

Hunters' General Disease Risk Sensitivity and Behaviors Associated with Chronic Wasting Disease

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This article examines deer hunters' general disease risk sensitivity relative to specific behaviors and beliefs about chronic wasting disease (CWD). Data were obtained from the 2003–04 Illinois Hunter Harvest Survey (n = 1521). Cluster analysis of perceived risks from CWD, Bovine Spongiform Encephalopathy (i.e., mad cow), Salmonella, Escheria coli (E. coli), West Nile Virus, and Lyme disease identified three hunter segments (i.e., no, slight, moderate risk). The risk sensitive (moderate) group (n = 281) reported the lowest hunting participation (64%), were the most likely to change their hunting behavior due to the presence of CWD (42%), and believed that CWD was a risk to humans (81%). General sensitivity to disease risks may result in lower or altered hunting participation. Measuring perceived risk based on multiple diseases may be useful for understanding how future disease outbreaks may impact hunting.

Keywords chronic wasting disease, deer hunters, risk perceptions, behavior, Illinois

Chronic wasting disease (CWD) is a prion disease, or Transmissible Spongiform Encephalopathy (TSE), that affects white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), Rocky Mountain elk (*Cervis elaphus nelsoni*), and Shira's moose (*Alces alces shirasi*) (Gross & Miller, 2001; Schaubert & Woolf, 2003; Baeten, Powers, Jewell, Spraker, & Miller, 2007). CWD is a degenerative fatal disease characterized in the end stages by abnormal behavior and emaciation. The disease has been found in wild cervid populations in eleven states (Colorado, Illinois, Kansas, Nebraska, New Mexico, New York, South Dakota, Utah, West Virginia, Wisconsin, Wyoming) and two Canadian provinces (Alberta, Saskatchewan). CWD has also been identified in captive herds in four additional states (Minnesota, Montana, Oklahoma, Michigan) and in South Korea.

The prion structure of CWD is similar to scrapie in sheep, Bovine Spongiform Encephalopathy (mad cow) in cattle, and variant Creutzfeldt-Jakob disease in humans (Williams, Miller, Kreeger, Kahn, & Thorne, 2002). Research suggests that mad cow, which has been detected in several hundred thousand cattle in the United Kingdom and other countries, has been transmitted to humans through the consumption of prion contaminated beef resulting in variant Creutzfeldt-Jakob disease (Kong et al., 2008). The link between mad cow disease and humans has raised questions about the potential for CWD to be a food-borne illness in

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humans (Anderies, 2006). There are no known cases of CWD leading to human illness, and research suggests there is a substantial species barrier for transmitting CWD to humans (Kong et al., 2005). Venison is also consumed at a much lower rate than beef and is therefore not considered as great a threat (Yam, 2003). The possibility of CWD transmitting to humans, however, cannot be dismissed (Mathiason et al., 2006; MaWhinney et al., 2006). CWD has been transmitted to squirrel monkeys (*Saimiri sciureus*) in the laboratory setting (Marsh, Kinkaid, Bessen, & Bartz, 2005), representing the first known primate infection.

State and provincial wildlife officials have been monitoring both captive and wild cervid populations in their respective states and provinces as well as developing and implementing regulations. Protective measures include: (a) banning all cervid imports or placing limits on cervid imports (e.g., banning importation of cervids or cervid parts from CWD counties, regions, or states, or requiring that the cervid be enrolled in an official CWD program), (b) testing captive and wild cervid populations, (c) banning feeding and/or baiting of cervids, and (d) placing restrictions on captive cervid operations. South Korean officials have banned all cervid and cervid parts imports.

CWD and Hunter Participation

State agencies are concerned that the presence of CWD will affect hunter participation (Gigliotti, 2004; Miller, 2004). Hunters play a vital role in reducing deer populations. Decreasing hunter participation impacts deer population reductions necessary to reduce deer density and control further spread of CWD among wild deer (Van Deelen & Etter, 2003). Decreasing hunter participation has also been linked to declining agency revenues from license sales (Fix, Pierce, Manfredo, & Sikorowski, 1998; Mehmood, Zhang, & Armstrong, 2003), and the social and economic stability of hunting-dependent communities (Herman, 2003) (see Needham, Vaske, & Manfredo, 2006 for a review of hunter participation and CWD impacts).

Given the importance of hunting in deer and elk management, researchers have examined hunters' behavioral intentions and behaviors in response to CWD (Miller, 2004; see Vaske, Shelby, & Needham, 2009 for review). Studies conducted shortly after CWD was discovered showed that less than 10% of hunters expected to change their hunting frequency or location (e.g., Gigliotti, 2004; Miller 2003, 2004); however, they were likely to watch for abnormal behavior, test animals, or not eat the meat (Brown et al., 2006; Gigliotti, 2004; Miller, 2003, 2004; Vaske, Timmons, Beaman, & Petchenik, 2004). Across eight states, 49% of hunters responding to hypothetical scenarios of increasing CWD prevalence indicated that they would stop hunting if a majority of deer or elk were infected with CWD (Needham, Vaske, & Manfredo, 2004).

Risk Perception

Risk perception is defined by the degree to which an individual discerns a threat from a specific source (Thompson & Dean, 1996; Siegrist & Cvetkovich, 2000; Sjöberg, 2000). People perceive risks differently depending on situational context (e.g., risk familiarity, potential severity, perceived locus of control), and personal factors (e.g., attitudes, risk sensitivity, morals, demographics, culture, social experiences) (Savage, 1996; Sjöberg, 2002; see Andries, 2006 for a review). Perceived risks affect human decision-making and behavior (Fischhoff, Slovic, Lichtenstein, Reid, & Combs, 1978; Siegrist, Gutscher, & Earle, 2005).

Chronic wasting disease research has explored hunters' risk perceptions. Majorities of hunters in eight states agreed that CWD may be a risk to humans, and that their families were concerned about eating deer or elk meat because of CWD (Needham & Vaske, 2006; Needham et al., 2006). Studies in New York, South Dakota, and Illinois have consistently shown that deer hunters were concerned or worried about the effects of CWD on hunting, human health, and/or deer health (Brown et al., 2006; Gigliotti, 2004; Miller, 2004). Research has identified a link between CWD risk perceptions and hunting behavior. In 2002, the majority of Wisconsin hunters who did not hunt were moderately or strongly influenced by perceived risks associated with CWD (Vaske et al., 2004). CWD risk perceptions could dramatically impact hunting behavior. Resident hunters, for example, were more likely to give up hunting permanently instead of traveling to non-CWD states to hunt (Needham et al., 2004, 2006).

Studies addressing risk perception facilitate understanding how stakeholder groups construct the issue and provide a foundation for determining the efficacy of management programs and information campaigns (Vaske et al., 2009). Research specific to perceptions of individual diseases is essential to understanding social ramifications of managing current and emerging wildlife diseases (Vaske et al., 2009). Understanding risk perceptions among specific stakeholder groups can assist in planning for the next potential wildlife disease outbreak. General understanding of risk perceptions across stakeholders coupled with overall knowledge of wildlife diseases may facilitate proactive risk management (Decker et al., 2006).

Little is known about the extent to which (a) different segments of the hunter population weigh perceived risk of wildlife diseases in general and (b) the extent to which hunters differentiate between CWD and other wildlife- and food-borne diseases and illnesses. This article addresses these knowledge gaps by exploring three research questions. First, to what extent will hunters' perceptions of CWD compare with wildlife- and food-borne diseases and illnesses (i.e., mad cow, *Salmonella*, *E. coli*, West Nile Virus (WNV), & Lyme disease) in regards to health risks? Second, can perceived risk from multiple diseases/illnesses be used to segment hunters' risk sensitivity? Finally, can general risk sensitive segments based on risk sensitivity for a composite of diseases and illnesses differentiate specific CWD-related beliefs, behavioral intentions, or behaviors?

Methods

Data were collected from a mail survey of resident Illinois hunters selected as participants in the 2003–04 Illinois Hunter Harvest Survey. This survey was part of annual efforts to record harvest of game and furbearer species in Illinois. A stratified random sample of 3,000 hunters were selected equally among residents who purchased mandatory Habitat Stamps ($n = 1,500$) and resident licenses ($n = 1,500$).

Each survey participant was mailed a 15-page questionnaire, cover letter, and stamped return envelope beginning mid-April 2004. A postcard reminder was mailed 14 days after the first mailing and a second complete mailing (i.e., questionnaire, cover letter) 28 days later to non-respondents. A final postcard reminder was mailed to hunters who failed to respond to the previous mailings 14 days after the second complete mailing. Of the 3,000 surveys initially mailed to hunters, 114 were undeliverable. A total of 1,879 usable questionnaires were returned, yielding a response rate of 65%.

Hunters identified their perceived levels of risk for CWD, two insect-borne diseases common among wildlife in the state (Lyme Disease and West Nile Virus), and three food-borne illnesses (i.e., *E. coli* and *Salmonella* bacteria, and Bovine Spongiform Encephalopathy/mad cow) (Table 1). Each of these items was coded on a 4-point scale:

Table 1
Perceived risks of diseases/illnesses among Illinois hunters in 2003–04 ($n = 1521$)

“Please give your opinion of the risk of the following:”	Perceived level of risk ¹				Mean	SD
	None	Slight	Moderate	High		
Eating meat contaminated with mad cow disease	36	45	10	9	1.93	0.91
Becoming ill from <i>Salmonella</i> poisoning	25	49	18	8	2.10	0.86
Becoming ill from <i>E. coli</i> bacteria	22	51	19	8	2.13	0.85
Becoming ill from CWD	20	56	17	8	2.12	0.81
Contracting West Nile Virus	9	48	32	11	2.45	0.81
Risk of contracting Lyme disease	7	51	34	8	2.43	0.74

¹Cell entries are percentages.

(1) no risk, (2) slight risk, (3) moderate risk, and (4) high risk. Pearson’s bivariate correlation coefficients examined the extent that hunters’ perceptions of health risks for CWD were related to the wildlife- and food-borne diseases and illnesses. Hunters were then segmented based on their risk sensitivity using k -means cluster analysis. One-way analysis of variance and Eta were used to analyze the differences among the clusters/segments.

Respondents indicated if they had hunted during the 2003 Illinois firearm deer season, and the possible effects of CWD on their future hunting behavior for the 2004–05 season. For the behavioral intentions question, response options included: (a) No change, I plan to hunt the same as always, (b) I will check how deer are acting before shooting, (c) I plan to hunt a different location, (d) I will check to see if CWD is in the area where I plan to hunt, and (e) I will consider not hunting deer in Illinois because of CWD. These single-item indicators of behavior and behavioral intention were analyzed by the hunter risk sensitivity clusters using a Chi-square test and Cramer’s V .

Beliefs about CWD were based on one question with four response options: (a) the threat of CWD has been exaggerated, (b) CWD poses some risk to deer, but not to humans, (c) CWD may pose some risk to humans, but not enough is known to be sure, and (d) CWD can possibly infect humans if they eat meat from animals infected with it. Hunters selected the response option that best fit their opinion of the disease. This single-item indicator of CWD beliefs was analyzed by the hunter risk sensitivity clusters using a Chi-square test and Cramer’s V .

Results

Perceptions that there was no risk of contracting CWD (20%) were similar to *Salmonella* (25%) and *E. coli* (22%), but less than mad cow disease (36%) (Table 1). Few hunters perceived no risk of contracting West Nile Virus (9%) or Lyme disease (7%). More hunters perceived contracting Lyme disease (34%) and West Nile Virus (32%) to be “Moderate” risks relative to *E. coli* (19%), *Salmonella* (18%), CWD (17%), and mad cow disease (10%). Perception that the risk was “High” for contracting or coming into contact with the six diseases or illnesses was relatively stable across all items: 8% for Lyme disease, CWD, *E. coli*, and *Salmonella*; 9% for mad cow disease; and 11% for West Nile Virus. Means for the six diseases showed approximately “Slight” perceived levels of risk (Mean = 1.93 to 2.45; SD = 0.74 to 0.91).

Table 2
Pearson's bivariate correlation coefficients for perceived risks of diseases/illnesses among Illinois hunters in 2003–04 ($n = 1521$)

"Please give your opinion of the risk of the following:"	1	2	3	4	5	6
1. Risk of contracting Lyme disease	—	.31	.35	.34	.23	.53
2. Becoming ill from CWD		—	.42	.42	.51	.34
3. Becoming ill from <i>E. coli</i> bacteria			—	.88	.45	.39
4. Becoming ill from <i>Salmonella</i> poisoning				—	.47	.39
5. Eating meat contaminated with mad cow disease					—	.38
6. Contracting West Nile Virus						—

All coefficients are significant at $p < .001$.

Significant ($p < .001$) bivariate Pearson's correlation coefficients were found among all six diseases and illnesses (Table 2). Correlation were "large" (Cohen, 1988) or "substantial" (Vaske, 2008) for associations between perceptions of *E. coli* and *Salmonella* ($r^2 = .88$), West Nile Virus and Lyme disease ($r^2 = .52$), and CWD and mad cow disease ($r^2 = .51$). "Medium" or "typical" associations were found for all other associations ($r^2 = .31$ to $.47$) with the exception of Lyme disease and mad cow ($r^2 = .23$, a "small" or "minimal" association). Hunters perceptions of CWD compared to the other wildlife- and food-borne diseases and illnesses resulted in "typical" to "substantial" relationships ($r^2 = .34$ to $.51$).

K-means cluster analysis was used to segment hunters by risk sensitivity to multiple diseases and illnesses. Three distinct segments of Illinois hunters were identified (Table 3). Cluster 1 ($n = 368$) centroids ranged from "none" to "slight" perceived risks and was labeled

Table 3
Between-groups differences for Illinois hunter perceptions of disease/illness risk in 2003–04 ($n = 1521$)

Risk factor ¹	Clusters ²			F^3	Eta
	No risk ($n = 368$)	Slight risk ($n = 872$)	Moderate risk ($n = 281$)		
Risk of contracting Lyme disease	1.92 ^a	2.45 ^b	2.99 ^c	220.58	.48
Becoming ill from CWD	1.52 ^a	2.06 ^b	2.96 ^c	402.50	.59
Becoming ill from <i>E. coli</i> bacteria	1.23 ^a	2.13 ^b	3.26 ^c	1299.35	.80
Becoming ill from <i>Salmonella</i> poisoning	1.19 ^a	2.09 ^b	3.27 ^c	1308.38	.80
Eating meat contaminated with mad cow disease	1.21 ^a	1.85 ^b	2.94 ^c	530.92	.64
Contracting West Nile Virus	1.83 ^a	2.43 ^b	3.21 ^c	337.51	.56

¹Scale: 1 = "None," 2 = "Slight," 3 = "Moderate," 4 = "High."

²Cell entries are means/centroids. Means with different superscripts are significant at $p < .05$ based on Tamhane's T2 method.

³All coefficients significant at $p < .001$.

“No Risk.” Cluster 2 ($n = 872$) contained individuals that viewed the six disease and illnesses as “Slight Risk.” Centroids for Cluster 3 ($n = 281$) were “moderate” for all six diseases; this segment was labeled “Moderate Risk.” For all six diseases, the centroids for the three clusters were significantly different ($p < .001$) with “substantial” effect sizes.

Individuals in three clusters reported different behaviors, behavioral intentions, and CWD-related beliefs (Table 4). The “Moderate Risk” Cluster (19% of hunters) was less likely to have hunted during the 2003–04 Illinois firearm season (36% did not hunt), than the “No Risk” or “Slight Risk” clusters (17% and 22% did not hunt, respectively). Given the presence of CWD for the 2004–05 deer hunting season, hunters in the “Moderate Risk” cluster were more likely to change their behavior (42%) than those in the “No Risk” (22%) or “Slight Risk” (27%) groups. Across all hunter segments, respondents that indicated they would make a behavior change were more likely to check how the deer was acting than hunt in a different location or consider not hunting. Relatively few respondents believed that the CWD threat was exaggerated ($\leq 20\%$ for all clusters). The three clusters differed in

Table 4
Beliefs and behaviors among Illinois hunter by perception of disease/illness risk ($n = 1521$)

Variables	Clusters			Chi-square ¹	Cramer's V ¹
	No risk ($n = 368$)	Slight risk ($n = 872$)	Moderate risk ($n = 281$)		
Did you hunt during the 2003–04 IL firearm season?				35.79	.15
No	17	22	36		
Yes	83	78	64		
Presence of CWD change for 2004–05				37.27	.13
No change	78	73	58		
Check how deer was acting	13	20	25		
Hunt different location	2	<1	1		
Hunt in CWD free areas	6	7	14		
Consider not hunting	1	1	2		
Current opinion of CWD				63.07	.15
Threat exaggerated	20	13	8		
Poses risk only to deer	24	17	12		
CWD may pose risk to humans	38	49	43		
CWD can possibly infect humans	19	21	38		

¹All coefficients significant at $p < .001$.

terms of beliefs about CWD posing a risk to humans or potentially infecting humans (“Moderate Risk” 81% vs. “No Risk” 57% and “Slight Risk” 70%).

Discussion

Illinois hunters expressed more concern over risks associated with Lyme disease and West Nile Virus (WNV) than other illnesses, as evident by the higher percentage of responses in the “Slight” to “Moderate” categories. Perceptions of risk due to West Nile Virus were higher overall among hunters in the No Risk and the Moderate Risk groups than perceptions of risk related to other diseases or illnesses; findings that might be attributed to the high prevalence of and publicity regarding WNV in Illinois at the time of this study. At that time, estimates of mortality due to WNV approached 70% of the populations for cervid species (e.g., crows, jays) during the study period (see Yaremych et al., 2004). Given media coverage cautioning hunters to guard against being bitten by mosquitoes (the vector for WNV), it was not surprising that hunters expressed more concern regarding WNV.

Responses for all risk categories were strongly associated with one another; stronger associations were found between similar diseases and illnesses: *Salmonella* with *E. coli*, mad cow disease with CWD, and WNV with Lyme disease. Such responses suggest that hunters understood the causes (e.g. *Salmonella* and *E. coli* due to bacterial contamination in food) or vectors (e.g., mosquitoes for WNV and deer ticks for Lyme disease) of the diseases and illnesses in question.

Perceptions of risk associated with the six illnesses differed among hunters. The largest cluster (No Risk) contained hunters who did not view CWD as a serious risk. Such perceptions might be associated with the distribution of CWD in Illinois during the study period (4 of 102 counties, with 27 additional counties subject to tissue samples collected at deer check stations). The four Illinois counties where deer tested positive for CWD were located along the northern border with Wisconsin. This distribution may have led hunters in other regions of the state to conclude that the disease was localized and not a threat to their county. Further research is needed to test this issue, as hunters sampled from CWD counties was too small of a portion of the sample ($n = 42$) to make such an inference possible.

What was evident, however, is that perceived risks associated with the illnesses influenced precautionary hunter behaviors and beliefs. Mean scores for *Salmonella* and *E. coli* indicated that hunters viewed these threats as similar, as was the case for both CWD and mad cow. By determining perceived risks of CWD to other diseases and illnesses, we can begin to understand how hunters conceptualize CWD relative to other known risks. CWD was ranked with the same perceived risk as mad cow disease, suggesting that some hunters perceive these two illnesses as similar.

Management Implications

Results of this study suggest a segment of the hunter population evaluates risk from CWD in the context of risks associated with other diseases and illnesses and translates such evaluations into behavioral responses and intentions. Illinois Department of Natural Resources has worked aggressively to combat the spread of CWD within the state. Results presented here suggest some individuals stop hunting due the presence of CWD. Illinois is not alone in experiencing declines in hunter participation (Miller & Vaske, 2003). Further research is needed to determine if, and to what extent, perceived risks of CWD may contribute to further declines in hunting participation. Such reactions may not be restricted to CWD, but

may also occur with diseases. Given existing difficulties in locating places to hunt, adding perceptions of risk for disease to the list of constraints may result in further decreased hunter participation.

Perceived risks related to wildlife diseases should be included in information and education campaigns conducted by state wildlife and health agencies. Perceptions based on erroneous information and misconceptions may render management efforts ineffective. It is important for managers to determine stakeholder perceptions and identify subgroups that hold specific risk orientations. Stakeholder risk perceptions are associated with agency trust (Needham & Vaske, 2008). If stakeholders do not trust the agency, education campaigns on diseases or other threats may go unheeded. Understanding how wildlife diseases are perceived by stakeholders is an important component of managing and containing these threats to our wildlife resources and ourselves.

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