Ecological Models Revisited: Their Uses and Evolution in Health Promotion Over Two Decades

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Abstract

Since the 1980s, ecological models of health promotion have generated a great deal of enthusiasm among researchers and interventionists. These models emerged from conceptual developments in other fields, and only selected elements of the ecological approach have been integrated into them. In this article, we describe the tenets of the ecological approach and highlight those aspects that have been integrated into ecological models used in health promotion. We also analyze how ecological models have been applied to the study of two important public health issues, namely physical activity promotion and the increased consumption of fruits and vegetables, by conducting an archival study of published research. Finally, we make a statement regarding the usefulness of ecological models for research and practice and propose recommendations for future research, program planning, and evaluation.
INTRODUCTION

An ecological approach to health issues and ecological models of intervention have become distinctive features of disease prevention and health promotion in public health. Since the 1980s, when key influential models and analyses were disseminated and key dimensions and basic principles underlying the ecological approach were set forth (6, 7, 51, 70, 72, 73), enthusiasm around this innovation has not waned. In fact, new models have been proposed, older models have been refined, and ecological discourse has permeated research and planning models as well as policy statements and action plans. Ecological programming has also become an object of research as factors associated with its implementation in public health organizations are now the focus of investigations (31, 45, 57, 58, 61). Given this interest and research, we aim to critically review and appraise the usefulness of the ecological approach in research and practice on public health intervention planning, implementation, and evaluation. Following a brief presentation of the historical context, rationale, definition, and basic principles of the ecological approach, we pursue three specific objectives. First, we describe the tenets and contours of ecological models published over the past two decades, emphasizing contemporary developments. Second, we analyze the manner in which ecological models have been applied to the study of health and health-related behaviors by examining the literature on determinants and intervention approaches on two frequently studied themes: physical activity promotion and increased consumption of fruits and vegetables. Third, on the basis of the results of the review of models and the examination of the literature on physical activity promotion and fruit and vegetable consumption, we make a statement regarding the usefulness of ecological models for research and practice and propose recommendations for future research, program planning, and evaluation.

ECOLOGICAL MODELS: HISTORICAL CONTEXT, DEFINITION, AND UNDERLYING RATIONALE

Ecological models have a long history as they emerged from developments in many disciplines and fields (e.g., public health, sociology, biology, education, psychology), which in turn converged to form the ecological and behavioral foundations of health promotion (29). Contemporary developments have reinforced their relevance to the field of public health. In particular, the resurgence of interest into social inequalities in health has directed interest into the central role of larger contextual determinants of health, such as socioeconomic factors, gender, and other social and cultural influences (13, 47). In parallel, epidemiologists have debated the limitations of epidemiology’s dominant causal models and methods, which emphasize a linear and sequential view of causality and a focus on investigating proximate, individual-level risk factors (42, 52, 78). Recognition of the importance of considering how social environmental and biological factors jointly influence health and the integration of a social ecological systems perspective that acknowledges complexity and emerging “ecologically inclined multi-level social epidemiological frameworks” (42, p. 672) is evidence of a paradigmatic shift placing epidemiology “on the track of ecologism” (78, p. 674). This shift in emphasis has brought about the need to develop and consolidate innovative methods that allow for investigations attuned with these new conceptual frameworks, for example multilevel (15) and spatial analyses (20). Such developments, in turn, have stimulated research on contextual factors. In health promotion, disappointment over results from experiments and trials in behavior change (12, 77) has led to calls for interventions and programs addressing not only individual behaviors and their cognitive determinants but also the multiple settings and social contexts that shape behaviors, including larger
social and cultural dimensions (49). The convergence of these factors has contributed to uphold enthusiasm regarding ecological models in health promotion.

To grasp the breadth of ecological models, an examination of the literature in a variety of disciplines is required—a task that, at times, is disparate and complex (50). For instance, the ecological approach is designated by a multiplicity of labels—including the ecological perspective, ecological model(s), and multilevel model(s)—which are often used interchangeably. As a result, a useful starting point is to review basic definitions. In their glossary, McLaren & Hawe (50) defined the ecological perspective as “a conceptual framework designed to draw attention to individual and environmental determinants of behavior. The visual metaphor is a series of concentric or nested circles which represents a level of influence on behavior” (p. 9). Inspired by McLeroy et al. (51), McLaren & Hawe outlined the existence of different levels of influence, including the intrapersonal realm, interpersonal processes, organizational processes, community, and public policy. Their definition also highlights notions of multilevel interventions and evaluation, interaction, reciprocal causation, as well as the need for environmental change and individual support for these changes. Within such a perspective, health issues are viewed as the consequence of reciprocal causation unfolding at multiple individual and environmental levels of influence; ecological models offer an elegant conceptual contour of these levels of influence and guide the development of multilevel intervention models, which underscore the need for enacting various health education and promotion strategies to achieve population-level changes (2, 17, 34, 67).

As comprehensively described in previous reviews (29, 50, 60, 65, 67), early ecological models stemmed from the rich theoretical legacies of Lewin (10) (i.e., field theory suggesting that the interdependent dynamics of all factors located in the “field” must be taken into account to explain behavior), Barker (1) (i.e., the settings in which behavior occurs are the best predictor of the behavior), and Bronfenbrenner (6) (i.e., ecological framework of human development emphasizing the micro, meso-, exo-, and macrosystem influences). Another fertile ground for the emergence of the ecological approach to human behavior was found in community psychology, a subfield that shares numerous intellectual and methodological commonalities with the field of public health (21, 26, 38). From the 1960s onward, community psychologists were increasingly dissatisfied with the individually and deficit-focused, positivistically derived frameworks classically used in psychology. As a result, researchers linked to community psychology developed and pursued a new research and intervention agenda that was cast within a contextualist understanding of behavior and was centered largely on explaining dynamic interactions between individuals and their environments (40). To guide their work, scholars borrowed and then adapted notions from the field of ecology, where life settings and patterns of exchanges between organisms and their environments were the preferred object of study. In a quest to define perspectives for research and intervention, Kelly, one of the founders of community psychology, formulated the “ecological metaphor,” which transposed principles from the field of biological ecology to the investigation of relationships between individuals and their environments (35–37, 79, 81). The classic principles of interdependence, adaptation, cycling of resources, and succession were proposed as the processes and structures that defined dynamic complexity within an ecosystem (46) and were cast as the foundations of a “framework for harnessing community research and intervention” (63). Far from being a construct- and hypothesis-laden theoretical outlook, the ecological perspective in community psychology was defined as “a metaconcept” (38, p. 15). Defining concepts were seen as “heuristics—a set of ideas to guide research and practice—rather than full-blown constructs and hypotheses that if operationalized could be empirically tested. Ecological ideas are topics for further clarification and illustration in very specific locales” (38, p. 252). From these rich
conceptualizations, ecological models emerged in public health.

**BASIC PRINCIPLES OF THE ECOLOGICAL APPROACH**

In health promotion and public health, the ecological approach has often been defined in terms of its principles (4, 67, 73). By contrast, Kingry-Westergaard & Kelly (40) outlined a broader perspective and identified four facets or constitutive components of the ecological approach, namely (a) theoretical propositions for the interrelationships between persons and settings; (b) constructionist premises, the social construction of ecological knowledge; (c) collaborative style; and (d) social processes. These constitutive components are described below.

Table 1 presents an outline of Kingry-Westergaard & Kelly’s theoretical propositions (i.e., the first constitutive component of an ecological approach) along with key ideas captured within each proposition. As can be seen, the ten theoretical propositions (or heuristics) pertain to the nature of interrelationships between persons and settings. Some of these principles, for example those pertaining to reciprocal relationships or to the influence of settings on behaviors or persons, are often cited in the health promotion and public health literature dealing with the ecological approach. However, other notions such as shared meaning and resources have not been extensively cited or developed within this context despite their obvious relevance.

Going beyond context and person-environment interactions, the second constitutive component of the ecological approach according to Kingry-Westergaard & Kelly (40) underscores the need to account for a central

### Table 1 Ten theoretical propositions pertaining to the interrelationships between persons and settings from Kingry-Westergaard & Kelly’s (40) overarching ecological approach. Source: Reference 40

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<tr>
<th>Key ideas</th>
<th>Statement of theoretical proposition</th>
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<tr>
<td>Observer/observed perspectives and mutual understanding</td>
<td>Concepts about persons and settings are derived from the observer and participants appreciating their own contexts and constructing a mutual understanding of their shared context.</td>
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<tr>
<td>Joint observation of resource creation and constraints</td>
<td>Persons in context are observed in terms of their role performance in creating resources and coping with personal, organizational, and community constraints.</td>
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<tr>
<td>Social norms as influences on resources and constraints</td>
<td>Social settings are observed in terms of the operation of social norms as they affect the definition, use, and response to resources and constraints.</td>
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<tr>
<td>Shared meaning</td>
<td>Social settings define the shared meaning and experience of persons and include being a member of a context in which occasions, places, and events define and maintain social norms.</td>
</tr>
<tr>
<td>Behavior as a function of resource creation, use, maintenance, and replenishment</td>
<td>Adaptive behavior is defined in terms of the resources that persons and settings create, use, maintain, and replenish.</td>
</tr>
<tr>
<td>Cross-situational and temporal variation</td>
<td>Adaptive behavior and the criteria for adaptive behavior may vary from place to place and from time to time.</td>
</tr>
<tr>
<td>Reciprocal relationships</td>
<td>Relationships are reciprocal: Persons affect settings, and settings affect persons; persons influence other persons, and one setting affects another setting.</td>
</tr>
<tr>
<td>Influence of outside settings</td>
<td>Events, settings, and persons outside the immediate social setting affect the expression of structures, roles, and norms inside social settings.</td>
</tr>
<tr>
<td>Within-setting transactions as determinants of outside settings</td>
<td>Person-setting transactions in one setting indirectly produce tangible effects for the interactions of other persons in other settings.</td>
</tr>
<tr>
<td>Social processes as facilitators and inhibitors</td>
<td>Social processes can facilitate or inhibit the interdependence of persons and social settings and the interdependence of roles and social norms.</td>
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</table>

epistemological assumption of the ecological approach, namely that of recognizing the social construction of ecological knowledge [“observations are bound by space, time, and the histories of role relationships of the participants” (p. 28) and are thus subject to participant perspectives]. Context is a preferred object of study in the ecological approach, but the authors acknowledge that what matters here is the construction that participants, including observers and those being observed, make of their own contexts. The adoption of this second constitutive component implies that alternative methodologies are required to capture the different constructions participants may create, their “different stories” of the intervention in community context (80). Despite the importance and relevance of the constructivist stance in health promotion (44), proponents of ecological models in health promotion have not explicitly referred to this aspect in their work.

The third constitutive component relates to the necessity for researchers and interventionists of adopting a collaborative style in the research and/or intervention enterprise: “[T]he observer [researcher] and the observed [participants] create together a shared agenda to discover and to understand community contexts” (40, p. 29). Such a collaboration is indeed essential because this partnership is the source for the construction of meaning about context or any other phenomenon to be investigated. Benefits of such a practice are purported to be the enhancement of the face validity, the usefulness of the research, the support for the intervention, the empowerment of participants, and the development of community resources (4, 80). Again, despite the fact that community-based participatory research is often cited as a preferred strategy in health promotion (27, 53), it is unclear whether this dictate has been integrated in research on ecological models in health promotion.

The final constitutive component pertains to the presence of social processes in the development of new knowledge: “[U]nderstanding the process of collaboration and the stages and sequences involved in the design of research and interventions is necessary for creating contextual knowledge” (40, p. 29). In the ecological approach, collaboration between participants is not only a tactical strategy; it is “part of the intervention paradigm itself” (80, p. 264). The interface between collaboration and community intervention has been an object of research in health promotion, particularly when conceptualized as community-based participatory research (27). Although it would be logical to integrate community-based participatory research and planning principles (2, 28) into research using ecological models, few ecological models have explicitly made this conceptual link.

In sum, in examining the constitutive components of the ecological approach, which are in keeping with key features of community psychology, it is apparent that the ecological approach is much broader than are ecological models and their current application in health promotion and public health, as the next section shows. In fact, Kelly goes as far as stating that the ecological approach is tantamount to a unique way of “looking at the world” (38) because it involves working in collaboration with groups and in settings situated in local environments to further the objective of community development or capacity building (79, 80).

ECOLOGICAL MODELS IN HEALTH PROMOTION AND PUBLIC HEALTH

Integrating and conceptualizing the environment amid other influences on behavior are key features of ecological models (17) that have been applied in public health discourse. In particular, in an effort to disentangle and highlight the complex pattern of relationships between individuals/populations and their environments, health-promotion and public health researchers have stratified the environment into various levels of influences to allow for an initial foray into the issue of levels of analysis. For example, following seminal contributions in developmental (6) and community psychology (54), Simons-Morton
et al. (70), McLeroy et al. (51), Cohen et al. (12), Flay & Petraitis (18, 19), and Stokols (73, 74) conceptualized and sometimes empirically tested environmental influences on population health outcomes. These initial contributions, which were cast as ecological models in health promotion, generated much interest as they led to reviews (29, 60, 64, 67) and applications to selected health issues (see below). Although the details are not reviewed here, it is nonetheless interesting to note that common to all these applications and models is the specification of a variety of environmental influences that can be placed on a continuum ranging from the generic to the more specific. For example, although McLeroy’s ecological model (51) outlines general classes of influences (interpersonal processes and primary groups, institutional factors, community factors, and public policy), the model by Cohen et al. (12) includes specific environmental dimensions such as physical characteristics of products and media messages. These early models also vary in the extent to which they outline specific processes through which environmental influences result in behavior adoption and maintenance. For instance, Cohen et al. provide specific illustrative examples of how environmental dimensions might result in different patterns of health behavior, whereas McLeroy et al. emphasize the unique contribution of each proposed dimension without venturing extensively into relationships between dimensions.

As shown in Table 2, more contemporary ecological models in health promotion depart from earlier contributions in that they either integrate new analytic dimensions or provide increased emphasis on conceptualizations emanating from other disciplines. As such, they are broader in perspective and thus closer to

Table 2  Model focus and key elements of contemporary ecological models developed in the field of health promotion

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<thead>
<tr>
<th>Author, year</th>
<th>Model focus</th>
<th>Key concepts</th>
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| Stokols et al. 2003 (75) | Typology of community assets for health promotion | - Material resources: economic capital, natural capital, human-made environmental capital, and technological capital  
- Human resources: social capital, human capital, and moral capital |
| Best et al. 2003 (4) | An integrative framework for community partnering to translate theory into effective health-promotion strategy | - Social ecology model  
- PRECEDE-PROCEED model  
- Life course health development model  
- Community partnering |
| Hovell et al. 2009 (32) | The behavioral ecological model | - Principles of learning with emphasis on contingencies of reinforcement  
- Influences from genetic, biological, and behavioral learning history interact with influences from the physical and social environment |
| Burke et al. 2009 (8) | A theoretical approach to social context | - The relationship between individuals and their social context is complex and is shaped and constituted by social, cultural, economic, political, legal, historical, and structural forces  
- This relationship is multidirectional, coconstitutive, and constantly in formation  
- The multilayered influences in which individuals are embedded are often beyond the level of individual consciousness |
integrating more than one of the four constitutive components of an ecological approach as outlined by Kingry-Westergaard & Kelly (38, 40). For example, in line with the participatory ideology of health promotion, Stokols (75) supplemented his earlier notion of health supportive environments (73) by emphasizing the concept of community capacity for health improvement and hence proposing a new typology of community assets for health promotion. That is, in addition to capital related to material resources (financial assets, natural resources, human-made physical and technological resources), he defined three types of human resources: resources related to social, human, and moral capital, the latter being defined as the investment of personal and collective resources toward the cultivation of virtue and justice. Similarly, Best et al. (4) proposed an overarching framework integrating not only a community partnering axis similar to Stokols’s social resources dimension but also a temporal dimension highlighting the centrality of life-course processes. Based on systems theory, the framework by Best et al. also integrates a planning model—the PRECEDE-PROCEED model (28)—to provide interventionists with a framework that not only integrates existing thinking on health determinants and critical factors for eliciting community change, but also includes a step-by-step process for developing health promotion programs.

Elsewhere, criticizing earlier ecological models for their lack of comprehensiveness and their lack of emphasis on learning principles, the behavioral ecological model (32) applies selected ecological principles but from the vantage point of behavior analysis. The behavioral ecological model calls for a return to principles of learning and underscores the additive and synergistic effects of social contingencies of reinforcement that influence lifestyle practices, from the highest levels of society to individual factors including genetics, biological processes, and behavioral learning history. Such an extension of behavior analysis to a population level is thought to allow for a better specification of change processes, thus making possible the engineering of social and cultural contingencies that will likely impact health behaviors. Finally, in a recent contribution, Burke et al. (8) lament the static and narrow vision of the social context in health behavior models, including socioecological models, and propose a theoretical approach to social context that draws on concepts from sociology and anthropology to understand the multiple dimensions of social and cultural phenomena as they relate to health behaviors. Although they do not explicitly cast their contribution within the ecological approach, their theoretical approach not only details the complex sociocultural and historical forces that define social context, but also includes a sophisticated discussion of the relationship of the individual to social structure, which takes into account a “theoretical understanding of the mutually constitutive relationship of individuals and social structures, the unconscious dispositions of individuals that reflect their social context, and the fluidity of both” (8, p. 65S).

Aside from these more generic ecological models, a variety of applications to specific public health issues have appeared in recent years with selected examples found in child health (16), physical activity (11, 65), nutrition (25, 62), or aging (68). A list of examples of contributions is available in Supplemental Appendix 1 (follow the Supplemental Material link from the Annual Reviews home page at http://www.annualreviews.org).

THE ECOLOGICAL APPROACH AND ITS APPLICATION IN RESEARCH: THE CASES OF PHYSICAL ACTIVITY PROMOTION AND FRUIT AND VEGETABLE CONSUMPTION

The proliferation of generic ecological models and specific applications to selected public health issues has generated considerable enthusiasm among scholars and interventionists in public health and health promotion. The prestigious Institute of Medicine adopted the
ecological approach as the framework underlying its thinking and recommendations regarding public health (71). Other American, European, and Canadian frameworks, policy statements, and action plans have adhered to the notion that the enhancement of population health demands action that focuses simultaneously on the personal and on the environmental determinants of health: The United States Physical Activity Plan, 2010 (http://www.physicalactivityplan.org/); The Integrated Pan-Canadian Active Living Strategy (69); Healthy People 2010 (83); The WHO Global Strategy on Diet, and Physical Activity and Health (87); as have other global declarations (e.g., Ottawa Charter for Health Promotion, The Bangkok Charter for Health Promotion: Addressing Health Issues in a Globalized World)

Furthermore, planning models such as the PRECEDE-PROCEED model (28) and Intervention Mapping (2) explicitly integrate concepts emerging from an ecological perspective into their conceptual underpinnings. Despite this enthusiasm and some clear guidelines, selected authors and commentators have underscored that individual characteristics continue to be the major focus of intervention research with corresponding mitigated results (12, 80). Some in-depth analyses of various sets of programs have empirically confirmed that such assertions are founded and that individual and interpersonal determinants continue to be the favorite or preferred levels targeted by planners and practitioners (56, 59, 63). The following section further contributes to this analytical endeavor by empirically examining through an archival study the manner in which investigators have applied ecological models to study the determinants and interventions relevant to two frequently studied health behaviors, namely physical activity involvement and fruit and vegetable consumption.

Physical activity involvement was chosen as a relevant theme for examining the application of ecological models in health promotion and public health for several reasons. First, the study of the impact of physical activity on health is relatively recent: One of the first landmark studies on the health benefits of activity was published as recently as 1953 (55). The recognition of physical inactivity as a major cause of noncommunicable disease is now widespread: The Surgeon General’s report on Physical Activity and Health appeared in 1996 (82), and the WHO’s recognition of physical inactivity as the fourth leading cause of chronic disease mortality appeared in 2004 (87). Furthermore, at least three groups of authors (11, 22, 65) have proposed that scholars apply the ecological approach to understand and promote physical activity. Finally, physical activity also seems to be a relevant choice because empirical literature linking environmental factors to involvement in physical activity has emerged over the previous 20 years, thus making this theme an interesting case study.

Similarly, promoting healthy diet, and specifically fruit and vegetable consumption as a proxy for healthy diet, was deemed relevant as a case study for ecological models in health promotion and public health. First, dietary guidance to improve nutritional status has been in place in the form of government food guides in most industrialized countries since the early 1900s (23). The growing recognition of diet and nutrition as a major cause of noncommunicable disease paralleled developments in the field of nutrition education as attempts to change diet behaviors progressed from simply disseminating scientific nutrition information to exploring and addressing relationships among psychological, social, cultural, political, and economic influences on diet (5). This scope includes most aspects of the ecological model. Furthermore, similar to the physical activity literature, the role of social/ecological/environmental factors in influencing nutrition behavior has gained momentum over the past 20 years, beginning with Glanz & Mullis’s [1988] (24) paper on environmental interventions to promote healthy eating as well as recent developments explicitly addressing application of ecological models (25, 30, 62, 66, 76). Thus, diet and specifically fruit and vegetable consumption is an interesting companion case study to physical activity.
Methodology of the Archival Analysis

To analyze the manner in which ecological models have been applied to study health and health-related behaviors and have impacted planning models and policy statements, we conducted an archival analysis of the literature on determinants and intervention approaches on two frequently studied themes, namely physical activity and consumption of fruits and vegetables. We analyzed the resulting articles to determine the extent to which selected dimensions of the ecological approach had been de facto integrated into research and practice in these domains. Rather than conducting an all-encompassing search of the literature, we elected to identify key journals and key time periods and then to examine a sample of publications within these target journals. This strategy was selected to capture the mainstream of research in health promotion and public health on physical activity and healthy eating and to capture changes across decades. Thus, we searched the following “general” health-promotion and public health periodicals: the *American Journal of Health Promotion*, the *American Journal of Preventive Medicine*, Preventive Medicine, and *Health Education Quarterly/Health Education and Behavior*; the following physical activity periodicals: *Journal of Sports and Exercise Psychology*, *Journal of Physical Activity and Health*, Medicine & Science in Sports & Exercise, and *Research Quarterly for Exercise and Sport*; and the following nutrition-related journals: *Journal of Nutrition Education/Journal of Nutrition Education and Behavior*.

To ascertain changes across time while working with a more reasonable amount of data, we examined papers published in three two-year time periods: 1988–1990, 1998–2000, and 2007–2009 as well as a selected subset of papers. Among these contributions, we included only those that pertained to physical activity, leisure time physical activity, walking, active transportation, and/or fruit and vegetable intake or diet as a proxy for fruit and vegetable consumption. Next, we excluded papers that were either editorials, reviews of the literature, or papers that conceptualized a problem, thus limiting the analysis to data-based papers. The data-based papers were then stratified according to whether they focused on identifying or quantifying determinants of physical activity/fruit and vegetable consumption or on understanding the impact of a specific intervention on these health-related behaviors. A list of the papers coded is included in the Supplemental References.

To capture the degree of integration of the constitutive components of the ecological approach into research, we coded each paper as a function of a series of five specific characteristics. In line with the analysis grid by Richard et al., which was designed to capture the degree of integration of the ecological approach (60), we coded first the number of determinants studied or the number of targets aimed at in the intervention and, second, the level of influence of the determinant(s) or intervention target(s) under investigation (i.e., individual, interpersonal, organizational, community, or political, or any combination of the previous) when there were, respectively, (a) only 1 determinant/target; (b) 2 determinants/targets, (c) 3 determinants/targets, and (d) 4 or more determinants/targets. Moreover, consistent with recent contributions highlighting the challenges inherent to assessing the degree of integration of an ecological approach into research (33, 41), two additional characteristics were examined in the papers on determinants. Acknowledging the complexity of interrelationships between health and its individual and environmental determinants within an ecological approach, we examined, third, the type of conceptualization and statistical modeling used (i.e., simple modeling or examination of associations versus complex modeling involving testing or exploring moderating or mediating effects). We also examined the importance accorded to the time dimension associated with the ecological approach by determining fourth whether the design used in the investigation was cross-sectional or longitudinal. Furthermore, in the case of papers pertaining to intervention, we examined fifth the type of setting within which any of the
Intervention study: an empirical investigation that addresses the impact or processes through which a program or policy influences health behaviors or outcomes.

All characteristics were independently coded by two raters, with each pair including at least one of the authors. Percentage of agreement ranged between 83% and 97% across characteristics. All disagreements were discussed between coders until consensus was reached.

Degree of Integration of the Ecological Approach in Physical Activity Determinants and Intervention Research

Across the three two-year time periods, a total of 1914 papers (96, 520, and 1298 papers, respectively) discussing physical activity were identified in the four general public health and four specialized physical activity journals. We elected to analyze all 96 papers from the 1980s and a 20% sample of papers from the 1990s and 2000s to have approximately equivalent numbers of contributions across the decades. The final sample included 96, 104, and 259 papers for a total of 459. Among these, 208 (45.3%) did not pertain to determinants of physical activity or interventions aimed at increasing physical activity (e.g., animal studies, studies of biological processes), 22 (4.8%) were editorials, 24 (5.2%) were descriptive papers, 51 (11.1%) were methodological papers, 39 (8.5%) pertained to conference abstracts, 15 (3.3%) were meta-analyses, and 98 (21.4%) were data-based papers.

As shown in Tables 3 and 4, of the 98 data-based papers, 51 (52.0%) addressed determinants of physical activity, whereas 47 (48.0%) focused on interventions to increase physical activity, and this approximate middle split was stable across the 3 time periods. The number of papers published from the late 1980s through the late 1990s and 2000s has increased substantially ($n = 19$, $n = 16$, and $n = 63$ representing respectively 100%, 20%, and 20% of data-based papers published across the two decades).

Turning now to selected characteristics of the ecological approach that were coded, Tables 3 and 4 also outline the number and levels of influence of determinants and intervention targets studied in research on determinants and interventions. Although the proportion of studies investigating only one or two determinants remained relatively stable across the two decades in the determinants literature (10/11 studies $= 90.9\%$, 9/9 studies $= 100.0\%$, 28/31 studies $= 90.3\%$), the level of influence of determinants that were studied evolved. Indeed, a very substantial amount of research dealing only with one determinant at the individual level of influence (7/9 studies $= 77.7\%$, 6/9 studies $= 66.7\%$, 13/31 studies $= 41.9\%$) suggests limited integration of the principles of an ecological approach. Interestingly, the proportion of such studies seems to have decreased over time. However, in the late 2000s, even studies involving single determinants more often dealt with determinants at a higher level of influence (e.g., community level), as did studies including more than one determinant (e.g., community and political).

In terms of modeling in studies of determinants of physical activity, we also observed change consistent with greater integration of the ecological approach. In the 1980s, 4 out of 11 studies (36.4%) included more complex modeling of determinants, whereas these ratios reached 6 out of 9 (66.7%) and 21 out of 29 papers (72.4%; one more methodological paper and a qualitative paper were excluded from the coding because they didn’t involve statistical modeling per se). Although nearly half the determinants studies in the first two time periods (5/11 and 4/9) involved longitudinal designs, this ratio decreased substantially in the third period (7/31 $= 22.6\%$) possibly because of emerging interest in a set of determinants at a yet unexplored level of influence.

However, in the intervention literature, although this predominance of intervening on targets at the individual or interpersonal levels of influence when there are only one or two targets is also present (5/8 studies $= 62.5\%$, 6/7 studies $= 85.7\%$, 17/32 studies $= 53.1\%$), there appears to have been a change in both the number and the level of influence of
Table 3  Number and level of influence of determinants studied, presence of a longitudinal design, and type of modeling in investigations focusing on determinants of physical activity involvement and fruit and vegetable consumption in four general public health, four physical activity–specific, and two nutrition-specific journals across three, two-year time periods (1988–1990, 1998–2000, 2007–2009)

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<th>Frequencies</th>
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<td></td>
<td>Period 1</td>
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<tr>
<td></td>
<td>Physical</td>
</tr>
<tr>
<td></td>
<td>activity</td>
</tr>
<tr>
<td>(n = 11)</td>
<td>(n = 6)</td>
</tr>
<tr>
<td>Number of determinants</td>
<td></td>
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<tr>
<td>Level of influence of determinants</td>
<td></td>
</tr>
<tr>
<td>One determinant</td>
<td></td>
</tr>
<tr>
<td>Individual (ind)</td>
<td>7</td>
</tr>
<tr>
<td>Interpersonal (int)</td>
<td>0</td>
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<td>Organizational (org)</td>
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<td>Community (com)</td>
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<td>Politic (pol)</td>
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<td>Other</td>
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<tr>
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<tr>
<td>Type of modeling</td>
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<tr>
<td>Complex</td>
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*One qualitative study was excluded from this coding.

Targets in interventions studied across the three decades. In the 1980s and 1990s, none of the intervention papers addressed three or four targets, whereas in the late 2000s, 5 out of 31 (16.1%) intervention papers addressed 3 or 4 targets. Furthermore, the level of influence of intervention targets is more diversified, often reaching targets at higher levels in the hierarchy of influence such as organizational, community, and political targets. In terms of context, we observe that intervention studies published in the 1980s and 1990s occurred mainly in organizational settings, most often in schools or worksites.
Table 4  Number and level of influence of targets studied in investigations examining the impact of interventions on physical activity involvement and fruit and vegetable consumption in four general public health, four physical activity–specific, and two nutrition-specific journals across three, two-year time periods (1988–1990, 1998–2000, 2007–2009)

<table>
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<th>Level of influence of targets</th>
<th>Period 1</th>
<th>Period 2</th>
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<td>Fruit and vegetable (diet) (n = 13)</td>
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<tr>
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</table>

Number of targets

Degree of Integration of the Ecological Approach in Fruit and Vegetable Intake Determinants and Intervention Research

Across the three two-year time periods, a total of 207 papers (62, 47, and 98 papers, respectively) were identified in the four general public health and two specialized nutrition education contexts. [7 out of 8 (87.5%) and 6 out of 6 (100.0%)], and sometimes in community contexts (1 out of 8 in 1988–1990). In 2007–2009, there was a diversification of settings with more community contexts [rather than organizational with 16 out of 32 (50.0%) and 13 out of 32 (40.6%)] and several societal context studies.

*aIn one investigation, it was impossible to code the context.
journals. For the first time period (1988–1990), no papers specifically addressed fruit and vegetable consumption. Therefore, we chose to maintain all papers that were identified as addressing determinants of dietary intake and nutrition interventions. By limiting the sample to all papers specifically addressing fruit and vegetable consumption in the latter two decades, we were able to identify a manageable number of papers. Among the 207 papers, 58 (28.0%) did not pertain to determinants of or interventions related to diet or fruit and vegetable intake (e.g., animal studies, studies of biological processes), 8 (3.8%) were conceptual papers, commentaries, or editorials, 15 (7.2%) were descriptive papers, 11 (5.3%) were methodological papers, 10 (4.8%) were systematic reviews or meta-analyses, and 105 (50.7%) were data-based papers. The final sample for coding included 105 papers: 19 for 1988–1990, 31 for 1998–2000, and 55 papers for 2007–2009.

Of the 105 data-based papers, 44 (41.9%) addressed determinants of dietary intake, whereas 61 (58.0%) focused on interventions to improve diet/increase fruit and vegetable intake. The number of intervention papers was about twice as large as the number of papers addressing determinants over the first two time periods, whereas in the most recent time period (2007–2009), numbers of intervention and determinants papers were almost equal.

Characteristics pertaining to the degree of integration of the ecological approach in research on determinants of fruit and vegetable intake and on related interventions appear in Tables 3 and 4. Similarly to the literature on physical activity (Table 3), a large proportion of papers discussed only one or two determinants (6/7 studies = 85.7%, 9/11 studies = 81.8%, 25/27 = 92.6%). In 1988–1990, only one paper moved beyond individual-level determinants to interpersonal influences (i.e., family, friends), suggesting almost no application of the principles of an ecological approach. In the latter two decades, more attention was given to interpersonal-level determinants, with approximately half the literature researching interpersonal-level determinants (6/11 studies = 54.5%, 17/27 = 63.0%), most frequently in conjunction with individual determinants. Very few papers addressed 3 or 4 targets, with organizational and community-level determinants gaining some attention in the 2000s (2/27 studies = 7.4%). No papers addressed public policy as a determinant of diet behavior.

In terms of modeling in studies of determinants of fruit and vegetable consumption, we observed that 4 out of 6 studies in the early decade involved complex modeling, whereas these ratios decreased in the 1990s and 2000s to 4 out of 10 (40.0%) and 10 out of 27 (37.0%), respectively. It is, however, noteworthy to link this observation with the notion that few studies included determinants at a higher level of influence. In terms of design, contrary to studies in physical activity, studies of the determinants of fruit and vegetable consumption showed an increased in the use of longitudinal designs from no papers in the late 1980s to 2 out of 11 (18.2%) in the late 1990s, and 5 out of 27 (18.5%) in the late 2000s.

In the intervention literature, in the latter two decades, there is a small tendency toward including a larger number of targets. In the earliest studies (1988–1990), no study included more than two targets, whereas in the 1990s and 2000s 10 out of 20 and 3 out of 28 studies included 3 or more targets. In terms of levels of influence of targets, we note that intervention studies include mostly targets at the individual, interpersonal, and organizational levels of influence, but few aim at changing targets at the community or political levels. Interestingly, though, there is an increase in the proportion of studies unfolding in community, societal, or supranational contexts rather than in organizational contexts across the two decades (2/13 studies = 15.4%, 5/20 studies = 25.0%, 9 out of 28 studies = 32.1%).

DISCUSSION
Over the past 20 years, the ecological approach in health promotion has been the object of numerous contributions. Generic ecological
models as well as applications to specific health issues have been proposed. Empirical studies investigating propositions derived from these models have been published in a variety of public health domains. Periodically, reviews and analyses of models and related literature (29, 60, 64, 67) have been offered. The present contribution is cast against this backdrop. We first have provided an updated presentation of definitions and basic principles of the ecological approach. Given the major role played by community psychologists in conceptual and methodological developments around the ecological approach, we have emphasized work published in this field, which Green (26) recently qualified as “a preferred go-to subdiscipline since the rebirth of the ecological model in public health” (p. 405). Next, adding to earlier contributions, we have reviewed models that have not been considered previously or which have been newly presented. Lastly, to investigate the extent to which ecological models have permeated empirical research in health promotion, we have analyzed a sample of the published empirically based literature on physical activity and fruit and vegetable consumption across a 20-year period to determine the extent to which selected dimensions of the ecological approach had been integrated into research and practice in these domains. Overall, such efforts allowed us to identify key trends about the evolution and uses of the ecological approach in health promotion and public health and lead to selected recommendations for future research and theorizing.

Of initial interest is the evolution noted in terms of the comprehensiveness of the ecological models discussed in health promotion. Although the first generation of models, e.g., those disseminated in the 1980s and 1990s, for the most part emphasized the notion of environmental determinants and their interactions with behavior and health, three among the models published in the past decade include and model additional innovative dimensions such as the life course perspective (4), community capacity for health improvement (75), community partnering (4), and the coconstructive relationship between the individual and his/her social context (8). For example, to the notion of health supportive environment, Stokols (75) integrates a new dimension that focuses on the nurturing of community human resources for health promotion through at least three processes: “1) mobilization and channeling of existing community assets (individuals’ expertise, energy, creativity, and material resources) into productive investments that bring about desired returns, such as improved health outcomes, 2) the broadening and diversification of a community’s existing pool of assets over time, and 3) the empowerment of community members to sustain health improvement efforts throughout extended periods” (p. 5). Such a focus on community resources is highly congruent with community psychologists’ vision of the ecological approach.

Indeed, Kelly’s ecological metaphor (35–37, 79, 81), Kingry-Westergaard & Kelly’s four constitutive components of the ecological approach (40), and Trickett’s recent comprehensive review (79), just to name a few, emphasize the importance of elements pertaining to the building of community capacity and resources. There is certainly much commonality here with the health-promotion field, in which community capacity (43, 86), collaboration and participation (27), partnership (9), and empowerment (84, 85) have ranked high among the core orientations and central concepts for decades. Furthermore, participation and collaboration are both central ingredients of current health-promotion planning models (2, 27, 28). It is comforting to note that such concepts have begun to permeate work conducted around the ecological approach in health promotion. We now need to develop further such innovative dimensions to better integrate work conducted on the ecological approach with the health-promotion vision.

An examination of the integration of selected dimensions of the ecological approach in published studies over a 20-year period is a second important contribution of this article. Although similar assessments had already been conducted in the past (33, 41, 48, 60), to our
knowledge, this is the first exercise conducted over a more lengthy time period, thus making possible the exploration of trends. Results of the archival analysis show favorable trends in studies on both determinants and intervention; advancement toward integrating an ecological approach is more discernable in the study of physical activity than in the study of fruit and vegetable consumption. Although studies involving only one or two intervention targets (most often individual or interpersonal) continue to populate the mainstream and specialized literatures heavily, there has been a sizeable increase across the past two decades in the number of studies including multilevel determinants of health-related behaviors or multilevel interventions. The most recent period (2007–2009) is indeed characterized by numerous instances of studies including multiple determinants or targets, involving more distal targets such as the community or, in the case of physical activity, the political environment.

In terms of contexts, the study of both physical activity and fruit and vegetable consumption seems to involve mainly organizational settings for interventions, most often schools or worksites. Nevertheless, with the development of interventions targeting the built environment to facilitate leisure and utilitarian physical activity (39, 65), the community is emerging as a preferred setting of intervention in the physical activity literature. In terms of research design, although there is limited change in terms of applying longitudinal designs across the three decades, there is clearly an increase in the complexity of analytic methods applied in research as more researchers strive to investigate moderator and mediator relationships. These latter trends are consistent with the ecological approach, which endorses the need for more complex theorization to capture fully the causal web of determinants leading to health behaviors and outcomes.

Thus, the archival analysis revealed overall that although individually focused research and intervention are still published frequently in the empirical literature pertaining to physical activity and fruit and vegetable consumption, health-promotion researchers and interventionists have begun in earnest to work within a multilevel perspective. This certainly demonstrates the usefulness of ecological models and is consistent with the conclusions of similar investigations (41, 56, 59). A limitation of the archival investigation is, of course, the small number of dimensions considered in the analysis. As detailed below, the ecological approach to health promotion means far more than integrating multiple levels of determinants or interventions. Research is needed to develop assessment tools that allow for the characterization of the innovative dimensions described earlier, such as community capacity development dimensions and the development of collaborative relationships between the program team and the community. Toward this end, authors such as Ryerson Espino & Trickett (63) and Jakes (33) have presented useful developments.

Aside from methodological developments, more research is needed to expand the knowledge base on the ecological approach. As revealed in our archival analysis, the literature is far from being replete with examples of multilevel intervention research, at least in regard to physical activity and fruit and vegetable consumption. Yet the large-scale implementation of the ecological approach in health promotion will hardly be possible in the absence of a solid evidence base related to the implementation and outcomes of ecological programs. As imperative as it is, such a research agenda poses many challenges. First, given the number and types of variables in question, the complexity of the interrelationships among them, and the time needed to observe an impact at the population level, a long-term enterprise must be envisioned (65). Political and cultural barriers will also have to be addressed. Indeed, in an essay on the implementation of innovative health policies, Berkeley & Springett (3) discussed how the transition from public health policy “rhetoric to [public policy] reality” is impeded by current political and cultural constraints, including the dominance of the biomedical paradigm with its emphasis on quantification and short-term targets of performance and political imperatives.
of immediate outcomes at odds with a health-promotion perspective. Moreover, being consistent with the ecological approach evaluation of multilevel interventions will also require addressing key elements such as community and social processes involved in the development, implementation, and evaluation of interventions, unintended effects of the interventions, and interactions with local culture (80). Last, the adoption of multiple perspectives and a collaborative style should be included among the core orientation underlying this research agenda. However, this too requires a change in the typical modus operandi.

Sharing many core orientations and values with the ecological approach, the health-promotion community is certainly well positioned to develop, conduct, and advance this research agenda. Indeed, more fully operationalizing the ecological approach may be key to developing a more thorough and nuanced understanding of complex health problems and means of addressing them to promote the public’s health.

SUMMARY POINTS

1. Over the past three decades, the ecological approach has generated much interest and enthusiasm among researchers and interventionists.
2. The ecological approach is much broader than ecological models and represents a “unique way of looking at the world.” (38)
3. Numerous ecological models focusing on health behaviors and public health outcomes have emerged in the past two decades.
4. Ecological models published in the past decade are closer to fully integrating basic principles of the ecological approach.
5. In two decades, physical activity research has become more ecological by involving more determinants at higher levels of influence.
6. Research on fruit and vegetable shows signs of becoming more ecological, although developments lag somewhat behind those in physical activity.
7. Greater integration of the constitutive components of the ecological approach offers promise for advancing knowledge.
8. Adoption of an ecological approach will accelerate the development of more powerful, effective population health interventions.

DISCLOSURE STATEMENT

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60. Presents a model of the ecological approach in health promotion and a grid for assessing the ecological dimension of programs.

65. Proposes an ecological model for addressing the issue of physical inactivity.

71. An *Institute of Medicine* report that adopts the ecological approach as the framework for developing public health recommendations.

73. Offers an ecological analysis of health promotion emphasizing the conceptualization of health-promotive environments.
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