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Application and Modification of the Integrative Model for Environmental Health

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Abstract

The Integrative Model for Environmental Health (IMEH) has guided research, literature reviews, and practice initiatives since 2002. This paper presents the Modified IMEH that was developed based on using the IMEH as a guiding conceptual framework in a community-based participatory research environmental health project. Concepts from the Model of Risk Information Seeking and Processing as well as emergent themes from the data analysis were instrumental in this process. The Modified IMEH alters the structure of the IMEH in that the Vulnerability and Epistemological Domains are more prominent and feedback between domains is included.

Keywords

Environmental health; Theory development; Theory application; Community Based Participatory Research

Since 2002, the Integrative Model for Environmental Health (IMEH) (Dixon & Dixon, 2002) has guided environmental health focused integrated literature reviews, empirical studies, and nursing practice initiatives (Ercolano, Hendrickson, Dixon, & Dixon, 2008; Greving & Santacroce, 2005; Harnish, Butterfield, & Hill, 2006; Perron & O'Grady, 2010). The IMEH, which was developed based on a literature review, experiences in academia and activism, and the recognition of the limitations of the epidemiological focus on the adverse health effects of environmental toxicants, has been characterized as a situation-specific theory (Butterfield, 2002; Dixon & Dixon, 2002; Im, 2005). Situation-specific theories are limited to a specific population or practice area and generally are grounded in clinical practice. Im (2005) advocated using an integrative approach to the dynamic, cyclical process of theory development. This paper describes the modifications to the IMEH using an

integrative approach in which: (1) the IMEH guided a community-based participatory research (CBPR) interdisciplinary pilot research project that focused on environmental health in an urban neighborhood, (2) the relevant theoretical literature was critically reviewed and the evolutionary nature of theory development was explored; and (3) operationalizing the IMEH thematic analysis categories and interpreting findings required expanding and restructuring the original model.

The Integrative Model of Environmental Health

The IMEH as described by Dixon and Dixon (2002) is comprised of four interrelated domains related to environmental health: Physiological, Vulnerability, Epistemological, and Health Protection (Figure 1). Elements within each of the four domains further delineate and explain the domain. The Physiological Domain is proposed as the starting point and addresses agent, exposure, incorporation (accumulation of substances), and health effects. Agents can be biological, chemical, or physical and can result in health effects when exposure and bodily accumulation occurs. The Vulnerability Domain has two elements - Individual (e.g., age, nutrition) and Community (e.g., location). The Vulnerability Domain is focused on the disparities in the distribution of environmental exposures and in susceptibility to environmental hazards. The two elements in the Epistemological Domain, which is concerned with how individuals and communities come to know about environmental hazards, are Personal Thought and Social Knowledge. Personal Thought begins with individual awareness of the potential hazard that can then lead to investigation of the hazard. Social Knowledge reflects communities coming together to share knowledge, responsibilities, and options to address the hazard. Ideally Personal Thought and Social Knowledge are foundational for actions that minimize environmental exposures and protect health. What to do about environmental health hazards is addressed in the Health Protection Domain. The three elements in this domain are: Concerns (about environmental risks), Efficacy, and Actions. Dixon and Dixon (2002) advocated a prevention focus by acting proactively to reduce or eliminate environmental risks at the individual and the community levels.

Critique and discussion of the model have been limited. Macdonald (2004) used the IMEH as an organizing framework in an analysis of the Toronto SARS experience. The Epistemological Domain was found to be the most useful domain as weaknesses in communication strategies and in microbiology laboratory resources were problematic in determining the causative agent. Macdonald concluded that although the model is an “evolution from the traditional public health model... [it] “does seem at times downstream” (Macdonald, 2004, p. 548). An ecological domain that emphasizes preventing or minimizing exposure to emerging diseases was suggested as a precursor to the Physiological Domain.

Larsson, Butterfield, Christopher, and Hill (2006) explored rural community leaders' (n=6) perceptions of environmental health issues using an interview guide based on the IMEH domains. The Physiological and the Health Protection Domains framed the study findings. With regard to the Health Protection Domain, the authors concluded that community leaders may minimize concerns about environmental hazards if environmental health information is perceived as potentially having political implications or if there is an expectation that other entities (e.g., federal government) will address the hazard.

In another study, the IMEH guided the development of interview questions assessing parents' (n=11) perceptions of environmental risks (Harnish et al., 2006). Data were analyzed initially for emergent in vivo themes (i.e., without a guiding framework) and then for congruence with the IMEH domains. Harnish and colleagues noted that data were grouped easily into the IMEH domains but acknowledged that the interview questions had

been formulated using the four IMEH domains. The IMEH was determined to be a “good fit, both conceptually and strategically, with field-generated data” (p. 470).

Perron and O’Grady (2010), who used the IMEH to structure an integrative literature review of childhood lead poisoning in Canada, commented that the IMEH reflects a balanced, system perspective. However they also noted that because the IMEH is rooted in primary prevention, it lacks “guidance for secondary and tertiary prevention within the Health Protection Domain” (p. E12). They advocated including components of the Community as Partner Model and the Community Action Model to enhance the Health Protection Domain. While these four papers provided insights into the usefulness of the IMEH, none specifically presented an evolutionary next step for the IMEH.

Application of the Integrated Model for Environmental Health

The application and the modification of the IMEH was an iterative process that began during the conceptualization of our CBPR environmental health project and continued through data analysis and interpretation. Environmental health experts often lack the skills to communicate effectively with community residents, who may not understand environmental public health concepts (National Institute of Environmental Health Sciences, 2009). Terms commonly used by environmental health experts such as risk assessment and environmental exposure often hold little meaning for communities. A common vocabulary between community members and environmental health experts can build environmental public health literacy and translate environmental health research into community action. The aim of this CBPR project was to begin building a common vocabulary between residents of an inner city urban neighborhood and experts (e.g., scientists, public health professionals) concerning an environmental public health issue salient to the residents.

Prior to beginning this CBPR project, we conducted three preliminary focus groups with residents to gather information on their environmental health concerns. A 15-member Steering Committee comprised of neighborhood residents (n=7), community partners (n=3), and researchers (n=5) was then formed to guide the CBPR project. Steering Committee members reviewed preliminary focus group findings and identified litter as a salient neighborhood environmental health concern for which to build the common environmental public health vocabulary (Morgan, Fischhoff, Bostrom, & Atman, 2002). We will describe how the data collection and analysis process, which was guided by the IMEH, led to our proposed modifications to the IMEH.

Data collection

Using the IMEH as a guiding framework, simultaneous assessments were conducted of neighborhood residents’ and experts’ perceptions of litter using open-ended in-person interviews, focus groups, and go-along interviews. Go-along interviews involve a researcher walking through the community along with a community member. The interviewer uses field observation methods and open-ended questions to elucidate the informants’ experiences and interpretations in their community (Carpiano, 2008).

Open-ended interview questions were adapted from published IMEH-based interview guides that broadly addressed environmental health concerns (Harnish et al., 2006; Larsson et al., 2006). We modified the interview questions to specifically focus on litter and trash. For example, the question pertaining to the health effects of litter (Physiological Domain) was “How could litter affect someone’s health?” The research team initially drafted the modified open-ended interview questions, presented the questions to a Steering Committee sub-committee for feedback, revisions were incorporated and the interview guide was reviewed and finalized by the full Steering Committee. The interview guide proceeded from the area

in which residents were most conversant as learned from preliminary focus groups (Epistemological Domain-Personal Thought) and built on that interaction to explore perceptions regarding health effects from litter (Physiological Domain), groups most at risk for those health effects (Vulnerability Domain), how information about the topic could be obtained (Epistemological Domain-Social Knowledge), and what actions could be undertaken to address those health effects (Health Protection Domain) (Table 1). The Ohio State University Human Subjects Institutional Review Board approved the study.

Data from residents were gathered through two focus groups (n=17 participants), seven in-person interviews, and three go-along interviews. Residents were recruited through notices and flyers posted in key gathering places throughout the neighborhood and by word of mouth. Participants received a grocery store gift card. Resident participants were primarily African American (63%), female (67%), unemployed (63%), had at least a high school education (89%), and rented their homes (72%). Participants ranged in age from 21–78 years. We also conducted one focus group (n=5 participants) and three interviews with experts. Experts, who were recruited via referrals, included representatives from the local health department, state environmental protection agency, city waste management services, a property developer, and a scientist. Experts were all college educated; most were white (87.5%), female (62.5%), and ranged in age from 35–57 years. Experts received a blank flash drive for participation.

Data analysis

All interviews, focus groups, and go-alongs were recorded digitally and transcribed by a contracted transcriptionist. A member of the research team verified each transcript for accuracy. A coding scheme was developed using the 2002 Dixon and Dixon article as a guide with the understanding that researchers were to code inductively using in vitro or in vivo coding labels to represent areas in the data that were not specifically designated in the IMEH (2002) framework. Although each of the four domains and its elements (Figure 1) provided a preliminary categorization of the data, the richness of the data prompted us to capitalize on the inductive aspect of our analysis and delve further into subcategorizing certain elements within each domain. For example, in the Physiological Domain the first element, *Agent*, was considered too broad as there were multiple agents in litter (e.g., physical [glass], biological [bacteria]). We therefore included sub-elements identified by Dixon and Dixon (2002) in their explanation of each domain. For example, in the Physiological Domain, the element *Agent* was sub-categorized to include the sub-elements of *Chemical* and *Microbial*; the element exposure included the sub-elements of *Ingestion*, *Inhalation*, *Dermal*, and *Experiential*.

Using this combined deductive and inductive coding scheme, the transcript from the first resident focus group was coded independently by each of the researchers. The unit of analysis was a phrase or sentence. When there was no sub-element code that adequately represented a concept in the transcript, one was created by the coder and brought to the research group for discussion. In this process, we identified that the sub-elements could be further delineated. At this point the language of domains, elements, and sub-elements became cumbersome and we renamed the coding categories. The four domains (Physiological, Vulnerability, Epistemological, and Health Protection) were termed 'Primary Domains.' The elements of each domain were termed 'Second-level Domains,' the sub-elements became 'Third-level Domains,' and so forth. Second, third, and fourth-level domains were created or modified as they emerged from the data and required 100% agreement among the researchers. For example, the original third-level domain of *Microbial* in the Physiological Domain was felt to be too narrow and therefore was renamed '*Biological*' with *Bacteria*, *Viruses*, *Rodents*, *Insects*, *Fungus/Mold* as fourth-level domains.

As described by Im (2005), a dynamic, cyclical process of theory development occurred as the researchers moved from interpreting the newly identified third and fourth-level domains into crafting a restructured version of the original IMEH (Dixon & Dixon, 2002). The restructuring progressed as the first revision of the original coding scheme then was applied to the transcript from the second resident focus group; modifications were made to the coding scheme following the same procedure and with agreement by all researchers. Two researchers coded each of the remaining transcripts and discussed any discrepancies until agreement was reached. Any additional modifications to the coding scheme were brought to the full research team for discussion, and concomitantly the conceptualizing of the restructured version of the IMEH developed. Table 2 illustrates the coding scheme for each Primary Domain.

Adaptation of the IMEH

Physiological and Vulnerability Domains

The adaptation of the Physiological and Vulnerability Domains of the IMEH occurred with the addition of third and fourth-level domains as these emerged from the data. For example, common health effects of litter identified by residents included the third-level domains of injuries, dermal exposures, and psychological impact. The psychological impact of litter is exemplified in this quote from a resident “It’s clear to me that it affects people’s moods. That it’s one of many contributing factors that affects how people feel about the space that they’re functioning in. And it makes people feel blue.”

Similarly, populations most frequently identified by participants as most vulnerable to the impacts of litter, and thus categorized as third-level domains, included age and health status. Community characteristics classified as third-level domains included urban blight, businesses in the neighborhood such as bars and fast food restaurants, and neighborhood housing density (Table 2).

Epistemological and Health Protection Domains

Dixon and Dixon (2002) provided adequate and detailed guidance for developing a coding scheme for the Physiological and Vulnerability Domains. This was not the case with the Epistemological or the Health Protection Domains. To more fully operationalize these domains the research team explored the theoretical literature and looked to the Model of Risk Information Seeking and Processing as a framework that provides insight into how people might seek information about a risk, and how those information seeking behaviors influence their risk-related behaviors (Griffin, Dunwoody, & Neuwith, 1999). The Model of Risk Information Seeking and Processing is based on a synthesis of the Heuristic-Systematic Model and the Theory of Planned Behavior (Ajzen & Fishbein, 1980; Eagly & Chaiken, 1993) and posits that the gap between what is known about an environmental health risk and what an individual believes he or she should know (perceived information sufficiency) is influenced by societal pressures to learn about the risk (informational subjective norms), the extent to which personally held values are threatened and the level of personal risk (perceived risk), and affective responses to the hazard such as worry and anger. Information gathering capacity, which is the perceived ability to find the information needed, and beliefs about the trustworthiness of those communicating about and responsible for managing the risk influence how much effort an individual will put into seeking out information about that risk and deliberating over that risk when choosing whether or not to act. The Model of Risk Information Seeking and Processing proposes “the perceived gap between what someone knows and what he or she needs to know ... motivates a person to devote more cognitive effort to processing messages about the behavior” (Griffin et al., 1999, p. S237). Greater seeking and processing of information leads to the consideration of more relevant behavioral

beliefs, and ultimately more stable positive or negative attitudes toward the particular health hazard. According to the Theory of Planned Behavior, whether or not someone takes action to address the hazard is influenced not only by individual attitudes, but also by perceived control and social pressure to act (Ajzen & Fishbein, 1980).

Examples of third-level domains added to the Epistemological and Health Protection domains of the IMEH and supporting quotes from the data follow.

Epistemological Domain – Personal thinking—As described by Dixon and Dixon (2002), *Personal Thinking* (second-level Epistemological Domain) in the IMEH includes *Awareness* of an environmental health risk as a third-level domain. Incorporation of concepts from the Model of Risk Information Seeking and Processing (Griffin et al., 1999) added *Perceptions*, *Personal Responsibility*, *Informational Subjective Norms*, *Information Sufficiency*, *Information Source*, *Trust of Information Source*, and *Information-Seeking* as third-level domains (See Table 2).

Perceptions involve individual estimates of the impact of the environmental risk to oneself and/or to society (Griffin et al., 1999). The following quote exemplifies *Perceptions* of litter “I think litter is a really visible indication of whether or not people care about an area.” *Personal Responsibility*, which is illustrated in the following quote, “Residents can certainly pick-up, participate in pickups, both formal and informal” reflects an individual’s motivation to seek information and address the perceived environmental risk. *Informational Subjective Norms* represent the “the knowledge a person believes he or she would be expected to hold about the risk” (Griffin et al., 1999, p. S234). An example of *Information Subjective Norms* is in the following response to the question asking if attitudes toward litter had been affected by the media, “Probably more of conversations with my neighbors through the civic association because it comes up a lot and people are concerned about it and they talk about it.” *Information Sufficiency* denotes a personal assessment of one’s current knowledge about the environmental risk compared to the desired amount of knowledge about the risk and is illustrated in the following, “I don’t know what’s in that dust. I have no history of allergies whatsoever. I can walk through a field of poison ivy, and not be affected. But whatever’s in there, my system does not like it.” *Sources of Information* about the health effects of litter identified by respondents included the health department, the city, EPA, and the internet. *Trust of the Information Source*, which is impacted by social, political, and cultural factors, is exemplified in this quote “I think I would mostly likely trust a report that I can read like off the internet. Or like even from ... the news, maybe.” Individuals can seek information about an environmental risk from a variety of sources (e.g., television, library, government agency) and for a variety of reasons (e.g., address the issue; reduce tension). *Information Seeking* is evident in this response to the interview question asking if participants had ever sought information about the health effects of litter “I went to COSI [Center for Science and Industry] to see the exhibits of litter and then they have underneath it, what litter does to your body.”

Epistemological Domain – Social Understanding—Based on our analyses, the work of Dixon and Dixon (2002) and of Griffin et al. (1999), the third-level domains in Epistemological Domain were expanded to include *Community Knowledge*, *Community Opinion*, *Social Norms*, *Community Responsibility*, and *System Responsibility*. *Community Knowledge* addresses community level of knowledge about an environmental risk while *Community Opinion* reflects community perceptions about the risk. A community’s knowledge level and opinions need to be respected and viewed as legitimate by health professionals and other experts (Dixon and Dixon, 2002). *Social Norms* are normative forces that identify appropriation action (e.g., what an individual believes “should” be done based on what others are doing), such norms influence gathering or not gathering

information, acting or not acting to address a hazard, etc. An example of *Social Norms* was evident in this comment regarding litter abatement, “People see people doing things. It takes a long time to make a change that way, but usually it’s a more lasting change” *Community and System Responsibility* reflects a community’s (e.g., neighborhood) or the larger society’s (e.g., city government) drive to seek-out information to address the environmental risk. *Community Responsibility* was heard in this comment about litter clean-up, “Pick it up, or have like certain days, like this block has this day to clean up and the next day, another block has a different day to clean up.” *System Responsibility* is evident in the following, “From the city we have to have enforcement around litter violations, and specifically illegal dumping violations.”

Health Protection Domain – Concerns—The Health Protection Domain of the IMEH includes the second-level domains of *Concerns*, *Efficacy*, and *Actions*. *Concerns* were further explicated by Dixon and Dixon (2002) as a *Sense of Threat*. *Concerns* are consistent with the affective responses or emotional reactions that influence how information is processed and actions taken (Griffin, et al., 1999). Affective responses identified by study participants included *Worry*, *Anger*, *Uncertainty*, *Lack of Control*, and *Concern over System Failure*. *Uncertainty* about the impact of litter is exemplified in the following, “so technically and scientifically can somebody catch something from litter?” A resident voiced *Lack of Control* concerning refuse pickup, “We don’t know when our trash man comes, it’s a mystery.” *Concern over System Failure* relates to concerns with the larger system (e.g., city government) that impact the environmental risk. An example of concern with refuse pickup is evident in the following, “I think these garbage men are just negligent is a big part of it; and [the trash] blows around.”

Health Protection Domain – Efficacy—Dixon and Dixon (2002) described both *Personal* and *Community Efficacy* as an individual’s or community’s beliefs in the ability to accomplish actions that will reduce risk. In their discussion of perceived hazard characteristics Griffin et al. (2002) addressed the likelihood that any actions taken will reduce the risk. We operationalized this likelihood as third-level domains of *Self-Response Efficacy* (will my actions reduce the risk?) and *Community-Response Efficacy* (will the community’s actions reduce the risk?). These domains are consistent with the idea of perceived control that is highlighted in the Theory of Planned Behavior (Ajzen & Fishbein, 1980). The following illustrates *Community-Response Efficacy* concerning litter clean-up, “We’ve always started with one property and you change that behavior, you provide them education and then it starts to spread because as people become aware and that becomes a new standard for that community.”

Health Protection Domain – Actions—Actions to address or avoid the environment risk can occur at the *Individual/Family*, *Community* or *System* levels (Dixon & Dixon, 2002). We provided greater specificity by coding actions as focused on the *Development of Action Steps*, *Education*, or *Advocacy*. The *Development of Action Steps* is the outlining of action strategies that can be taken to address the environmental risk and is noted in the following “Right now there is a beautification group organized to tackle the problems of litter; and it’s got to be twofold: the education of the citizens who live there in addition to ongoing abatement of [litter].” *Education* of residents was frequently noted as an action that can be taken to reduce litter “I think educational; they need to know—this is what happens when you keep litter. It’s not going to clean itself for one... Just education about littering: what it can do, what it can cause, how it looks as a whole?” *Advocacy* is clearly illustrated in this statement by an expert participant “Residents can certainly advocate for sensible solutions they feel are most appropriate.”

The Modified Integrative Model for Environmental Health

An integrative approach in which relevant literature concerning the IMEH was critically reviewed and the qualitative data analyzed using the coding scheme described above led to the development of the Modified IMEH presented in Figure 2. The modifications included five structural changes in the depiction of the IMEH. First, we moved the Vulnerability Domain to the upper left of the Modified IMEH and the Physiological Domain to the upper right. While Dixon and Dixon (2002) acknowledged the need for greater emphasis on the Vulnerability Domain, nursing's inherent focus on vulnerable populations (Flaskerud & Winslow, 1988) and the desired broader upstream perspective drove the change to place the Vulnerability Domain in a more prominent location. The second structural change was the placement of the Epistemological Domain in the center of the model. This new placement provides greater emphasis on this domain and reflects the influence of both the Vulnerability and the Physiological Domains on the Epistemological Domain. This placement also underscores that information seeking at the personal or societal level can be the impetus for Health Protection actions. The third structural change was the additional of a bi-directional arrow between the Vulnerability and the Physiological Domain to designate the co-influence of these domains upon each other. As noted by respondents in our study, those most vulnerable (e.g., children) may be at greatest risk for exposure to environmental hazards (e.g., broken glass). The fourth change was to insert an arrow from the Health Protection Domain to the Vulnerability Domain to symbolize the potential for actions by an individual or community to decrease Vulnerability to environmental hazards. For example, litter clean-ups were noted to decrease the perceived neighborhood blight and increase the number of children who played outside without fear of injury from litter and trash. Consistent with the original IMEH (Dixon & Dixon, 2002) the arrows in the Modified IMEH indicate directionality and do not imply causality. Finally, compared to the representation of the original model, we chose to portray a more circular, fluid pattern that eliminates a linear view. Although Vulnerability and Physiology influence information seeking behaviors, the resulting knowledge of environmental hazards is paramount to Health Protection. It is protection of health that is the primary goal.

In addition to the five structural changes noted above, we added the second-level domain of *Societal Characteristics* to the Vulnerability Domain. Dixon and Dixon (2002) included public policies within their discussion of community characteristics in the Vulnerability Domain; however, state and federal policies (e.g., clean air or water legislation) would not instinctively be considered a community characteristic. The inclusion of societal characteristics in this domain provides greater consistency with a proactive ecological and multiple determinants of health approach (Butterfield, 2002; US Department of Health and Human Services [USDHHS], 2010).

The modifications to the structural presentation of the IMEH, the additions to the third-level domains based on the work of Griffin and colleagues (1999) (Table 2), and the specificity of the fourth-level domains resulted in our also concluding that the Modified IMEH is useful in guiding qualitative data analysis. Our application of the IMEH has emphasized the "integrative" character of Dixon and Dixon's useful model and the emergent nature of qualitative research. In this case the emergent nature of qualitative research was enhanced using an approach to data analysis that was guided by an existing theoretical framework (i.e., the IMEH) but also included openness to an inductive approach that allowed the researchers to move beyond the specifics of the framework.

Discussion

The IMEH (Dixon & Dixon, 2002) has been shown to be a valuable framework for developing and conducting public health nursing research related to environmental health issues. Our study illustrates that the model is flexible enough to be adapted if needed but inclusive enough to support a logical flow from planning through conducting a study and for identifying practice implications.

As Dixon and Dixon (2002) noted, the IMEH is an appropriate starting point for scholarly work and conversations about issues in research and applications to practice. Our work typified a CBPR approach to investigating an environmental health concern in an urban neighborhood. The research team saw the model as an ideal fit between our research questions and scope of work. Whereas the primary and secondary domains of the IMEH generally would be consistent across studies, it is anticipated that some of the third and fourth-level domains would vary based on the circumstances of a particular study. In our study focusing on litter in an urban neighborhood, neighborhood characteristics (within the Vulnerability Domain) included poverty and crime/violence. These may not be relevant if the focus of the study were, for example, pesticide use in a rural community.

The utility of the IMEH (Dixon & Dixon, 2002) is evident not only through our work and that reported by other researchers but in its relevance to ongoing developments in the realms of practice and research. Even with our suggested changes, the Modified IMEH is consistent with the Healthy People 2020 framework (USDHHS, 2010) and supports the National Prevention Strategy (USDHHS, 2011). The Healthy People 2020 framework is built on an ecological approach that characterizes health/health outcomes as being determined by multiple factors – individual behaviors, biology and genetics, health services and policies – interacting in and with the physical and social environments. The National Prevention Strategy identifies safe and healthy environments as one of the four strategic directions that are the foundation for efforts to promote health. The theoretical domains of the Modified IMEH are linked easily with the multiple factors or determinants of health (USDHHS, 2010) that can emanate from the environment (USDHHS, 2011): Vulnerability Domain represented by individual, community, and broader system characteristics that impact health as well as dimensions of disparate health hazards and health outcomes among various populations; Physiological Domain represented by agents and exposures in the environment as factors or determinants of health, and incorporation and health effects as representations of health and health outcomes; Epistemological Domain foci of individual personal thinking and social understanding; and the Health Protection Domain process of environmental health engagement generated from individual and community concerns, efficacy, and resultant action through individual and community behavior and/or social policy.

Conclusion

The original IMEH is adaptable and also useful for public health nursing research and for evidence-based practice. The Modified IMEH expands the model's usefulness while retaining its simplicity and sophistication. The delineation of third-level domains provides clarity and specificity to the domains. The inclusion of risk communication concepts further explicates the Epistemological Domain to include perceptions of risk, pressures to know more about the risk, trust in information sources, and individual patterns of information seeking and processing. The Health Protection Domain also benefitted from the field of risk communication specifically with the inclusion of personal and community response efficacy. These additions and the restructuring of the depiction of the model provide a stronger upstream perspective as well as greater specificity as to how environmental health

knowledge is sought and applied allowing for broader usefulness for research and practice in environmental health nursing as well as other public health disciplines.

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Figure 1.
Integrative Model for Environmental Health (Dixon and Dixon, 2002).

Figure 2.
Modified Integrative Model for Environmental Health.

Table 1

Interview and focus-group questions.

Domain	Questions
Epistemological	<ul style="list-style-type: none"> • Would you consider litter to be a problem in this neighborhood and if so, why? • Where does the litter come from? • What types of litter are in this neighborhood? • Where is most of the litter in this neighborhood? • What happens to the litter? • Have you ever looked for information about the health effects of litter? If so, why? And from where? • Who do you trust to give you good information about the health effects of litter? • Have your attitudes towards litter in this neighborhood been affected by TV or radio, Civic association, books, gardening or anything else?
Physiological	<ul style="list-style-type: none"> • How could litter affect someone's health? • How could people who live in this neighborhood come in contact with or be exposed to litter? • How much contact would someone have to have with litter to make them sick?
Vulnerability	<ul style="list-style-type: none"> • What type of person might be more at risk for health problems if they were exposed to litter/trash? • Have you or anyone you know in this neighborhood, had their health affected by litter? • What do you think makes this community more at risk for health problems from litter?
Health Protection	<ul style="list-style-type: none"> • What types of things are being done now in this neighborhood about litter? • What are things that people/families living in this neighborhood could do about litter? • What are things that the organizations, businesses, or groups could do about litter in this neighborhood? • What would help neighborhood residents' deal with litter? • What do you think can actually be done about litter in this neighborhood by you? By other residents? By the civic association?

Table 2

Applied primary, second, and third-level IMEH domains.

Primary Domains	Second-Level Domains	Third-Level Domains
Physiological	Agent	Aesthetic, Biological, Chemical, Physical
	Exposure	Dermal, Experiential, Ingestion, Inhalation
	Incorporation	Body burden
	Health Effects	Cardiac, Cancer, Dermal, Injury, Latent health effects, Psychological, Respiratory, Other unspecified illnesses
Vulnerability	Individual characteristics	Age, Gender, Functional status, Health status, Income, Lack of knowledge, Nutrition, Occupation, Race, Residence,
	Community characteristics	Blight, Businesses, Community activism, Crime/violence, Housing density, Location, Policies, Poverty
Epistemological	Personal Thinking	Perceptions, Personal Responsibility, Informational Subjective Norms, Information Sufficiency, Information Source, Trust of Information Source, Information-Seeking
	Social Understanding	Community knowledge, Community opinion, Social norms, Community responsibility, System responsibility
Health Protection	Concerns	Sense of Threat, Anger, Lack of control, System failure, Uncertainty
	Efficacy	Self-efficacy, Self-response efficacy, Community efficacy, Community-response efficacy
	Actions	Community advocacy, Community education, Community organizing/action steps, Self/family education, Self/family action steps, System action steps