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Hunters' knowledge, attitudes, and practices towards wildlife diseases in Ohio

Pallavi Oruganti, Rebecca B. Garabed, and Mark Moritz

Department of Veterinary Preventive Medicine and Department of Anthropology, The Ohio State University, Columbus, Ohio, USA

ABSTRACT

This article used ethnographic methods to examine how Ohio hunters' knowledge, attitudes, and practices affect risk exposure to infectious disease. Semi-structured interviews were conducted with hunters from Southeast Ohio, and an online survey was distributed to a random sample of licensed Ohio hunters. Data analyses indicated that Ohio hunters learn about wildlife disease through word-of-mouth, hunting publications, and online sources. They perceived low-to-no risk of exposure to infectious diseases. Although hunters were generally knowledgeable about infectious wildlife diseases, they were more concerned about the impact on wildlife populations than their own health. The results contribute to a better understanding of the role of hunter behavior in response to disease events, the identification of future interventions that would most effectively inform hunters about wildlife diseases, and how to minimize their risk of exposure.

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Introduction

Hunters are at the interface of disease transmission between humans and wildlife. Research on the human dimensions of wildlife disease transmission, however, has focused mainly on chronic wasting disease (CWD), which has revealed that hunters vary in their behavioral response to the disease (Vaske, 2010). Lyon and Vaske (2010) found that perceptions of health risk do influence behavior and stakeholder knowledge of infectious diseases does vary. Examining the impact of human behavior in critical stakeholder populations can improve our understanding of the ecology of infectious disease. Generally, human behavior plays an important role in the spread of infectious diseases. Understanding the influence of behavior on the spread of diseases can be key to improving control efforts (Funk, Salathé, & Jansen, 2010).

This article used the knowledge, attitudes, and practices (KAP) framework to study hunter–wildlife diseases and to explore how KAP shapes exposure to wildlife diseases. We used an ethnographic approach to assess the KAP of hunters in Ohio. This research connects social science methods to understanding issues related to wildlife conservation and emerging infectious diseases.

CONTACT Pallavi Oruganti oruganti.4@osu.edu The Ohio State University, A100G Sisson Hall, 1920 Coffey Rd., Columbus, OH 43210, USA.

Background

While CWD is a unique transmissible spongiform encephalopathy (Williams, 2005), there are other infectious diseases of concern for hunters. These include epizootic hemorrhagic disease (EHD), which affects ruminant species, and zoonotic diseases such as Lyme disease (transmitted by ticks), tuberculosis, leptospirosis, hantavirus, and tularemia, which are associated with contact with infected wildlife (American Veterinary Medical Association [AVMA], 2016).

While the zoonotic potential of CWD is considered low or nonexistent, strains of CWD have been identified and much remains unknown regarding eradication and treatment (Saunders, Bartelt-Hunt, & Bartz, 2012). CWD has been detected in 24 states in the United States, two provinces in Canada, and in isolated herds in Korea and Norway (Benestad, Mitchell, Simmons, Ytrehus, & Vikøren, 2016; Edmunds et al., 2016; Samuel & Storm, 2016). Recently, there have been outbreaks of wildlife diseases that have caused widespread concern in Ohio. CWD was detected in Ohio at captive deer facilities in Holmes County in 2014, and in Guernsey County in 2018 (Ohio Department of Natural Resources [ODNR], 2015a; ODNR & Ohio Department of Agriculture, 2018). Infectious disease spread and the spread of CWD could potentially affect hunter participation and the local economies of affected areas (Bishop, 2004; Lyon & Vaske, 2010; Miller, 2004; Seidl & Koontz, 2004). In Ohio, hunting is both a popular pastime and important economic contributor. Ohio ranks fifth nationally in resident hunters and eleventh in the number of jobs associated with hunting-related industries, and the activity has an estimated $853 million economic impact in Ohio (U.S. Fish and Wildlife Service [USFWS], 2011).

Previous research has examined hunters' behavioral intentions and response to CWD in areas such as Wisconsin, Colorado, and Illinois. Perceptions of CWD did impact hunting behavior (Holsman & Petchenik, 2006; Needham, Vaske, & Manfredo, 2004; Vaske & Lyon, 2011; Vaske, Timmons, Beaman, & Petchenik, 2004; Zimmer, Boxall, & Adamowicz, 2011). Hunters were likely to watch for abnormal behavior, test animals, or avoid eating the meat of harvested animals in areas impacted by CWD (Brown et al., 2006). Conversely, other studies have indicated that less than 10% of hunters expected to change their hunting frequency or location based on CWD presence (Miller, 2003). A survey in 2003 in Illinois following an outbreak of CWD demonstrated that presence of CWD did not affect hunting participation (Miller & Shelby, 2009).

Understanding how hunters perceive their risk of exposure allows us to better assess how that perceived risk may influence hunting behavior, and thus the actual risk of exposure to infectious diseases. Risk perception is defined by the degree to which an individual discerns a threat from a specific source, and perceived risks affect human decision-making and behavior (Miller & Shelby, 2009). Hunters who perceived a low risk of exposure to wildlife diseases like CWD may not change their behavior (Gore et al., 2009). Hunters who perceived higher risks from CWD were predisposed to rate all other risks as large, including risks to personal health (Needham, Vaske, & Petit, 2017). General sensitivity to disease risks may result in lower or altered hunting participation, and measuring perceived risk based on multiple diseases may be useful for understanding how future disease outbreaks may impact hunting (Miller & Shelby, 2009).

Culture shapes how and why members of a community perceive risks. It comprises upbringing, education, religious beliefs, political leanings, societal norms for behavior and values, availability of information sources, membership in community organizations, and

common recreational activities (Decker et al., 2010). There are few ethnographies and cultural studies of hunters in the United States. What literature exists describes hunting as a learned social behavior that occurs mostly in rural areas where family members teach hunters at an early age (Heberlein, 1987). Culture predisposes individuals to think in certain ways about the risks associated with given events. These predispositions vary between people from different cultural backgrounds, and people from the same culture may rely on these predispositions to a different degree (Decker et al., 2010). If hunting is a learned social behavior, cultural factors and social networks may affect the transmission of hunting knowledge. Previous CWD studies in Wisconsin reveal that it is difficult to change behavior through changing attitudes (Heberlein & Stedman, 2009). Research is needed to understand how cultural influences predispose people to perceive wildlife-associated disease risk (Decker et al., 2010).

Conceptual framework

The examination of KAP to address determinants of health issues is known as the KAP model. Previous studies examining CWD and hunter behavior have not used the KAP model, although KAP has been used to assess perceptions of avian influenza and Chagas disease in U.S. hunting populations (Dishman, Stallknecht, & Cole, 2010; Garcia, Murphy, Gross, Wagner, & Murray, 2015). The KAP survey obtains general information about public health knowledge regarding treatment and prevention practices and about sociological variables underlying these health behaviors (Launiala, 2009; Vandamme, 2009). KAP surveys have been used to study knowledge, perceptions, and behavior related to infectious diseases in varying cultural settings (Abbate, Di Giuseppe, Marinelli, & Angelillo, 2006; De Rochars et al., 2011; Haasnoot, Boeting, Kuney, & Roosmalen, 2010). With the KAP model, KAP are identified separately. Relationships between these three are then examined. KAP was chosen here over other methods as it integrated the three aspects of KAP within the larger ethnographic approach and connected perceptions of risk to actual hunting behaviors. A previous study examining infectious disease knowledge sharing found a difference between declarative knowledge and practical knowledge (Moritz, Ewing, & Garabed, 2013). A KAP approach distinguishes these types of knowledge and how that may affect behavior and potential exposures.

Methods

There were two phases in this study: an exploratory phase to better understand the Ohio hunting population and develop the survey instrument and an explanatory phase to assess the roles of KAP in relation to hunters and infectious diseases. Ethnographic semi-structured interviews were conducted, and descriptive questions identified how hunting practices develop and affect risk of exposure to infectious disease. The interviews contributed to the development of an online survey.

In the first phase, semi-structured interviews were conducted with 21 hunters in Southeast Ohio during the summer of 2014. Snowball sampling was used to identify the interviewees, starting with previous research contacts at the Wilds, the Ohio Department of Natural Resources (ODNR), and the Ohio State University School of Environment and Natural Resources. Each interview lasted approximately 1 h. A semi-structured interview

guide was constructed dividing the interview into questions regarding knowledge, attitudes, practices, and demographic information. The first section asked participants to describe their hunting background and how they first started hunting. The next set of questions asked them to describe their hunting practices, including field dressing and preparation of meat after hunting. The following section asked the participants to describe where they get hunting information and information about wildlife disease. The final set of questions asked about disease knowledge and perceptions of personal risk of exposure, including asking participants to free-list diseases they know to affect wildlife (Weller & Romney, 1988). The interview allowed for additional tailored follow-up questions and discussion with the participants based on the given responses.

Each interview was recorded and transcribed line by line. Each transcript was analyzed, and codes were developed based on the hunter responses. For example, when describing their hunting background, words indicating a familial connection to hunting such as "father," "uncle," "passed down," or "tradition" were noted and grouped. The personal concerns of hunters were words such as "safety," "disease," "infections," "protection," and "clothing" and grouped accordingly to the nature of the concern. Patterns in the data were interpreted to distinguish KAP, and whether there were connections between these three categories regarding wildlife disease and hunting knowledge and behaviors. If there were connections, the types were also distinguished and differentiated.

In the second phase, the following year, an online survey was distributed to a subset of Ohio hunters who provided e-mail addresses on ODNR hunting license applications. A random sample of 4,000 hunters was selected from the database of Ohio hunters and sent an invitation to participate in the survey. A follow-up e-mail was sent to the same 4,000 chosen e-mails 2 weeks after the initial invitation to encourage participation.

The online survey contained questions about hunters' KAP regarding wildlife disease and demographic information. Some questions asked participants to respond by scale, by selecting from multiple choices, by listing or filling in a response, or by indicating the extent they agree or disagree with a statement. For practices, respondents were asked to respond to statements based on a scale of "never," "sometimes," "often," or "always" of how often they complete the indicated action. These actions included field dressing game, wearing gloves in the field, and processing meat on their own. A 5-point scale was used for questions in the knowledge and attitudes sections (1 indicating strongly disagree to 5 indicating strongly agree). These questions asked the respondent to rank their agreement for statements such as "Diseases can be transmitted from animals to humans" and "Wildlife diseases are more dangerous to wildlife populations than my own health." A 5-point scale was used to assess the level of risk the respondents believed they had of personally being infected with an infectious wildlife disease (1 indicating no risk to 5 indicating very high risk). Other data were collected using ranking and multiple-choice selections, such as which sources of information hunters use most, who they learned hunting from, how often they hunt, if they hunt by themselves or with others, and what species of game they hunt.

Questions were sorted based on their indication of KAP, and these data were analyzed using qualitative research methods to characterize KAP and any connections between these three components. Descriptive analysis was used to summarize differences in male and female hunters, age of hunters, level of experience, and type of hunter, while correlations were used to determine the relationships between indicators of KAP.

Results

In total, 386 responses were collected from the e-mail survey. The online survey response rate was 8.9% including postsurvey follow-up. Reponses were weighted based on the percentage of respondents living in urban versus rural areas to account for low response rate. Of the sample population, 60% reported being urban residents, while the overall hunting population was made up of 26% urban residents (USFWS, 2011).

Ninety-five percent of respondents hunted whitetail deer. Of the total population of hunters in Ohio, 90% hunted deer in 2015 (ODNR, 2015). On average, hunters had 27 years of hunting experience. Respondents were from 80 of the 88 counties in Ohio, representing 90% of all counties in Ohio. The average age of respondents was 46 years and ranged from 19 to 87. The median age of all Ohio hunters, collected in 2011, was 39 (U.S. Fish and Wildlife Service, 2011). The survey respondents were 94% male. Of the whole population of all Ohio hunters in 2015, 93% were male (ODNR, 2015b). Table 1 summarizes demographic information of the sample population.

Knowledge

Hunters acquired knowledge from a variety of sources, including family members, friends, state wildlife agencies, word-of-mouth, Internet sources, and hunting magazines and publications. There was a statistically significant relationship between where hunters obtained general hunting information and where they get information about wildlife diseases ($\chi^2 = 84.44$, $df = 40$, $p < .001$, Cramer's $V = .21$). For example, if they indicated family or friends as a main source of knowledge for general hunting knowledge, they also tended to indicate family or friends as a source of wildlife disease information. The ODNR was the primary source of information for both disease and general hunting information. Word-of-mouth followed this for sources for wildlife disease information and friends/colleagues for general hunting information. Table 2 summarizes hunters' knowledge sources.

Hunters were asked to free-list disease they knew to affect whitetail deer. The most commonly mentioned diseases were CWD and EHD. When asked to list diseases that affect other wildlife, hunters most often listed rabies, distemper, tularemia, Lyme disease, and parasites. There were 301 responses to the question related to deer-related disease versus 134 responses to the question related to disease in other wildlife. Table 3 summarizes free-listing of diseases from the survey.

Table 1. Demographic characteristics.

Variable	Category/descriptive results	Frequency (weighted)	Percent
Age	Mean = 46 years, SD = 14.12	-	-
Hunting experience	Mean = 27 years, SD = 15.69	-	-
Gender	Male	363	94
	Female	23	6
Game hunted	Whitetail deer	365	95
	Turkey	199	52
	Squirrel	175	45
	Coyote	136	35
Geography	Ohio counties represented in sample (of 88 total)	80	90
Community type	Rural	150	40
	Urban	226	60

Table 2. Sources hunting and wildlife disease information.

Type of information	Knowledge source	Frequency (weighted)	Percent
General hunting information	ODNR	307.95	80
	Friends/colleagues	286.25	74
	Magazines/newspaper	269.02	70
	Family	255.25	66
	Shops/stores/businesses	89.78	23
	Hunting organizations	83.82	22
	Social media	80.10	21
	Online/websites	23.30	6
	Other	19.53	5
Disease information	ODNR	307	80
	Websites/social media	248	64
	Word-of-mouth	230	60
	Magazines/newspapers	217	56
	Television	24.6	9
	Other	23	6

Table 3. Free-list of wildlife diseases.

Disease	Number of mentions
Chronic wasting disease (CWD)	330
Epizootic hemorrhagic disease (EHD)	67
Bluetongue disease	66
Lyme disease	11

Attitudes

Interview data indicated that hunters in Southeast Ohio were generally not concerned about wildlife disease in the areas they hunt, and they perceived little-to-no risk of personal exposure. Fifty-four percent of respondents indicated that Ohio hunters were concerned about wildlife diseases, while only 30% agreed or strongly agreed that hunters were knowledgeable about wildlife diseases. From the online survey data, there was a relationship between the ranking of whether participants believed other Ohio hunters are knowledgeable about wildlife diseases and the ranking of whether hunters are concerned about wildlife diseases ($\chi^2 = 170.25$, $df = 16$, $p < .001$, Cramer's $V = .34$). This supports patterns from the semi-structured interviews, which indicated hunters believe other Ohio hunters were not as knowledgeable about wildlife diseases and need to be more concerned. Hunters were more concerned about impacts on wildlife populations rather than impacts on their own health. There was a statistically significant relationship observed between perceived personal risk of infection and agreement that wildlife diseases were more dangerous to wildlife populations than to personal health ($\chi^2 = 70.28$, $df = 16$, $p < .001$, Cramer's $V = .22$). Of the respondents, 61% perceived no or low risk of being exposed to an infectious wildlife disease, while 61% strongly agree or agree that wildlife diseases are more dangerous to wildlife populations than their own health. This was reflected in the interview data, as one hunter noted, "But [diseases] haven't been a problem in Ohio yet so it's not a big deal for most Ohio hunters." Overall, the data showed that Ohio hunters were split about their perceived knowledge of diseases and concern over disease.

The lack of statistically significant relationship in the cross-tabulation of the specific individual hunter health concerns versus attitudes toward general hunter population

health concerns about wildlife diseases indicated that there was no direct or inverse relationship between personal concerns of health and perception of general population concerns of health. This contrasts with the interview data, where multiple informants indicated that they were concerned about wildlife diseases but expressed that the general hunting population was not.

Practices

Hunter practices were informed by outside sources and information as well as the hunters' personal experience over time. Hunting practices were motivated by maintaining safety and awareness with the usage of weapons, the desire to harvest an animal, and keeping meat fresh in the field until it can be processed. The hunting process was best summarized in these steps based on the information from the interviews: (a) preparation/scouting; (b) waiting/searching for target animal in a tree stand or blind; (c) taking the shot; (d) tracking animals until down if needed; (e) field dressing; and (f) meat processing and distribution. Understanding hunters' motivations and what behavior may lead to a risk of disease exposure, as each phase of the hunting procedure requires varying time investment and varying risks for disease exposure.

There was a relationship between teaching hunting and hunting with others ($\chi^2 = 12.40$, $df = 2$, $p = .002$, Cramer's $V = .18$). Those who teach hunting also hunt both by themselves and with others. This indicated that practices related to knowledge sharing were related to hunting with others. The hands-on nature of teaching hunting practices was often described in the interview data, especially to family members and children. As one hunter noted, "I try to teach people who don't have any knowledge about hunting whether they want to hunt or not about why I hunt and why hunting is beneficial." Eighty-one percent of respondents indicated they taught hunting to a family member, and 30% indicated they taught hunting to a child or young adult (either a family member or not a family member). The frequency of glove use was also characterized, with 48% indicating using gloves "always" or "very often."

Based on hunter's description of hunting practices in both the interviews and survey, several potential risks of exposure could be identified. These include field dressing of deer and other game, insect bites, having regular contact with domestic animals or wildlife outside of hunting, leaving viscera in the field after dressing, butchering and meat processing, cooking, storing meat improperly, and feeding portions of game meat to domestic animals, which may also pose a risk to the animal's health.

Knowledge–attitudes relationship

There was no significant relationship between responses to the statements "I know what I can do to prevent spread of infectious wildlife diseases" and "How much risk do you believe there is of being exposed to or infected by a wildlife disease through hunting" statements ($\chi^2 = 21.33$, $df = 16$, $p = .17$). Additionally, there was no significant relationship between perceived knowledge of disease prevention and perception of risk exposure. Just because a hunter may know about a wildlife disease and how to prevent exposure does not imply they perceive risk of exposure. Knowledge of zoonotic disease transmission alone did not affect the perception of high-risk exposure; those who agreed that disease can be

transmitted between animals and humans also perceived low risk of personal exposure to wildlife diseases (χ^2 = 34.73, df = 16, p = .004, Cramer's V = .15). About three-quarters indicated that they would like to learn more about wildlife diseases, indicating that Ohio hunters are open to further information and knowledge regarding wildlife diseases.

A relationship was observed between the ranked responses for "There is enough information about wildlife diseases available to hunters" and "I would like to learn more about diseases in wildlife" (χ^2 = 111.39, df = 16, p < .001, Cramer's V = .27). This indicates that hunters want to learn more about wildlife diseases but believe there was is enough information about wildlife disease available to hunters. It is not knowledge of zoonotic disease transmission alone that impacts risk exposure perception.

Knowledge–practices relationship

There was no relationship between frequency of glove use and the knowledge of infectious transmission prevention practices. Additionally, there was no significant relationship between contacting a wildlife officer after seeing a sick animal when hunting and the source of information used most often for general hunting information (χ^2 = 10.53, df = 20, p = .96). This may indicate that this type of behavior is not learned from any one source and that it could be learned either from ODNR suggestion or from personal sources.

Attitudes–practices relationship

There was no significant relationship seen between respondents who indicated having direct contact with wildlife and their perceived risk of exposure (χ^2 = 5.00, df = 4, p = .29). Being exposed to wildlife outside of hunting did not impact the perception of exposure to wildlife diseases. Attitudes about wildlife disease were characterized by low perception of risk. Because of this, hunting practices were unaffected by the state of attitudes toward wildlife disease. Additionally, as seen in our interview data, older and more experienced hunters perceived less concern over wildlife disease than younger and less experienced hunters.

Discussion

From the ethnographic interviews, hunters had varied sources of knowledge that shaped their practices and attitudes toward wildlife diseases, which in turn affected risk exposure and disease prevention. Perceptions of risk come from the portrayal of risk from these knowledge sources, whether that be state agencies, articles, or word-of-mouth. The major source of information for hunters for both general hunting information as well as information about wildlife diseases was the ODNR. This was not necessarily anticipated before the interviews, as the tradition of hunting within families and communities is strong. We expected to see word-of-mouth more commonly used. Channels of acquiring general hunting knowledge may not be separated from channels of acquiring information about diseases. Current perceptions of low risk of exposure lead to decreased use of risk-reducing behaviors in the hunting practice. However, there may be a difference between declarative knowledge and practical knowledge (Moritz et al., 2013). Hunters were aware

of wildlife diseases and the potential impact of diseases, but they may not be actively preventing transmission when they do not see an immediate risk to their health. This was not expected, as we anticipated that awareness and knowledge of disease would translate to changes to practices. Their perceived immediate risk is derived from their sources of knowledge and experience in the field. Findings that older, more experienced hunters perceive less risk of exposure to wildlife disease are supported in a study of duck hunters in Georgia regarding avian influenza, which found that older hunters reported less concern regarding wildlife disease or change in their hunting practices due to an infectious disease outbreak (Dishman et al., 2010). Knowledge alone does not determine attitudes or practices. It points to larger implications for public health education and programming and indicates that knowledge and "spreading the word" about certain public health messages may not be effective in achieving behavioral change among hunters.

However, many practices were not intentionally done to prevent disease, but helped to prevent exposure to infectious disease such as wearing gloves to keep clean or wearing bug spray and bug nets. Multiple practices must be considered that may increase or decrease the risk of exposure of the hunting population. A similar conclusion was reached by a KAP study of Texas hunters and Chagas disease (Garcia et al., 2015). This KAP study supports our findings regarding the importance of understanding the role of knowledge, sharing of information, and how that may affect ultimate risk of exposure.

Limitations of our study included low sample size and response rate for the survey. Additionally, the survey was sent to only a subset of hunters who had an e-mail address. Future research looking at perceptions of disease risk in hunters should include a broader sample of hunting population across the United States and examine regional variations of hunting practices within states. We relied on self-report of hunting practices. Future research should incorporate direct observations of hunting activities to compare with interview data.

This article applied social science methods to issues of wildlife health and infectious disease. This approach addressed different factors, such as infectious disease spread and wildlife conservation, that impact health worldwide (Buttke, Decker, & Wild, 2014). There are several implications not only for wildlife conservation but also in how this specific stakeholder population may react to wildlife disease. For example, wildlife disease may influence the number of hunters, which in turn can impact wildlife population numbers either positively or negatively (Buttke et al., 2014). Continuing to research specific populations like hunters can help highlight the context of infectious disease and the factors that influence these risk environments.

Practically, it is necessary to examine the relationships among KAP to understand how they impact behavior and overall disease risk. To effectively address any knowledge gaps about disease risk, it is important to understand how individuals perceive wildlife-associated disease, so risk messages are relayed in ways that effectively inform people (Decker et al., 2012). In the case of Ohio hunters, public health messages related to wildlife diseases and targeted toward the hunting population in Ohio should use the extended reach of the ODNR to best communicate with hunters in Ohio about public health concerns, education, and outreach. The complex relationships between KAP highlight the use of an ethnographic approach. Ethnographic methods allowed for hunters to respond to our questions in their own words. Qualitative data described from an emic perspective the experience of Ohio hunters

and how that shapes their attitudes and knowledge of disease. Others have asserted that infectious diseases cannot be understood through biology alone but rather must be considered within the context of the cultural and social worlds they inhabit (Singer, 2014). Using ethnographic interviews and the KAP survey, the interrelationships between cultural and biological drivers of infectious disease could be more clearly explained.

Understanding these complex relationships is critical in terms of informing future management strategies and hunters about wildlife diseases in case of disease outbreaks such as CWD. It can also inform future interdisciplinary research to better understanding the role of hunters in the ecology of wildlife diseases, as well as the development of policy related to wildlife populations and disease management.

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