for youth, and multicultural approaches are often coordinated by community coalitions. Evaluations support the importance of the combination of multiple components in comprehensive campaigns (Siegel, 2002).

Comprehensive Interventions at the National Level. The combination of efforts at all levels of the ecological model contributed to a marked drop in smoking rates among adults in the United States, from 42 percent in 1965 to 21 percent in 2005 (Centers for Disease Control and Prevention, 2006). This has been achieved through the best example of an array of multi-level population-based health behavior interventions to date. Highlights at several ecological levels include wide dissemination of individualized smoking cessation programs, nicotine replacement therapy, counseling by health professionals (individual level), workplace and community-based programs, as well as programs tailored to reach different groups (social/cultural and organizational levels), news coverage, government reports, anti-smoking campaigns of various health agencies (population-level mass communication), clean indoor air restrictions (physical environment and policy levels), and restrictions on access to cigarettes and tax increases on their sale (policy level) (Fisher and others, 2004; Task Force on Community Preventive Services, 2005). Interactions among levels are likely to be important. For example, worksite smoking restrictions have motivated employees to seek help in quitting smoking, mass communication and social marketing have promoted individual cessation interventions such as quitline-based telephone counseling, and increased excise taxes have probably helped to reduce youths’ initiation of smoking and to increase the acceptability of policy changes, such as restrictions on where people can smoke.

In summary, multiple, varied, and sustained interventions are responsible for the massive decline in smoking in the United States. Tobacco use is now widely recognized as a social and public health problem, not just an individual behavior. To explain the population changes in smoking *requires* an ecological perspective, and population-level changes reflect the aggregate of the many interventions promoting not smoking, not a single-level “magic bullet.”

Application to Health Interventions: Diabetes Self-Management

Diabetes is a major cause of mortality through cardiovascular and other diseases. Substantial evidence indicates that self-management training enhances diabetes management (Norris and others, 2002). It may seem surprising to examine *self*-management from an ecological perspective. Self-management is often conceptualized as an individual responsibility in which “only the patient can be responsible for his or her

day-to-day care over the length of the illness” (Lorig and Holman, 2003). However, research does not support the contention that self- management interventions make individuals self-sufficient or autonomous in managing their disease. Rather, a meta-analysis of diabetes self-management programs found sharp declines in benefits a few months after the interventions ended (Norris and others, 2002). These findings are congruent with an ecological perspective in which the long-term success of “self-management” depends on the contexts that surround the individual.

An ecological approach to diabetes self-management guided program development in fourteen ethnically and economically diverse primary care and community settings of the Robert Wood Johnson Foundation’s Diabetes Initiative (<http://www.diabetesinitiative.org>). From an ecological perspective, people with diabetes need diverse resources and supports for self- management to manage the disease in their daily lives. These include (1) individualized assessment, (2) collaborative goal-setting, (3) opportunities to learn skills specific to diabetes (for example, measuring blood sugar) and for addressing challenges, including negative emotions, that may interfere with management, (4) ongoing follow-up and support, (5) community resources, such as for regular physical activity and healthy diet, and (6) continuity of quality clinical care. As indicated in Figure 20.2, several of the Resources and Supports for Self Management (RSSM), such as individualized assessment and collaborative goal setting, are most often addressed at the individual level while others, such as access to resources and continuity of quality clinical care, must be addressed at the group, health system, community, or policy levels. Consistent with ecological models’ emphasis on interactions among levels, policies influence the resources and choices available to the individual, and individuals learn skills to access resources.

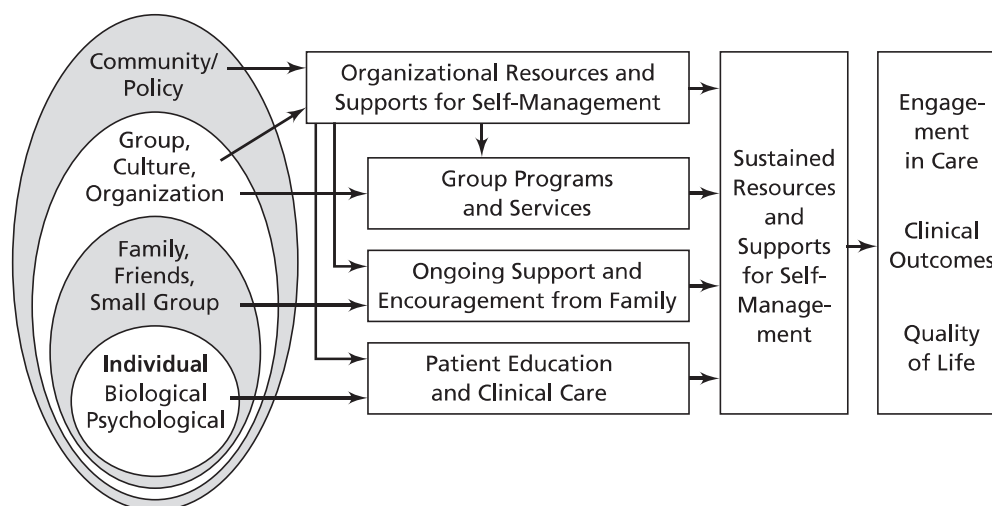


FIGURE 20.2. Illustrative Model of Relationships among Organizational Factors and Supports for Diabetes Self-Management. (*Reprinted with permission.*)

There is a substantial literature on evaluations of individual and group approaches to this intervention model of RSSM (Fisher and others, 2005). To highlight the contributions of an ecological framework, the following sections review ongoing follow-up and support, community resources, and organizational and system approaches to continuity of quality clinical care.

Ongoing Follow-Up and Support. The goals of follow-up include continued assistance in refining problem-solving plans and skills, encouragement in the face of challenges, and assistance in responding to problems that emerge in the course of a chronic disease. Several approaches to providing follow-up and support can be used, including phone calls with nurses and contacts with community health workers, lay health workers, and *Promotores de Salud* (Health Coaches).

The structure of clinical care may contribute to ongoing support through group medical visits (Trento and others, 2004). In these visits, patients with diabetes are scheduled for two- to three-hour group visits that include medical appointments, education (for example, reviews of self-management plans or cooking classes), and supportive discussions. As one example of this type of strategy, the Open Door Health Center in Homestead, Florida expanded group medical visits to a weekly open group that included cooking demonstrations, physical activity, group support, opportunities to ask questions of health care staff, and, when scheduled, physician appointments.

Diabetes is “for the rest of your life,” and the meta-analytic review by Norris and colleagues (2002) points to the critical role of duration of follow-up and support. However, most of the U.S. health care system and most intervention research are oriented toward time-limited treatment. Few diabetes intervention studies include follow-up periods longer than one or two years, yet many with diabetes live thirty or forty years with the disease. One health center secured state funding for Health Coaches for diabetes, but the funding was time-limited and restricted to newly diagnosed cases and those whose disease had gotten worse. *Ongoing* follow-up and support for *good self-management* are among the effective and recommended components of diabetes self-management, but they are infrequently provided.

Continuity of Quality Clinical Care. Self-management and quality clinical care are dependent on each other. Without sound clinical care, the individual’s efforts may be misdirected. An example would be frustration over failure of dietary changes to lower cholesterol when cholesterol-lowering medications are indicated. Without self-management, clinical care will fall short of its potential, through failure to achieve healthful behavior patterns (for example, increased physical activity or healthy diet), nonadherence to recommended use of prescribed medications, or both.

A comprehensive approach to improving diabetes care services developed in one health system included handouts and manuals, out-patient programs, Web-based programs, telephone/nurse case management, financial incentives for physicians’ meeting testing guidelines, and patient incentives for annual eye exams. The multi-level intervention led to improvements in a variety of outcomes (Larsen, Cannon, and Towner, 2003). As only 30 percent to 40 percent of patients with diabetes report receiving self-management interventions (Austin, 2006), there is a need to better disseminate integrated comprehensive clinical and self-management services.

Access to Resources in Daily Life. Recent studies demonstrate the connections between health behaviors and access to healthy food outlets in neighborhoods (Glanz, Sallis, Saelens, and Frank, 2005) and resources for physical activity (Humpel, Owen, and Leslie, 2002). It makes little sense to teach someone about physical activity and healthy diet while ignoring her neighborhood, where it is dangerous to walk alone, food sellers offer little healthy food, and there is limited public transportation to access health resources. Deprivation of community resources is more common in low-income and minority neighborhoods and may contribute to the disproportionate burden of diabetes in low-income and minority communities. Research-based approaches to increasing community resources for diabetes management include community approaches to enhancing resources for physical activity and healthy eating (Nasmith and others, 2004), as well as Web-based discussion groups (Goldberg and others, 2003) and training pharmacists to support self-management (Cranor, Bunting, and Christensen, 2003).

Diabetes self-management illustrates the potential for ecological models to address a complex array of health behaviors. Ecological models can be used to reframe behavior often seen as the “responsibility” of the individual to include required change at the clinical (organizational) and community levels. Finally, because diabetes is an excellent model of chronic disease care in general, the ecological RSSM model may also be applied in the management of other chronic diseases.

CRITICAL EXAMINATION OF ECOLOGICAL MODELS OF HEALTH BEHAVIOR

Ecological models have been central to health promotion for several decades now. Health policy groups rely increasingly on multi-level interventions to solve the most pressing health problems. Based in part on the success in reversing the epidemic of tobacco use, there are high expectations that interventions based on ecological models can reverse the obesity epidemic by improving environments and policies that drive physical activity and nutrition behaviors. The Institute of Medicine (2001; Koplan, Liverman, and Kraak, 2005) and the World Health Organization (2004) propose solutions to obesity that require policy and environmental change. The increasing emphasis on applications of ecological models creates a need for a critical examination of their strengths and weaknesses. Enthusiasm for the potential of ecological models does not reduce the need to understand the benefits and limitations of multi-level interventions, test hypotheses derived from ecological models, and continue to refine the concepts and methods used in research and practice informed by ecological models.

A key strength of ecological models is their focus on multiple levels of influence that broadens options for interventions. Policy and environmental changes are expected to affect virtually entire populations, in contrast to interventions that reach only individuals who choose to participate (Glanz and Mullis, 1988). Policy and environmental interventions establish settings and incentives that can persist in sustaining behavior changes, helping to solve the problem that the effects of many individually directed interventions are poorly maintained.

A weakness of many general ecological models of health behavior is their lack of specificity about the most important hypothesized influences. This puts a greater burden on health promotion professionals to identify critical factors for each behavioral application. A related weakness—even for behavior-specific ecological models—is the lack of information about how the broader levels of influence operate or how variables interact across levels. Thus, the models broaden *perspectives* without identifying specific variables or providing guidance about how to use ecological models to improve research or interventions. By contrast, individual-level psychosocial theories of health behavior are more likely to specify the variables and mechanisms by which those variables are expected to influence behavior (see chapters Three through Six). A major challenge for those working with ecological models is to develop more sophisticated operational models that lead to testable hypotheses and useful guidance for interventions. Other key challenges of ecological models of health behavior also warrant attention.

Are the Principles of Multi-Level Influences and Interactions Across Levels Supported?

Physical activity researchers have begun to test principles of ecological models by developing testable behavior-specific and study-specific hypotheses. Though the number of studies is small and many have important methodological limitations, there is consistent support for the principle of multi-level influences but inconsistent support for interactions across levels. Giles-Corti and Donovan (2002) compared the ability of psychological, social, and physical environment variables to explain exercise. Each category of variables was significantly related to exercise, but associations were strongest for individual variables and weakest for physical environment variables. This study provides some support for the multi-level principle but found no significant interactions across levels.

Two studies examined the combined and interactive effects of the Theory of Planned Behavior (TPB) and perceived physical environment variables to explain walking (Rhodes, Brown, and McIntyre, 2006) and overall physical activity (McNeill and others, 2006). McNeill and colleagues (2006) found both social and physical environment factors were related to physical activity, but Rhodes and colleagues (2006) reported the effects of physical environment factors were completely explained by psychosocial variables. Rhodes and colleagues (2006) tested an interaction based on the hypothesis that mixed land use would make it easier for people to follow through on their intentions. The interaction was significant and of moderate strength, supporting the principle of interactions across levels. All of these studies relied on self-report measures and examined only a few variables, so they cannot be considered definitive.

Studies from diverse fields also support the principle of multi-level influences. For example, a study of youth smoking (Leatherdale and others, 2006) found that smoking of significant others and the broader social environment variable of school smoking rate helped to explain youth smoking. In an international study of alcohol

abuse (Cherpitel and others, 2006), perceptions of harmful effects of drinking differed in low- and high-consumption countries. Improved understanding of the multi-level and interactive influences could lead to more targeted and effective interventions.

Methodological Challenges of Multi-Level Interventions

Ecological principles point to complex interactions of personal, social, and community characteristics that are difficult to manipulate experimentally. The goal of experimental designs—to isolate an intervention from the effects of its context—may be conceptually at odds with the ecological emphasis on studying how intervention components are influenced by their context. Although controlled experiments with multi-level interventions are challenging to design and conduct, rigorous analytical strategies can be applied productively (Bull, Eakin, Reeves, and Riley, 2006). For example, a community program to promote childhood asthma management intervened on personal, social, and community factors (Fisher and others, 2004). The program was evaluated with a nonrandomized design using structural equation modeling. Individual-level factors like parents' attitudes toward asthma predicted children's medical utilization. In addition, social support from lay asthma workers and asthma management classes predicted reduced emergency and hospital care. Thus, interventions targeted at multiple levels predicted outcomes.

With the application of multi-level analytic approaches, evaluations could be expanded to examine the impact on outcomes of further individual-level factors like genetic predispositions, neighborhood features measured objectively with Geographic Information Systems, variability in multiple intervention components, and contextual factors at organizational, community, and policy levels. With sufficient numbers, multi-level analyses can yield estimates not only of the contributions of interventions to outcomes but also of the extent to which those contributions are influenced by moderating factors. Multi-level statistical models are increasingly accessible, and their use is increasing in evaluations of multi-level interventions and observational studies of the multi-level etiology of health behaviors and diseases (Bingenheimer and Raudenbush, 2004).

Logistical Challenges of Conducting Research and Interventions Based on Ecological Models

Research based on ecological models is, by definition, more demanding than behavioral research at a single level. Developing and collecting measures of influences at multiple levels, expanding the number of disciplines represented in investigative teams, conceptualizing and implementing interventions at multiple levels, and using more sophisticated statistical strategies place substantial demands on investigators and program evaluators. However, multi-level studies are the only way to generate knowledge that will lead to effective multi-level interventions.

Of equal importance, the difficulty of implementing multi-level interventions should not be underestimated. The length of time required to change policies and

environments is a deterrent to program directors who are called on to make changes to meet legislators' schedules or within grant timelines. Most environmental variables and policies of interest are not controlled by health professionals, and change requires a political process. To implement multi-level interventions, public health professionals must become more skilled in advocacy and political change, or partner with those who have such skills.

Ecological Models, Individual Responsibility, and Human Dignity

The reframing of health behavior as the result of influences across diverse ecological layers rather than the responsibility of individuals raises interesting issues about the role of individual responsibility for change. Consider how cigarette smoking has become widely viewed as an addiction with biological, behavioral, social, and economic determinants rather than simply an "individual choice." One could view ecological models as "robbing the individual of dignity" by attributing their behaviors to such a range of forces. Alternatively, one could view the ecological perspective as removing an unreasonable attribution of responsibility to the individual—a sort of victim blaming—by recognizing the many forces that shape each individual's behavior. Ecological models transcend philosophical and political polarization over individual versus external influences. From an ecological perspective, individual level and many levels of external influence are integrated in a single framework, making it clear that causation of behavior is widely distributed, not lodged in one or another source. Ecological models can enhance human dignity by moving beyond explanations that hold individuals responsible for, and even blame them for, harmful behaviors.

SUMMARY

Ecological models help us to understand how people interact with their environments. That understanding can be used to develop effective multi-level approaches to improve health behaviors. The basic premise of the ecological perspective is simple. Providing individuals with motivation and skills to change behavior cannot be effective if environments and policies make it difficult or impossible to choose healthful behaviors. Rather, we should create environments and policies that make it convenient, attractive, and economical to make healthful choices, and then motivate and educate people about those choices. The challenge for health promotion researchers and practitioners is to be creative and persistent in using ecological models to generate evidence on the roles of behavioral influences at multiple levels, and on the effectiveness of multi-level interventions on health behaviors, and to translate that evidence into improved health.

REFERENCES

- American Lung Association. "Smoking 101 Fact Sheet." [<http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=39853#fourteen>]. June 2007.
- Austin, M. M. "Diabetes Educators: Partners in Diabetes Care and Management." *Endocrinology Practice*, 2006, 12(Suppl 1), 138–141.

- Bandura, A. "Social Foundations of Thought and Action: A Social Cognitive Theory." Englewood Cliffs, N.J.: Prentice Hall, 1986.
- Barker, R. G. *Ecological Psychology*. Stanford, Calif.: Stanford University Press, 1968.
- Biddle, S., and Mutrie, N. *Psychology of Physical Activity: Determinants, Well-Being and Interventions*. London: Routledge, 2001.
- Bingenheimer, J. B., and Raudenbush, S. W. "Statistical and Substantive Inferences in Public Health: Issues in the Application of Multilevel Models." *Annual Review of Public Health*, 2004, 25, 53–77.
- Bronfenbrenner, U. "The Ecology of Human Development." Cambridge, Mass.: Harvard University Press, 1979.
- Brownson, R. C., Hopkins, D. P., and Wakefield, M. A. "Effects of Smoking Restrictions in the Workplace." *Annual Review of Public Health*, 2002, 23, 333–348.
- Bull, S., Eakin, E., Reeves, M., and Riley, K. "Multi-Level Support for Physical Activity and Healthy Eating." *Journal of Advanced Nursing*, 2006, 54, 585–593.
- Burton, N. W., Turrell, G., Oldenburg, B., and Sallis, J. F. "The Relative Contributions of Psychological, Social, and Environmental Variables to Explain Walking, Moderate-, and Vigorous-Intensity Leisure-Time Physical Activity." *Journal of Physical Activity and Health*, 2005, 2, 181–196.
- Centers for Disease Control and Prevention. "Tobacco Use Among Adults—United States, 2005." *MMWR, Morbidity and Mortality Weekly Report*, 2006, 55(42), 1145–1148.
- Cherpitel, C. J., and others. "Multi-Level Analysis of Causal Attribution of Injury to Alcohol and Modifying Effects: Data from Two International Emergency Room Projects." *Drug and Alcohol Dependence*, 2006, 82, 258–268.
- Cohen, D. A., Scribner, R. A., and Farley, T. A. "A Structural Model of Health Behavior: A Pragmatic Approach to Explain and Influence Health Behaviors at the Populations Level." *Preventive Medicine*, 2000, 30, 146–154.
- Cranor, C. W., Bunting, B. A., and Christensen, D. B. "The Asheville Project: Longterm Clinical and Economic Outcomes in a Community Pharmacy Diabetes Care Program." *Journal of the American Pharmaceutical Association*, 2003, 43, 173–184.
- De Bourdeaudhuij, I., Sallis, J. F., and Saelens, B. E. "Environmental Correlates of Physical Activity in a Sample of Belgian Adults." *American Journal of Health Promotion*, 2003, 18, 83–92.
- Fisher, E. B., and others. "Cigarette Smoking." In J. Raczynski, L. Bradley, and L. Leviton (eds.), *Health Behavior Handbook*, Vol. 2. Washington, D.C.: American Psychological Association, 2004.
- Fisher E. B., and others. "Ecologic Approaches to Self Management: The Case of Diabetes." *American Journal of Public Health*, 2005, 95(9), 1523–1535.
- Flay, B. R., and Petraitis, J. "The Theory of Triadic Influence: A New Theory of Health Behavior with Implications for Preventive Interventions." In G. S. Albrecht (ed.), *Advances in Medical Sociology*, Vol. IV: *A Reconsideration of Models of Health Behavior Change*. Greenwich, Conn.: JAI Press, 1994.
- Giles-Corti, B., and Donovan, R. J. "The Relative Influence of Individual, Social and Physical Environment Determinants of Physical Activity." *Social Science and Medicine*, 2002, 54, 1793–1812.
- Giles-Corti, B., Timperio, A., Bull, F., and Pikora, T. "Understanding Physical Activity Environmental Correlates: Increased Specificity for Ecological Models." *Exercise and Sport Sciences Reviews*, 2005, 33, 175–181.
- Glanz, K., and Mullis, R. M. "Environmental Interventions to Promote Healthy Eating: A Review of Models, Programs, and Evidence." *Health Education Quarterly*, 1988, 15, 395–415.
- Glanz, K., Sallis, J. F., Saelens, B. E., and Frank, L. D. "Healthy Nutrition Environments: Concepts and Measures." *American Journal of Health Promotion*, 2005, 19, 330–333.
- Glass, T. A., and McAtee, M. J. "Behavioral Science at the Crossroads in Public Health: Extending Horizons, Envisioning the Future." *Social Science and Medicine*, 2006, 62, 1650–1671.
- Goldberg, H. I., and others. "Using an Internet Comanagement Module to Improve the Quality of Chronic Disease Care." *Joint Commission Journal on Quality & Safety*, 2003, 29, 443–451.
- Hovell, M. F., Wahlgren, D. R., and Gehrman, C. A. "The Behavioral Ecological Model: Integrating Public Health and Behavioral Science." In R. J. DeClemente, R. A. Crosby, and M. Kegler (eds.), *Emerging Theories in Health Promotion Practice and Research: Strategies for Improving Public Health*. San Francisco: Jossey-Bass, 2002.
- Humpel, N., Owen, N., and Leslie, E. "Environmental Factors Associated With Adults' Participation in Physical Activity: A Review." *American Journal of Preventive Medicine*, 2002, 22, 188–199.
- Institute of Medicine. *Health and Behavior: The Interplay of Biological, Behavioral, and Societal Influences*. Washington, D.C.: National Academies Press, 2001.
- Koplan, J. P., Liverman, C. T., and Kraak, V. I. (eds.). *Preventing Childhood Obesity: Health in the Balance*. Washington, D.C.: National Academies Press, 2005.

- Larsen, D. L., Cannon, W., and Towner, S. "Longitudinal Assessment of a Diabetes Care Management System in an Integrated Health Network." *Journal of Managed Care Pharmacy*, 2003, 9, 552–558.
- Leatherdale, S. T., and others. "A Multi-Level Analysis Examining How Smoking Friends, Parents, and Older Students in the School Environment Are Risk Factors for Susceptibility to Smoking Among Non-Smoking Elementary School Youth." *Prevention Science*, 2006, 7, 397–402.
- Lewin, K., and Cartwright, D. *Field Theory in Social Science*. New York: Harper, 1951.
- Lorig, K. R., and Holman, H. "Self-management Education: History, Definition, Outcomes, and Mechanisms." *Annals of Behavioral Medicine*, 2003, 26, 1–7.
- Matsudo, S. M., and others. "Physical Activity Promotion: Experiences and Evaluation of the Agita Sao Paulo Program Using the Ecological Mobile Model." *Journal of Physical Activity and Health*, 2004, 1, 81–97.
- McLeroy, K. R., Bibeau, D., Steckler, A., and Glanz, K. "An Ecological Perspective on Health Promotion Programs." *Health Education Quarterly*, 1988, 15, 351–377.
- McNeill, L. H., and others. "Individual, Social Environmental, and Physical Environmental Influences on Physical Activity Among Black and White Adults: A Structural Equation Analysis." *Annals of Behavioral Medicine*, 2006, 31, 36–44.
- Moos, R. H. "Social-Ecological Perspectives on Health." In G. C. Stone, F. Cohen, and N. E. Adler (eds.), *Health Psychology: A Handbook*. San Francisco: Jossey-Bass, 1980.
- Nasmith, L., and others. "The Challenge of Promoting Integration: Conceptualization, Implementation, and Assessment of a Pilot Care Delivery Model for Patients with Type 2 Diabetes." *Family Medicine*, 2004, 36, 40–50.
- Norris, S. L., and others. "Self-Management Education for Adults with Type 2 Diabetes: A Meta-Analysis of the Effect on Glycemic Control." *Diabetes Care*, 2002, 25, 1159–1171.
- Ottawa Charter for Health Promotion. Ottawa: Canadian Public Health Association, 1986.
- Owen, N., and others. "Understanding Environmental Influences on Walking: Review and Research Agenda." *American Journal of Preventive Medicine*, 2004, 27, 67–76.
- Owen, N., and others. "Neighborhood Walkability and the Walking Behavior of Australian Adults." *American Journal of Preventive Medicine*, 2007, 33, 387–395.
- Pierce, J. P., and others. "Tobacco Industry Promotion of Cigarettes and Adolescent Smoking." *Journal of the American Medical Association*, 1998, 279, 511–515.
- Rhodes, R. E., Brown, S. G., and McIntyre, C. A. "Integrating the Perceived Neighborhood Environment and the Theory of Planned Behavior When Predicting Walking in a Canadian Adult Sample." *American Journal of Health Promotion*, 2006, 21, 110–118.
- Saelens, B. E., Sallis, J. F., and Frank, L. D. "Environmental Correlates of Walking and Cycling: Findings from the Transportation, Urban Design, and Planning Literatures." *Annals of Behavioral Medicine*, 2003, 25, 80–91.
- Sallis, J. F., and Owen, N. "Ecological Models of Health Behavior." In K. Glanz, B. K. Rimer, and F. M. Lewis (eds.), *Health Behavior and Health Education: Theory, Research, and Practice*. (3rd ed.) San Francisco: Jossey-Bass, 2002.
- Sallis, J. F., and others. "An Ecological Approach to Creating More Physically Active Communities." *Annual Review of Public Health*, 2006, 27, 297–322.
- Siegel, M. "The Effectiveness of State-Level Tobacco Control Interventions: A Review of Program Implementation and Behavioral Outcomes." *Annual Review of Public Health*, 2002, 23, 45–71.
- Skinner, B. F. *Science and Human Behavior*. New York: Macmillan, 1953.
- Stillman, F. A., and others. "Evaluation of the American Stop Smoking Intervention Study (ASSIST): A Report of Outcomes." *Journal of the National Cancer Institute*, 2003, 95(22), 1681–1691.
- Stokols, D. "Establishing and Maintaining Healthy Environments: Toward a Social Ecology of Health Promotion." *American Psychologist*, 1992, 47, 6–22.
- Stokols, D., Grzywacz, J. G., McMahan, S., and Phillips, K. "Increasing the Health Promotive Capacity of Human Environments." *American Journal of Health Promotion*, 2003, 18, 4–13.
- Task Force on Community Preventive Services. "The Guide to Community Preventive Services: What Works to Promote Health?" New York: Oxford University Press, 2005.
- Trento, M., and others. "A 5-year Randomized Controlled Study of Learning, Problem Solving Ability, and Quality of Life Modifications in People with Type 2 Diabetes Managed by Group Care." *Diabetes Care*, 2004, 27, 670–675.

- U.S. Department of Health and Human Services. "Preventing Tobacco Use Among Young People: A Report of The Surgeon General." Atlanta: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1994.
- U.S. Department of Health and Human Services. "Physical Activity and Health: A Report of the Surgeon General." Atlanta: Centers for Disease Control, 1996.
- U.S. Department of Health and Human Services. "Healthy People 2010." Washington, D.C.: U.S. Department of Health and Human Services, 2000a.
- U.S. Department of Health and Human Services. "Treating Tobacco Use and Dependence." Washington, D.C.: Public Health Service, 2000b.
- World Health Organization. *Framework Convention on Tobacco Control*. [http://www.who.int/tobacco/framework/WHO_FCTC_english.pdf]. Geneva: World Health Organization, 2003.
- World Health Organization. *Global Strategy on Diet, Physical Activity, and Health*. [http://www.who.int/gb/ebwha/pdf_files/WHA57/A57_R17-en.pdf] Geneva: World Health Organization, 2004.

