Research Article

Examining the Breadth and Depth Of Environmental Health Through A Modified Delphi Technique

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ABSTRACT

Background: *Environmental health, a crucial part of our everyday lives, is a multidisciplinary field with many discrepancies as to what encompasses the core areas.* ***Purpose:*** *This study intended to establish core areas and corresponding topics of environmental health as a preliminary step to identifying knowledge, attitude and behavior questions for use in needs assessment and program planning.* ***Methods:*** *Fourteen to sixteen experts in various fields of environmental health participated in a modified three-round Delphi Technique.* ***Results:*** *Experts established 11 core areas and 25 corresponding topic areas, and identified 443 potential questions for environmental health survey development.* ***Discussion:*** *The core areas, topic areas and corresponding survey questions were produced to be applicable for people in all areas of United States. This is important for continuity within the field to have a universal tool to measure awareness across the country.* ***Translation to Health Education Practice:*** *Standardizing the core areas and specific topics of environmental health may assist practitioners in conducting thorough needs assessments and guide program planning and research.*

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BACKGROUND

Environmental health is an important part of our lives and influences our daily decisions regarding work, family and nutrition.[1] Definitions of environmental health vary by agency, yet most have a similar undertone regarding dynamic interactions between humans and their environment.[2] The U.S. Department of Health and Human Services (HHS), Environmental Health Policy Committee and Risk Communication and Education Subcommittee in 1998 compiled over 28 different definitions of environmental health.[3] According to the World Health Organization,[2,4] environmental health is defined as,

> [Comprising] those aspects of human health, including quality of life, that are determined by physical, chemical, biological and social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations.

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In contrast to this definition, the National Center for Environmental Health (NCEH) defines environmental health as, "the discipline that focuses on the interrelationships between people and their environment, promotes human health and well-being, and fosters a safe and healthful environment."[3] To add more complexities to the matter, different agencies (local, state and federal) have inconsistencies regarding the core areas and the corresponding sub-categories or topic areas within environmental health.

According to the *Environmental Health Competency Project*[5] administered by the National Center for Environmental Health, the Centers for Disease Control and Prevention (CDC), and the American Public Health Association (APHA), environmental health can include 23 areas including ambient and indoor air quality, water pollution, safe drinking water, radiation, food safety, bioterrorism, vector and pesticide control, and healthy housing to list a few. Although this list includes many well-established areas of environmental health, other agencies' lists of core areas may differ depending on the locality of the environmental health program/department. For example, in the *Guidebook for Local Health Officials* jointly created by the National Association of County and City Health Officials (NACCHO) and NCEH,[6] 18 areas of environmental health were listed including motor vehicle accidents, loss of biodiversity, violence, AIDS and natural disasters. While NACCHO's list had overlapping core areas with the CDC's, there were also contradictions between their lists. The HHS's *Healthy People 2010* had six environmental health objectives including outdoor air quality, water quality, toxics and waste, healthy homes and healthy communities, infrastructure and surveillance, and global environmental health; with a total of 30 sub-categories under the objectives.[7] Due to the inconsistencies of the current listings for the core areas of environmental health (Table 1), a standardized listing of the core areas is needed for future research and program implementation.

Tempte and McCall[8] predicted patient environmental health attitudes addressing environmental health concerns. Their survey included approximately "seven environmental issues [including] air quality, water quality, radiation, population growth, land use, biodiversity and food quality,"[8] however it is uncertain how they developed the content of their survey and its entirety to the field of environmental health. Other studies by Dunlap and Van Liere,[9] Weigel and Weigel,[10] Howe,[11] and Scott and Willits[12] measured environmental health attitudes with a focus on ecological and environmental distress, not necessarily environmental health hazards and risks.

PURPOSE

Because environmental health is such a broad field, encompassing nearly every aspect of daily life from air to water to food to the chemicals in the products we use, this study strove to create a standardized list of the core areas and underlying topics within each area to facilitate discussion, future research and program development and implementation. In addition, this study is intended as a preliminary step to identify knowledge, attitude and behavior questions for use in needs assessment and program planning.

The Delphi Technique was first used in the 1950s[13-16] to acquire the thoughts and opinions of specialists methodically[13,15,17-19] in a particular field. Presented by the RAND Corporation,[17] the technique concentrates on a main problem or theme. Named after the Greek oracle that predicted future events,[13,14,16,19,21,22] the technique has specific guidelines including anonymity of expert participants[13,17,23] and expert reasoning to the centered problem,[17] while using questionnaires or survey-based methods to obtain responses. For this study, a modified technique was used to identify the core areas of environmental health as well as their corresponding topics for practical use in many diverse types of programs.

METHODS

Recruitment

Human Subjects Committee Institutional Review Board (IRB) approved this project prior to recruitment of panel members. To assure breadth and generalization, panel members were represented from various locations throughout the United States. Approximately 50% of the panel members were selected for the study using a cohort list from the Environmental Public Health Leadership Institute (EPHLI). EPHLI is a one-year sponsorship by the CDC for 30 practicing environmental health officials to enhance individual and community research.[24] The remaining members were chosen from a diverse group of federal, state and local experts. Panel members were chosen for this project on the basis of formal training, practice and leadership in the field of environmental health. According to De Villiers et al.,[16] a Delphi technique expert is characterized by possessing knowledge and experience applicable to the field of study,[14,18,19,22] while also encompassing the reverence of their colleagues. Panel members varied in their educational experiences, number of years of post-secondary education, locality of employment and number of years in the field (Table 2). The number of participants needed to complete Delphi rounds is ambiguously described in literature. A study depicting Delphi research procedures reported as few as 10 individuals to as many as 1,685 is sufficient to participate;[25,26] whereas other studies have described 15-60 participants is adequate.[20,27,28] Exactly 20 experts were contacted and 18 agreed to participate (N=18), but only 16 panel members completed round one, thus reducing the number for future rounds. For purposes of this study, the terms "panel member" and "expert" are synonymous.

Panel Member Communication

Panel member anonymity was vital to this study. To reduce any biases and communication regarding the material, experts' names were not disclosed nor were the number of members within the group. Communication was through blind-copy email instead of conventional mailing methods, and experts were only contacted when a new round was initiated or to update the status of a pending round. Panel members were invited to email questions about the project,

Table 1. Comparison of Environmental Health Core Areas

Environmental Health Research Group (2009)[1]	Environmental Health Competency Project (2001)	Department of Health and Human Services (DHHS): Healthy People (2000)	NACCHO & NCEH Guidebook for Local Health Officials (2000)
	Core Area Similarities		
Air	Ambient Air Quality Indoor Air Quality	Outdoor Air Quality	Ambient (outdoor) Air Pollution Indoor Air Pollution
Water	Safe Drinking Water	Water Quality	Drinking Water Quality
Radiation	Radiation		
Food Safety	Food Safety		Food Safety
Emergency Preparedness	Disaster Planning and Response		
Healthy Housing	Healthy Housing	Healthy Homes	
Infectious disease and Vector Control	Vector and Pesticide Control		Infectious Diseases Pesticides
Toxicology	Toxic Chemical Control	Toxics and Waste	
Injury Prevention	Unintentional Injury		
Waste and Sanitation	Solid Waste Management		Hazardous Waste Disposal
Weather and Climate Change	Global Health Issues Water Pollution Control	Global Environmental Health	Water Pollution Global Climate Change
	Core Area Differences		
	Noise Pollution Industrial Hygiene Childhood Lead Poisoning Acid Deposition Cross Connection Elimination Institutional Environmental Control Recreational Area Environmental Control On-Site Liquid Waste Disposal Bioterrorism	Infrastructure and Surveillance	AIDS Overpopulation Radon Depletion of Natural Resources Motor Vehicle Accidents Loss of Biodiversity Natural Disasters Use/Abuse of Alcohol and Controlled Substances Violence
11	**23**	**6**	**18**

[1]Based on results from Delphi round one

but if they had specific questions regarding the content or instructions of a particular round, they were instructed to complete as much as they understood. This was implemented to reduce any biases by indirectly assisting a panel member in filling out the survey by answering questions regarding a specific round.

Determining Consensus

Presenting simple statistics including mean and median values[15] representing consensus among panel members is an

Table 2. Panel Member Demographics

		Total Panel Members (N = 12)[1]	% Panel Members
Degree	Master of Science Degree	1	8.3%
	Doctoral Degree	7	58%
	Professional (MPA, MPH, MD, PharmD)	4	33%
# Years Post-Secondary Education	1-6	5	41.6%
	7-12	5	41.6%
	13-16	2	16.6%
Number of years experience	5-10	3	25%
	11-15	0	0
	16-20	1	8.3%
	21-25	3	25%
	26-30	4	33%
	31 and up	1	8.3%
Specialty2	Air Quality	1	8.3%
	Asthma	1	8.3%
	Climatology	1	8.3%
	Drinking Water	1	8.3%
	Emergency Preparedness	1	8.3%
	Epidemiology	1	8.3%
	Food Safety	2	16.6%
	Hazardous Materials	2	16.6%
	Health Housing	4	33%
	Injury Prevention	1	8.3%
	Lead Poisoning	3	25%
	Pest Management and Surveillance	1	8.3%
	Public Health	1	8.3%
	Radiation	1	8.3%
	Recycling	1	8.3%
	Risk Assessment	1	8.3%
	Solid Waste	1	8.3%
	Toxicology	3	25%
	Waste Water	1	8.3%
	Water Quality	3	25%
Type of Employee	Academia	2	16.6%
	Local Government	2	16.6%
	State Government	4	33%
	Federal Government	3	25%
	Private Sector	1	8.3%

[1] Based on 12 out of 16 panel members who completed demographic information
[2] Does not add to 12 panel members, due to possibility of more than one specialty

important aspect of the technique with the ultimate goal of acceptance of a proposed topic with little variance.[14,16] Previous studies have used varying numbers of responses to achieve consensus including 70% in the first round[16] and at least 51% in all rounds.[16,18] Due to the variability among the Delphi rounds, consensus among the panelists oscillated depending on the specificity of the content within the round. In general however, consensus was reached if panel members had agreed entirely on a particular topic, or had at least 60% (10 out of 16 panel members) agreement among experts.

Delphi Round One

For the first round, it was important to establish the core areas of environmental health. To accomplish this, 18 panel members were sent a cover letter expressing gratitude for agreeing to assist with the project, as well as two other attachments: a project overview containing goals and objectives, and the Delphi round one form. Based on an open-ended limitless question, panel members listed what they believed were the core areas of environmental health. A comments section was also added in case panel members wished to express other ideas, thoughts, or questions regarding the project or first round. Experts had one week to complete the first round. Depending on the depth of the answers, the first round was estimated to take approximately 15 minutes to complete.

Delphi Round Two

The results of round one were used as a basis for impending Delphi rounds. The goal of the second round was to identify key topics within each core area. Using Delphi round one as a template for the second round, the research team compiled 177 potential environmental health topics for panel member evaluation. *SurveyGizmo* version 2.6.149[29] an online survey tool, was used to collect responses during the second round. Panel members were asked to rate topics within core areas that would be the best gauge of an individual's overall awareness of environmental health issues.

A Likert-type style scale ("very unimportant," "unimportant," "neutral," "important," "very important," "not sure") was used by the panel members to answer survey questions. If there was a topic the experts believed should have been included within a particular category but was not present within round two, they were asked to list the topic in the designated "comments" section and determine it if was "important" or "very important." At the end of the survey document, there was a questions/comments section for the entire survey document. The following protocol was used to determine consensus among panel members' responses: at least 66% agreement on a particular topic (labeled as important/very important), at least 10 panel members agreeing it was an "important" topic, and having an average consensus of greater than 3.5 out of 5. Experts were given one week to finish Delphi round two, estimated to take approximately 30-35 minutes to complete. A reminder email was sent one week after the deadline to any remaining panel members who did not complete the second round. They were asked to complete it at their earliest convenience or request an extension for completion if needed.

Delphi Round Three

This round involved the compilation of knowledge, attitude and behavior questions from each topic area identified in the second round. Due to the labor-intensive task of survey question development, the research team developed potential survey questions for the panel members to identify as suitable for a consumer survey. Utilizing various resources including CDC literature and environmental health textbooks, the research team identified 576 questions for the panel members to analyze for appropriateness in a survey. Developing these questions was an enormous task that required planning and categorization of questions that represented topic areas which corresponded to the core areas. Each topic area needed at least 3-5 knowledge, attitude and behavior questions in order to achieve acceptable reliability for the final survey instrument. To minimize potential panel member dropout due to respondent fatigue, the research team decided to divide the survey tool into five separate instruments (sections A, B, C, D and E) thereby setting the maximum number of review questions at 115 or less per instrument. Each instrument contained five different topic areas; instruments were assigned to specific panel members based on their area of expertise within environmental health. Panel members were to respond to each question by selecting one of four options: "the public already knows this question," "the public should know this question, but most of them do not know," "it is not necessary for the public to know this," and "do not know."

Panel members were each sent a cover letter containing information regarding the third round and the corresponding link to their assigned survey. It was only necessary that each panel member complete one survey; however, if panel members wished to complete extra surveys, they were sent additional links to the other sections. It was estimated that panel members would take approximately 30-40 minutes to complete Delphi round three. Due to the length and dedication required for the third and final round, panel members were given approximately three weeks to respond. Consensus among panel members was set at 50% agreement.

RESULTS

Delphi Round One

From the original list of 18 experts who agreed to participate, 16 returned round one, with a response rate of 88%. Based on the responses from the first Delphi round, 27 core areas were provided with some responses overlapping. From the core areas developed in round one, the research team compiled the most commonly reported responses into the core areas used for the remainder of the study. It was the discretion of the research group to compile core areas if felt they were overlapping. Core areas with fewer than two supporting experts were discarded from the project. The research team identified the most commonly reported core areas as well as areas that could have been combined to be one area. This included the combination of recreational safety, poison control and injury/violence prevention into one area of injury prevention, coalescing waste management and sanitation, and finally building/hazardous materials and pest control into toxicology. After compiling the responses from round one, 11 core areas of environmental health were identified for consumer/public awareness (Table 1). The most common answers provided by the panel members were "air," "water," "toxicology" and "food." The following core areas were identified by one or more panel members but were excluded from

the final list of 11 core areas because they did not meet the research team's consensus criteria: soil, geology, biology, population density, promotion of safe workplaces and safe industrial hygiene.

Delphi Round Two

The next round decided what topics were important within the 11 specific core areas. Fifteen panelists returned completed online surveys; creating an 83% response rate (15/18 members). Surveys were tabulated and scores for each topic area were averaged for an overall consensus. Following the general protocol, 33 topic areas (47%) from the original list of 70 topics, were removed. The remaining 37 topics were condensed by their topic themes to yield 25 areas (Table 2). Comments in the second round were geared towards providing the correct placing of topic areas and providing additional environmental health concepts not included in our original listing. These included items such as radon, ozone, air fresheners and colognes in the air category; personal hygiene in food handling, frequency of eating raw foods and hormone usage in animal products in the food safety topic area; and industrial radiation exposures and protecting children from severe burns in the radiation category.

Delphi Round Three

The third round identified appropriate questions for the survey instrument. Fourteen panel members returned completed surveys for round three, resulting in a 77% response rate (14/18 members). Four panel members completed extra surveys, with two members completing three and two members completing two surveys total. Questions were analyzed in the category "public should know this, but most do not," with consensus set at 66% agreement among panel members. Out of 576 total questions that were analyzed, the results of this round removed 133 questions for a remaining total of 443 knowledge, attitude, and behavior questions (Table 3). Comments from the third round comprised their categorizing of questions, suggesting the addition of questions and clarity.

Table 3. Summation of Delphi Rounds Two and Three

Topic Areas (Delphi Round Two)	Total Survey Questions (Delphi Round Three)
Smoking and Second hand smoke	15
Carbon Monoxide	21
General Air Quality	9
Asthma	18
Radon	19
Mold	10
Water Sources	18
Drinking Water	23
Water Usage	13
Waste Water	19
General Weather and Climate Change	26
Food Preparation and Storage	38
Food Supply	27
General Healthy Housing	27
Recycling	19
Garbage and Disposal	8
Integrated Pest Management	16
Communicable Disease	15
General Radiation	20
General Injury Prevention	9
General Emergency Preparedness	10
Heavy Metals	24
Pesticides	22
General Toxicology	7
Drugs	10
25 Topic Areas	**443 Questions**

DISCUSSION

Understanding public health topics can affect important decisions made by consumers including the interpretation of health risks, political and environmental issues, and deciphering biases in media-reported health information.[30,31] Environmental health has shifted from traditional categories such as food safety, communicable disease, water quality and air quality to also comprise more emerging categories including "nuclear power, war and terrorism, global climate change and energy resources."[32] To ensure both emerging and traditional areas of environmental health were represented in the survey, the research team not only assessed the commonalities of the round responses, but also kept core areas (i.e. weather and climate change/emergency preparedness) that were not widely agreed upon by the experts as being the main core areas of environmental health.

As depicted in Table 1, there was overlap with the core areas developed in this study with the core areas delineated in other sources [*Environmental Health Competency Project*,[5] HHS: *Healthy People*,[7] and NACCHO and NCEH *Guidebook for Local Health Officials*[6]]. However, the agencies listed several areas of environmental health (AIDS, loss of biodiversity, natural disasters, on-site, liquid waste disposal and bioterrorism) that were

not included within our study. In regards to the traditional vs. emerging components of environmental health, a majority of the agencies had many traditional areas of environmental health with only one including global climate change. Several of the agencies decided to have multiple core areas with similar themes including *The Environmental Health Competency Project*[5] which had two categories for "air" including ambient and indoor air quality. This study chose to have those categories combined to one specific core area of "air." This was also similar for other categories including infectious disease and vector control and water.

Throughout each Delphi round, it was important to receive comments from panel members regarding not only the content of the round, but also concerning suggestions for future studies. Regarding the construction of core areas, a panel member stated "I find it hard to not see an environmental connection to just about everything;" whereas, another panel member stated "environmental health focuses on all aspects of these major areas including scientific investigation and development of policy to mitigate negative health consequences." Another panel member stated, "rather than considering any single core area independently, it is important to realize that many of the disciplines of environmental health are intertwined both within and outside core areas." Understanding the perspective of the experts provides insight into the difficulties in selecting the core areas and topic areas that encompass the broad field of environmental health. Delphi rounds one and two were intense rounds that intricately involved developing and selecting practical core areas that would not be limited by geographical location.

This study developed core areas similar to Tempte and McCall's study on environmental awareness[8] including water and air quality, radiation, and food safety. However, this study went further by ensuring the content included aspects of traditional and emerging environmental health, as well as expert validation.

A beneficial component to this study was the utilization of the online survey tool, *SurveyGizmo*, to administer Delphi rounds two and three. This proved to not only be excellent for data collection, but also for the creation of the survey document and was practical for all panel members to easily access.

The core areas, topic areas and corresponding survey questions were produced to be applicable for people in all areas of the United States. Plans for future research include implementation of focus groups to narrow down the number of identified survey questions for practical use by consumers and to clarify any questions that are ambiguous and may be misunderstood. Having a standardized instrument to measure knowledge, attitudes and behavior of consumers will allow for a better understanding of public and environmental health, while isolating localities deficient in environmental health literacy.

Limitations

Although this study was able to successfully obtain the core components of environmental health, it would have been beneficial to include a Delphi round that encompassed a qualitative aspect from the experts. Each round had a qualitative component for feedback, especially the first round where participants listed what they believed were the core areas of environmental health. However, this could have been enhanced by perhaps asking them to list what they believed were the core areas along with why they thought they were important in the field. In round one, it also may have been important to ask the panel members to identify each of their listed core areas as emerging or traditional. It was significant however, for the responses of the first round to be completely developed by the experts themselves and not lead any of their answers.

Another limitation to this study was the loss of four panel members from the original 18 who agreed to participate. Delphi rounds two and three were time intensive, and all rounds were completed by participants that volunteered their time without compensation. Respondent fatigue was a concern in round 3, although we tried to minimize this factor as described above. Despite the declining response rates between rounds (16 to15 to14), we were able to maintain the critical mass of opinions necessary to complete the project.

TRANSLATION TO HEALTH EDUCATION PRACTICE

As one of the seven core areas of responsibility for Certified Health Education Specialists,[33] conducting a needs assessment, is a fundamental aspect of program planning. A standardized list of core areas and specific topics for consideration may assist practitioners in conducting thorough environmental health needs assessment. In addition, the specific knowledge, attitude and behavior questions may serve as the basis for future development of a standardized survey tool. Use of a standardized instrument for measuring the knowledge, attitudes and behaviors of the general public, regardless of their geographic location, will allow state and local health departments to search for weaknesses within specific localities and plan targeted interventions. This is especially important to increase community awareness and outreach and for assessing the behaviors practiced by various communities. Isolating areas with decreased environmental health literacy will assist the practitioner to effectively plan and prepare to better educate individuals on the importance of environmental health.

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