Toward a comprehensive model of physical activity

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Abstract

Background and purpose. Despite the widely acknowledged public health burden and years of individually based intervention approaches, physical inactivity remains a growing concern among industrialized nations. Interventions aimed at changing individual dispositions that increase physical activity generally result in small changes in behavior that dissipate within weeks. Correlational research testing theories and models focusing on these same individual dispositions explain, at best, 20–40% of the variance in physical activity. As a result, recent calls have been made for consideration of broader, multilevel, ecological approaches to physical activity promotion. The purpose of this article is to define a comprehensive model for understanding physical activity and consider future directions for research.

Methods. Relevant literature is reviewed within each of the areas being discussed.

Results and conclusions. Ecological models incorporate both intra- and extra-individual influences that may impact on individual physical activity. However, the role of extra-individual factors has not been clearly defined in current ecological models of physical activity. We present the theoretical background of ecological models of health behavior, and define an ecological model for physical activity promotion. This model portrays physical activity behavior as being influenced by interplay between environmental settings and biological and psychological factors. Further testing of this and existing ecological models of physical activity is recommended.

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Toward a comprehensive model of physical activity behavior

Human anatomy and physiology has remained relatively unchanged over the past 40,000 years (Astrand, 1994; Cordain, Gotshall, Eaton, & Eaton, 1998). The interrelationship between our energy intake, energy expenditure, and physical activity requirements are essentially the same as our Stone Age forebears. But, in terms of energy expenditure resulting from physical activity, Cordain and colleagues estimate that contemporary Westerners expend approximately 38% of the energy that their Paleolithic ancestors did. To equal the total energy expenditure of modern hunter–gatherers (e.g., the Kung! bushmen), a typical 70 kg North American male would have to walk approximately 19 kms more per day in addition to usual activities (Cordain, Gotschall, Eaton, & Eaton, 1998). Thus, while human bodies are biologically endowed for high levels of energy expenditure, the luxuries of modernization facilitate a sedentary lifestyle.

Physical inactivity is currently acknowledged as a serious public health burden throughout the industrialized world (US Department of Health & Human Services, 1996; Villeneuve, Morrison, Craig, & Schaubel, 1998; World Health Organization, 1997). Traditional physical activity promotion interventions that employ individual approaches have demonstrated limited success in promoting long-term maintenance (Dishman & Buckworth, 1996; Marcus & Forsyth, 1999). Although these interventions often alter individual behavior initially, it is likely that enduring social and environmental factors shape return to previous sedentary behavior once the intervention is over (Gauvin, Levesque, & Richard, 2001; Laitakari, Vuori, & Oja, 1996). Correlational research testing theories and models that focus on the individual explain, at best, 20–40% of the variance in physical activity (see Baranowski, Anderson, & Carmack, 1998; Godin & Kok, 1996; McAuley & Mihalko, 1998; Spence, Courneya, Blanchard, & Wilson, 2000). One alternative to testing only individual influences has been to focus on broader and multiple factors that may influence behavior. Ecological models of health behavior focus on individual influences as well as on social and environmental factors that may facilitate or inhibit individual behavior (Sallis & Owen, 1997). Ecological models posit that multiple levels of influence determine individual behavior.

In an effort to classify the multiple levels of intervening influences within, between, and external to individuals that can change human development, Bronfenbrenner (1977) differentiated the external influences into levels of settings with the most proximal setting being the microsystem and the most distal setting to the individual being the macrosystem. For the purposes of discussion, levels of influence and intervention in ecological models can be broadly divided into intra-individual (person) and extra-individual (environment). Intra-individual influences might include individual attributes, beliefs, attitudes, and behaviors, while extra-individual influences might include environmental topography, social and cultural context and policies. For example, change at an intra individual level of influence might include improving attitudes toward physical activity, thereby increasing the probability that physical activity behavior might occur. Change at an extra-individual level of influence might include providing safe spaces to do physical activity, also increasing the probability that physical activity might occur. Working within an ecological model requires that measurement and assessment take place at more than one of these levels.

In the research defining ecological models of health behavior, a number of typologies of ecological variables have been identified (e.g., Cohen, Scribner, & Farley, 2000; McLeroy, Bibeau, Steckler, & Glanz, 1988; Richard, Potvin, Kishchuk, Prlic, & Green, 1996; Stokols, 1992). How-
ever, until recently, little discussion existed on how ecological models could apply specifically to physical activity (see Dzewaltowski, 1997; Gauvin, Levesque, & Richard, 2001; Owen, Leslie, Salmon, & Fotheringham, 2000; Sallis, Bauman, & Pratt, 1998; Welk, 1999). One challenging issue for employing ecological models to the study of physical activity is the definition of a theoretical and conceptual framework to study the putative relationships between extra-individual causal mechanisms and behavior (Sallis, Bauman, & Pratt, 1998). Further, of the ecological models that have either been applied (Gauvin et al., 2001) or developed (Sallis, Bauman, & Pratt, 1998; Welk, 1999) in the physical activity domain, little consideration has been given to the role that biological factors may play in determining behavior. A primary goal of this paper is to address these issues and discuss future directions in the development and application of ecological models. First, we will briefly review the theoretical underpinnings of ecological models.

Theoretical underpinnings of ecological models

A growing body of rhetoric and research argues that there may be synergy between individuals and environments that may exert influence on individuals beyond individual characteristics (Susser & Susser, 1996). Ecological models posit that this synergy is born out of a good “fit” between the individual and environment (Kelly, 1990). A good fit refers to a matching of intra-individual attributes with environmental (extra-individual) attributes that produces positive human health behavior beyond the summation of the intra- plus extra-individual environment. Similarly, a poor individual–environment fit is a mismatch between individuals and environments that leads to poor health and disease. A good individual–environment fit can be improved by enhancing either side, the individual or the environment. In the case of a poor fit, ecological models posit that it is more efficient to enhance environment rather than change individuals, because enhancing one environment can have implications for many individuals.

Because improvements in the individual–environment fit can be achieved from changes at either the intra-individual or extra-individual level, there are multiple levels of influence and points of intervention. Ecological models have been described as typologies of individual, social, and environmental features (Sallis & Owen, 1997), reflecting and building upon the work of Bronfenbrenner (1977). Others have depicted aggregate, contagion, environmental and structural features (Blakely & Woodward, 2000) that operationalize extra-individual influences in terms of strategies of measurement and methods of impact on human health. Others classify ecological influences in terms of resource availability, physical structures, social structures and cultural and media messages (Cohen, Scribner, & Farley, 2000).

While many typologies of ecological models are discussed, they all share common features. Regardless of which typology is employed, ecological models posit that constituents (intra- and extra-individual) are interdependent (Kelly, 1990) and can exert direct effects on each other. If a change is made at one level of influence, all other levels may be affected. For example, a national public health campaign to promote physical activity could stimulate a municipality to build a park in a low-SES neighborhood, which, in turn, may encourage the local residents to be more active. The increase in resident activity might feed back to the municipal leaders via community empowerment, spawning more community resources.

Since all levels of ecological models are interdependent, it follows that available resources cycle among the levels of influence (Kelly, 1990). If the resources that are available at one level
of influence change, then the other levels will have to compensate for this change. For instance, if the extra-individual-level influence of the park in the previous example is removed, then residents will have to change their intra-individual-level behavior to accommodate the extra-individual-level change in resources. Thus, removing the park may mean that children will relocate to the street, families will not have a convenient spot to toss a tennis ball to their dog, and neighbors will not be able to socialize in a space free from passing car exhaust. The interdependence of levels in the ecological system provides health promoters with novel points of intervention (see Gauvin, Levesque et al., 2001; Richard, Potvin, Kishchuk, Prlic & Green, 1996; Stokols, 1996). Interventions made at either intra- or extra-individual points will have implications for all other parts of the system. Therefore, extra-individual (i.e., environment change) interventions can influence the individual behavior of all members of that environment. Because persons are interdependent with their environments, extra-individual influences can directly constrain some behaviors and facilitate others. Barker (1968) proposed that behaviors occur in consistent patterns of regularly encountered environments that are called behavior settings. In behaviorist terms, the behavior setting represents the discriminate stimulus (Skinner, 1954) that elicits predictable human behavior. The “behavior” of the environment that mandates specific human behavior is independent from the people in the environment in the sense that settings (environments) themselves generate forces necessary for their own maintenance and survival. However, individuals have the capacity to change their environments, leading back to the interdependence of intra- and extra-individual levels.

Similar to behavioral definitions (Skinner, 1954), ecological models posit that individuals adapt, or vary their behaviors or characteristics in response to available, changing resources in the extra-individual environment. Change in the environment can create conditions that are more favorable for one group of individuals and less favorable for others. The group with the more favorable conditions is likely to dominate in terms of power and influence and may show more favorable health behaviors. For instance, despite individual demographic characteristics (e.g., age, gender, social class, income) merely residing in a more affluent neighborhood will likely increase individual physical activity (Ecob & Macintyre, 2000; Ellaway & Macintyre, 1996; Gauvin, Richard et al., 2001; Yen & Kaplan, 1998) and decrease smoking (Diez-Roux et al., 1997). These studies show that something about the neighborhood of residence influences individual behavior beyond individual demographic characteristics. Sampson, Raudenbush and Earls (1997) note that social and organizational characteristics of neighborhoods are associated with variations in individual behavior that are not explained by individual characteristics alone. Perhaps extra-individual environments (e.g., neighborhoods) generate common values and qualities that influence residents beyond individual characteristics (Sampson et al., 1997).

While not well documented or explained, ecological models also include temporal features, acknowledging that subtle relationships in ecological systems can take a long time to manifest themselves (Moore & Carpenter, 1999). Levine, Toro and Perkins (1993) posit that all ecological perspectives must be longitudinal. However, ecological models may not necessarily foster linear temporal relationships because of the dynamic and unpredictable nature of human environments. A critical implication of the temporal nature of ecological influences is that environmental effects may be subtle and only observable after years of exposure, while at the same time, effects may be dramatic, resulting in rapid behavior changes (e.g., smoking bans and reductions in smoking rates).
From a historical perspective, the current physical inactivity levels evident in most industrialized nations are extreme. If we are to understand the physical activity choices of contemporary humans, then we should not ignore changing cultural and environmental forces (Frankish, Milligan, & Reid, 1998; Powell, Kreuter, Stephens, Marti, & Heineman, 1991; Siedentop, 1996; Treloar et al., 1999). The Inuit peoples of northern Canada provide a vivid example of the corrupting influence of modernization on physical activity and fitness. As a result of acculturation (e.g., introduction of motor boats, televisions, motorized ski mobiles), these people are experiencing dramatic decreases in physical fitness (Rode & Shephard, 1994) as well as generational shifts in preferences from traditional cooperative games and activities to more competitive pursuits (Glassford, 1976).

To appropriately assess these influences on physical activity, conceptual models describing how extra-individual factors relate to behavior and interact with one another are required. Dzewaltowski (1997) and Sallis and Owen (1997) were among the first to discuss the need for an ecological approach to physical activity research and promotion. Welk (1999) followed with the Youth Physical Activity Promotion (YPAP) Model, which he termed a “heuristic model” for bridging the gap between theory and practice. Its goal was to serve as a guide for physical activity promotion programs. Couched within a social ecological framework (McLeroy, Bibeau, Steckler & Glanz, 1988) and the Precede–Proceed Model (Green & Kreuter, 1991), the YPAP model recognizes the influence of both intra- and extra-individual factors on children’s physical activity participation. At the individual cognitive level, Welk (1999) makes a useful distinction between “am I able?” (e.g., perceptions of competence, self-efficacy) and “is it worth it?” (e.g., enjoyment, beliefs, attitudes) variables. This model could be adopted for research purposes but to date we have seen no evidence of it being used.

Recognizing the lack of conceptual models to guide environmental and policy interventions, Sallis, Bauman, and Pratt (1998) developed a model “for conceptualizing the steps that may be required to implement macro-level interventions” (p. 388). The model acknowledges the role of advocacy or coalition groups (e.g., public health, sport, fitness industry), agencies (e.g., park and recreation departments, schools, media, medical), policies, and environments (supportive settings, facilities, and programs). However, because of its macro focus, this model does not suggest how the home environment may influence physical activity behavior. Moreover, it implies that environmental and policy interventions only have direct effects on physical activity, and it avoids discussion of interpretation of these influences on the part of the individual. Last, Sallis et al. (1998) have given little consideration to how cultural factors should be included in macro-level interventions.

A structural model of the environment

Based upon ecological systems theory (Bronfenbrenner, 1989), Wachs (1992) has outlined a model for understanding the role of the environment in children’s development. We believe his structural model of the environment (SME) is readily adaptable for describing environmental
influences on physical activity behavior (see Fig. 1)\textsuperscript{1}. According to the SME, environmental factors are categorized in a hierarchical, multilevel, and multidimensional fashion. This model describes a dynamic system that operates across space and time.

At the most proximal level in the SME is the \textit{microsystem}. This is the immediate setting within which individuals interact. It can consist of both social (e.g., verbal support) and physical (e.g.,

\begin{itemize}
  \item Physical Ecology (e.g., climate)
  \item Pressure for Macrosystem Change (e.g., urbanization, modernization)
  \item Macrosystem Dimensions
  \item Exosystem Dimensions
  \item Mesosystem Dimensions
  \item Microsystems Dimensions
  \item Higher Level Mediators
  \item Behavior
\end{itemize}

Fig. 1. A structural model of environmental influences on behavior (adapted from Wachs, 1992).

\textsuperscript{1} Garcia Bengoechea and Johnson (2000) have recently used a version of Bronfenbrenner’s (1977, 1989) ecological systems theory to understand the determinants of sport participation in children.
the presence of a safe playground) characteristics. Examples of microsystems are workplaces, schools, homes, and parks. It is likely that more than one microsystem plays a role in understanding physical activity.

Encompassing the microsystem is the mesosystem, in which two or more microsystems may interact to exert influence on physical activity behavior. The most important features at this and all subsequent levels are the “linkages and processes” occurring between settings. Thus, it is not just the presence of positive facets (e.g., walking trail) in the setting but also the quality of the interaction that takes place within and between settings. For instance, a child’s physical activity level may be influenced by both the verbal support received in the home microenvironment and the physical and social microenvironments at school.

Other microsystems, external to the individual, also exert influence on behavior. Exosystem dimensions are composed of the linkages and processes between two or more microsystems, at least one of which does not include the physically active/inactive person. An example of an exosystem dimension is the relationship between a parent’s workplace (e.g., existence of a health promotion program) and a child’s physical activity in school.

The fourth, and most distal, level consists of macrosystem dimensions. The macrosystem is the larger sociocultural context (e.g., social class structure, cultural values, community) in which the person resides. It encompasses the micro, meso, and exosystems

with particular reference to the developmentally instigated belief systems, resources, hazards, lifestyles, opportunity structures, life course options and patterns of social interchange that are embedded in each of these systems. (Bronfenbrenner, 1989, p. 228)

The finding that childhood SES is strongly related to subsequent adult participation in physical activity (Lynch, Kaplan, & Salonen, 1997) could be construed as an example of a macrosystem dimension.

Other constructs included in the SME are physical ecology, pressure for macrosystem change, and higher level mediators. Physical ecology (e.g., climate, topology) and pressure for macrosystem change are thought to influence behavior through the macrosystem. For instance, the climate and topology have dictated to a great degree the types of activities and games that are part of the Inuit culture (e.g., static indoor games, cooperative hunting activities). However, the Inuit have experienced a change in their cultural norms because of modernization (Glassford, 1976). Wachs (1992) does not explain what the “higher level mediators” are in his model (see Fig. 1). We assume that they are the individual dispositions of the developing person. Therefore, the environment in the SME influences behavior indirectly through these higher level mediators.

**Nature of the structural model of the environment**

The more distal the level in the SME from the individual, the broader the influence that the dimensions can exert over behavior. Therefore, upstream interventions (Orleans, 2000) that target population-level changes in behavior incorporate macrosystem dimensions, whereas downstream interventions target the mesosystem or microsystem levels. Distal processes can modify the pattern of relationships between environment and individual behavior occurring at levels that are more proximal. For example, the provision of quality physical education in the school (mesosystem
influence) can strengthen or reduce the effect of parental support for a child’s participation in physical activity at home (microsystem).

Because of the bidirectional nature of the SME, processes at the more proximal levels of the environment can influence distal levels. For example, if nursing home residents demand the provision of quality exercise programs and equipment, it could lead to the development of certification guidelines for older adult activity instructors and policy for such programs. Wachs (1999) maintains that the more proximal the dimension to the individual, the more influential it will be to immediate behavior. Thus, supportive proximal environments, such as parental support for physical activity and active school programs, can buffer detrimental macrosystem influences (e.g., low SES).

Because it is possible for both distal and proximal processes to serve as moderators of each other, the question for physical activity researchers becomes “under what conditions is higher order environmental moderation of more fundamental proximal processes most or least likely to occur” (Wachs, 1999, p. 362). Thus, it is important for researchers to develop hypotheses about the linkages between the various levels of the environment as they relate to physical activity behavior.

The ecological model of physical activity

To understand physical activity participation, we believe that four further additions need to be made to the SME (see Fig. 2) that focus on clarifying the roles of biological processes, higher-level mediators, and physical ecology, and illuminating direct versus indirect roles of the environment. First, there should be little doubt that biological processes can influence behavior (Bouchard & Shephard, 1994). Evidence suggests that energy exertion is probably controlled to some extent by an “activity-stat” or biological set-point (see Rowland, 1998) that controls the amount of activity in which an individual will be capable of participating. For instance, Goran, Gower, Nagy and Johnson (1998) found that as girls begin to experience puberty they maintain their resting metabolic rate while demonstrating a reduction in energy expenditure which is explained by a 50% reduction in physical activity. Goran et al. interpret this as being evidence for an energy-conserving mechanism that prepares girls for the demands of growth and maturation that take place in puberty. If such a mechanism is in place, then the interpretation of gender differences in adolescent physical activity (Garcia et al., 1995) needs to include more than the usual sociological (e.g., roles) or cultural explanations. Further, research shows that many facets of physical fitness (e.g., body composition, maximal oxygen uptake, flexibility, speed) are partially genetically determined (Bouchard, Malina, & Perusse, 1997). In fact, it is possible that there is heritability of behavior (see McGue & Bouchard, 1998), including physical activity behavior (e.g., Beunen & Thomas, 1999; Bouchard & Perusse, 1994).

Second, as mentioned previously, the “higher-level mediators” in the Wachs (1992) model were probably supposed to consist of both biological and psychological factors. However, we believe

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2 Throughout this manuscript we use the terms mediator and moderator to describe the roles of variables in various theories and models. When considering the relationship between three or more variables (X, Y, M…), and where X is assumed to affect another variable Y, mediation is said to take place when X no longer affects Y after M has been controlled (Baron & Kenny, 1986). Further, for the X–Y relationship to be mediated by M, it is required that X temporally precede M and Y (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). A variable is considered a moderator if it influences the association between X and Y.
biological factors are more likely to serve as moderators than mediators between extra-individual factors and behavior. That is, biological factors (e.g., body composition, physical fitness, pubertal status) are likely to influence the type and extent of activity but not serve as the reasons for being physically active. The more likely mediators of extra-individual factors on behavior will be psychological factors such as cognitive and, possibly, personality constructs. Sufficient evidence exists documenting relationships between physical activity and constructs such as self-efficacy, perceived barriers, perceived benefits, enjoyment of activity, and social support (Sallis & Owen, 1999). We suggest that the constructs from a cognitive- or personality-oriented theory with clearly identified mediators, such as social cognitive theory (Bandura, 1986) or theory of planned behavior (Ajzen, 1991), or possibly even the exercise self-esteem model (Sonstroem & Morgan, 1989), be used test the relationship between environment and behavior.
Third, physical ecology should be recognized as having a direct influence on both biological and psychological factors that may then moderate or mediate the physical ecology–physical activity relationship. For instance, heat stress (Wenger, 1999) and air pollution (Linn & Gong, 1999) can compromise the biological capacity of the body to participate in physical activity. Further, physical ecology may influence psychological factors (e.g., attitudes) that may also limit physical activity participation. For example, severe climate conditions, such as cold and ice, are often perceived as barriers to participation in outdoor activities by older adults (see O’Brien Cousins, 1998) that may, in turn, reduce physical activity participation.

Finally, in keeping with theoretical underpinnings of ecological models (see Sallis & Owen, 1997), we propose that environment has both direct and indirect effects on physical activity. For example, if stairs are the only route to one’s office, then this environment will increase stair-climbing participation. If the stairs are nicely appointed with attractive floor and wall preparations, the environment may also influence psychological factors that will increase favorable attitudes toward stair climbing that may generalize to other environments where stairs may be an option. We acknowledge that the notion that the environment has direct, unmediated, effects on behavior is contentious (cf. Bandura, 1996), and we will discuss it further in a latter section of this paper.

We call our model the Ecological Model of Physical Activity (EMPA). In presenting the EMPA, we are not suggesting that researchers working within an ecological framework address each dimension and factor in the model. Rather, we hope that we have presented a conceptual framework that can guide our work whether we choose to use the complete model or only selected parts. The important point is that researchers have a clear understanding of the rationale behind collecting data from multiple sources and at multiple levels. At present, the EMPA will be most useful in identifying ecological determinants and correlates of physical activity in descriptive research. While this model could be used to guide intervention research, the paucity of evidence for the relationship between some aspects of the environment and physical activity may limit its effectiveness. Once more evidence becomes available, we should be able to identify specific characteristics of the relationships among factors in the model. We propose the following hypotheses to generate data to guide the future development of the model:

- **Hypothesis 1. The influence of more distal processes on physical activity should be buffered by proximal factors.** For instance, low household SES should not influence a child’s physical activity if there is a quality physical education program in their school and support for physical activity at home. Similarly, children living in high SES households will be inactive if there is no support for physical active at home or in the school setting.

- **Hypothesis 2. The environment exerts a direct effect on physical activity.** This is a key proposition of ecological models. Thus, once individual dispositions such as cognitive constructs are accounted for, a relationship should still exist between extra-individual factors and physical activity.

- **Hypothesis 3. Psychological factors mediate most of the relationship between extra-individual factors and physical activity.**

- **Hypothesis 4. Biological and genetic factors influence physical activity participation.**

- **Hypothesis 5. The influence of biological and genetic factors on physical activity are moderated by extra-individual factors such as physical ecology.**
Methodological considerations

The EMPA should include data from both objective and subjective assessments. Objective data can be derived from both contextual (e.g., aggregated group data, neighborhood SES) and observational (e.g., number of joggers using a running path) sources. However, few tools for conducting objective assessments of the physical and social environments in relation to physical activity are available. Some scales have been developed to assess home (McKenzie et al., 1991), school (Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997), and workplace settings (Plotnikoff, Fein, & Milton, 2001), but there is a need for more work in this area. Subjective data would include any assessments of individual dispositions (e.g., attitudes, perceived norms, self-efficacy) along with measures of perceived environment. The latter is important because it is possible that individual behavior patterns may be determined more by the perception of the environment than the environment itself (see Stokols, 1992; Wachs, 1999). Observational and subjective assessment tools are needed to determine the quality of interactions and support within and between settings described in the EMPA, because of the emphasis on the linkages and processes within and between settings.

Collecting both subjective and objective data at both intra- and extra-individual levels may ameliorate some of the pitfalls observed in the public health arena. Group-level data analysis has been avoided in this area (see Macintyre & Ellaway, 2000), because of concerns surrounding the “ecological fallacy” (i.e., inferring individual-level relationships from relationships observed at the aggregate level). However, if individual-level data (i.e., physical activity, household income, educational level) is collected along with group-level data, as suggested by the EMPA, then ecological inference is not a problem (King, 1997).

Because extra-individual effects may manifest themselves subtly and only be detectable after a long period of exposure, research is needed that assesses the longitudinal aspects of ecological models. These strategies must be sensitive to the multiple levels of influence to avoid the trap of the ecological fallacy, and determine true ecological exposure effects. Spatial analyses using geographic information systems (GIS) show promise as a multidimensional venue for integrating the multiple levels (intra- and extra-individual) of ecological analyses (Moore & Carpenter, 1999). GIS allows data sources at different levels of analysis to be layered and examined simultaneously. There will need to be ongoing development of strategies and techniques to understand the dynamic and multilevel nature of ecological data.

Future directions

More than fifty years ago, Lewin (1951/1997) proposed his idea of “lifespace” and that behavior was a function of the person and his or her environment. His work influenced much of the thinking in environmental psychology (e.g., Barker, 1968) and led to the development of social ecological models for understanding behavior (e.g., Bronfenbrenner, 1977; McLeroy, Bibeau, Steckler & Glanz, 1988). In the health arena, researchers and practitioners have recognized a critical need to develop ecological strategies that include influences beyond the individual (Green, Richard, & Potvin, 1996). The issue for exercise and health psychologists, who attempt to understand physical activity, is whether such approaches will be adopted in the field. If researchers and practitioners in the area are to embrace ecological models, the following issues need to be addressed.
While Sallis, Owen and Fotheringham (2000) define behavioral science as an inclusive term that can encompass the activities of researchers in “psychology, sociology, communication, and other fields” (pp. 297–298), the intervention literature in behavioral science has been dominated by psychological approaches (Green, 1984). The most popular health behavior theories, such as social cognitive theory (Bandura, 1986), theory of planned behavior (Ajzen, 1991), and transteoretical model (Prochaska & Velicer, 1997), are psychological in nature. Throughout this manuscript we have maintained that to understand physical activity, more attention needs to be focused on physical and social environmental influences that can affect behavior. In addition, the role of biological processes that interact with those extra-individual factors to moderate our behavior must also receive more attention. For instance, providing walking trails in a community populated predominantly with older adults may not be effective until the joint pain that many of the residents may experience is overcome. If, as McLeroy, Bibeau, Steckler, and Glanz (1988) maintain, “the purpose of an ecological model is to focus attention on the environmental causes of behavior and to identify environmental interventions” (p. 366), then perhaps we need to revise our definitions. A model such as McLeroy et al. described should be called an environmental model whereas one that situates the individual (including biological and psychological factors) within the broader environmental context should be called an ecological model.

Further, researchers will need to spend time and energy fostering cross-disciplinary relationships, because conducting physical activity research with an ecological framework requires expertise that usually derives from more than one discipline (e.g., exercise science, public health, urban planning, geography, sociology). Researchers must overcome the parochial nature of disciplines and recognize that disciplines by definition usually focus on only one level within ecological frameworks (Cacioppo, Bernston, Sheridan, & McClintock, 2000). For instance, sociologists are concerned with macrosystem factors such as socioeconomic status and culture, whereas physiologists focus their work at the cellular level.

Another challenge for ecological models will be to demonstrate direct, unmediated effects of the environment on physical activity. One of the holdovers from its behaviorist roots is the claim that, within an ecological framework, the environment exerts a direct effect on behavior (Barker, 1968; Sallis & Owen, 1997). This feature is, according to Sallis and Owen what “distinguishes ecological models from intrapersonal theories, which sometimes hypothesize that selected environmental influences are mediated through psychological processes” (p. 412). An example of an intrapersonal theory that closely approximates an ecological approach is social cognitive theory (Bandura, 1986). Social cognitive theory recognizes person–environment–behavior interactions that are mediated by cognitive processes (i.e., efficacy beliefs). Further, similar to the biological factors identified in the EMPA, social cognitive theory hypothesizes that efficacy beliefs are driven in part by physiological cues. Bandura (1996) gives little credence to the idea that external influences on behavior are unmediated by cognitive processes. Thus, the main difference between Bandura’s perspective on behavioral determinants and ecological approaches is the direct influence of environment on behavior. Unless shown to be otherwise, theorists can claim that ecological models are just social cognitive theory incorporating multiple levels of environmental influences (e.g., Ewart, 1991, 1993). In the general psychology literature, there is some evidence to indicate that unmediated influences of external stimuli can take place on behavior (see Bargh & Ferguson, 2000), however this needs to be substantiated in the physical activity research domain. In fact much of the research that has collected data on environmental factors and potential cognitive
mediators (e.g., self-efficacy) of physical activity has excluded these mediators from the final analysis because they account for too much of the variance and overshadow the contribution of the environmental variables (e.g., Booth, Owen, Bauman, Clavisi, & Leslie, 2000; Leslie et al., 1999; Sallis et al., 1989).

Informing intervention and policy

Measurement of community and environmental indicators (Baker, Brennan, Brownson, & Houseman, 2000) will be important for informing policy and decision makers. One possible implication of ecological approaches is that neighborhood planners should consider creating spaces for physical activity. Despite the dearth of ecological data, this has already begun to happen with such policies as California’s Safe Routes to School Initiative (J. Corless, Surface Transportation Policy Project, Northern California, personal communication, January 19, 2001) that aims to increase the number of safe walking and cycling routes for children during to and from school travel. New communities may be designed and older communities modified to increase walking and cycling spaces for adults. Worksite policies may be implemented that include time and facilities at the worksite to increase physical activity. Further, neighborhood social context may need to be changed, for example, communities and policy makers may need to enhance neighborhood social capital and safety.

Ethical considerations

Numerous ethical considerations are implicated in ecological models that consider multiple levels of analysis. The tradition of health educators and outreach to individuals that has been employed by western medicine has always fostered great freedom and choice for individuals. Such traditional, individually based approaches rely on individual informed consent for participation. Research involving communities and environments does not have a forum for traditional participation consent procedures. Community and environmental approaches to changing individual behaviors have historically been the purview of public health and policy makers. These strategies are driven by the will of the majority rather than individual choice. Public health campaigns are typically implemented by government agencies that are comprised of decision makers that represent the good of the public. Policies are made via elected officials who represent the public good or via majority-voted referenda. Still, despite the implicit consent of the public majority, interventions that endeavor to manipulate social policy and human environments merit ethical concern. Changing policies and environments may not always produce the desired result. For example, installing neighborhood parks may give people a place to engage in physical activities. However, the same park may also give social miscreants a place to engage in illicit behaviors. Social policies and environmental changes must be considered carefully to ensure that they improve human health rather than endanger it.

A second ethical issue lies in the sanctity of identifying information. In research on individuals, all identifying information is kept confidential, to avoid stigmatization. Multilevel data that use geographic information from individual addresses must be kept confidential, as must information about geographic spaces, or communities. Identifying information about communities must be considered with the same kind of care that information about individuals is given to avoid stigmat-
ization and ill affects from residence in or near these communities. In addition to increasing stigma, research that identifies communities as unsafe and impoverished may also increase problems with securing resources (e.g., adequate housing, Troutt, 1993), creating a cycle of disadvantage.

Another potential ethical hazard of health research and promotion is the tendency for “Blaming the Victim” (Ryan, 1976). Victim blaming holds individuals to task for behavior that is largely dictated by environmental circumstances. For example, the failure of an intervention that implemented a walking program among individuals who lived in unsafe areas might result in part from the lack of safety, rather than aspects of the individual. Ecological models that specify the environment, as well as individual facilitators and barriers to physical activity participation, have a great opportunity to reduce this hazard.

Ecological models propel physical activity researchers and promoters to examine both physical as well as social structures that may impact on physical activity participation. Culture that encompasses socially transmitted behaviors, beliefs, and institutions may be a determinant of physical activity participation (Siedentop, 1996). Culture stems from national, ethnic, and social backgrounds and will need to be defined and included in ecological models. At the same time, health researchers, promoters and policy makers will need to be responsive and sensitive to cultural traditions. Partnerships with community advisory boards may be one way to address this concern (Strauss et al., 2001). It is important to incorporate cultural traditions while maintaining respect for these traditions.

Conclusions

Physical inactivity is a major public health burden with estimates that upwards of two-thirds of the industrialized world does not achieve minimum physical activity guidelines (Craig, Russell, Cameron and Beaulieu, 1999; Oja, 1995; US Department of Health & Human Services, 1996). Based upon population-attributable risk estimates, approximately 20% of premature mortality could be avoided if everyone became physically active (Katzymaryk, Gledhill, & Shephard, 2000). This “epidemic” of inactivity has led theorists, researchers and practitioners to seek innovative models and methods to understand and increase physical activity. Traditional individually based approaches remain important and efficacious (Marcus & Forsyth, 1999); however, they are limited by their scope (Glasgow, Vogt & Boles, 1999). We have presented the theoretical background of ecological models of health behavior, and defined an ecological model for physical activity promotion. This model portrays physical activity behavior as being influenced by interplay between environmental settings and biological and psychological factors. Further testing of this and existing ecological models of physical activity is recommended. Development of other conceptual models of physical activity is a next step, and this will include implementing innovative methodological strategies to evaluate ecological models. Ultimately, as Lewin (1951/1997) would concur, we need to get practical and start testing some ecological theories.

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