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Risk Sensitivity and Hunter Perceptions of Chronic Wasting Disease Risk and Other Hunting, Wildlife, and Health Risks

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ABSTRACT

This article examined relationships among hunter perceptions of personal health risks from chronic wasting disease (CWD), knowledge and information about CWD, and perceptions of other hunting, wildlife, and health risks. Data were obtained from surveys of 2,725 deer and elk hunters in Colorado. Cluster analysis grouped hunters into no (42%), slight (44%), and moderate (14%) risk groups based on perceptions of personal health risks from CWD (e.g., concern about health, become ill from CWD). There were minimal differences among groups in demographics, information sources, and knowledge about CWD. Hunters who perceived higher health risks from CWD (i.e., moderate risk), however, perceived greater risks associated with CWD to other humans, CWD to wildlife, hunting to personal health, other diseases to health, and the future of hunting. These findings illustrated the concept of risk sensitivity where hunters who perceived higher risks from CWD were predisposed to rate all other risks as large.

KEYWORDS

Chronic wasting disease; hunting; information sources; knowledge; perceived risk; risk sensitivity

Introduction

Chronic wasting disease (CWD) is a neurological disease found in free-ranging white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis, Cervus elaphus*), moose (*Alces alces*), and reindeer (*Rangifer tarandus*; Haley & Hoover, 2015; Saunders, Bartelt-Hunt, & Bartz, 2012; Williams, Miller, Kreeger, Kahn, & Thorne, 2002). This disease is also found in captive (i.e., farmed) populations. Caused by a prion protein mutation, CWD causes abnormal behavior and emaciation, and is fatal in all infected animals (Edmunds et al., 2016). CWD is a transmissible spongiform encephalopathy disease similar to bovine spongiform encephalopathy (BSE) in cattle (Mad Cow disease), scrapie in sheep, and Variant Creutzfeldt-Jakob disease in humans (McKintosh, Tabrizi, & Collinge, 2003). Although no evidence currently exists showing that CWD poses a risk to human health, transmission to humans cannot be completely dismissed (Belay et al., 2004; Haley & Hoover, 2015; MaWhinney et al., 2006).

CWD was first identified in captive animals during the 1960s and in free-ranging herds during the 1980s in Colorado, but by the end of 2016, this disease had spread to free-ranging herds in 21 states across the United States, two Canadian provinces, and Norway (Edmunds et al., 2016; Williams et al., 2002). This disease has also been found in captive populations in

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several additional states and countries (e.g., South Korea). In many of these locations, some hunters have stopped hunting because of concerns about CWD, and studies have shown that this change in behavior has been at least partially influenced by perceptions of risk associated with this disease (Lyon & Vaske, 2010; Miller, 2004; Miller & Shelby, 2009; Needham & Vaske, 2008; Needham, Vaske, & Manfredo, 2004, 2006; Stafford, Needham, Vaske, & Petchenik, 2007; Vaske, 2010; Vaske & Lyon, 2011; Vaske, Timmons, Beaman, & Petchenik, 2004).

Perceived risk is the extent that an individual believes he or she may be exposed to a particular hazard (Sjöberg, 2000a; Slovic, 2000, 2010; Thompson & Dean, 1996). Although people can perceive risks from a hazard such as CWD, it is possible that some of these perceptions are not always driven by particular concerns about CWD at all, but rather by an inherent predisposition to rate all risks in life as large (Sjöberg, 2000a, 2002). This phenomenon is most commonly known as general risk sensitivity, but it has also been referred to as personal risk amplification or attenuation (Sjöberg, 2004). This article focused on risk sensitivity within the context of CWD by examining relationships between hunter perceptions of personal health risks associated with this disease and perceptions of other hunting, wildlife, and health risks.

Conceptual foundation

Risk perceptions and CWD

Risk involves the objective probability and actual consequences of hazards (i.e., severity of outcomes; Adams & Smith, 2001; Breakwell, 2014; Slovic, 2000, 2010; Thompson & Dean, 1996). Perceived risks, on the other hand, are subjective and intuitive judgments that are unique to each individual risk target and partially informed by risk communication efforts (Breakwell, 2014; Siegrist, Gutscher, & Earle, 2005; Slovic, 2000). Risk targets are the entities (e.g., oneself, friends, society in general) perceived to be affected by a hazard, and these targets can influence risk perceptions (Roeser, Hillerbrand, Sandin, & Peterson, 2012; Sjöberg, 2000a). Individuals, for example, often rate risks to themselves (i.e., personal risk) lower than the same risks to others (i.e., societal or general risk) irrespective of objective probability estimates (Sjöberg, 2000a). This is known as risk denial and is influenced by the control that individuals believe they have in protecting themselves against a hazard (Bronfman & Cifuentes, 2003; Sjöberg, 2000a; Slovic, 2000).

These public perceptions of risks and control over hazards do not always reflect expert judgments. When experts judge risk, their responses tend to correlate with objective, analytical, and rational estimates of probabilities and consequences, whereas risk perceptions by members of the general public are often associated with more subjective and emotional responses to characteristics of hazards (Kunreuther & Slovic, 1996; Sjöberg, 1998; Wilson & Arvai, 2007). This difference in risk perceptions between experts and the public has been conceptualized as the probabilist (i.e., experts) versus contextualist (i.e., public) positions (Thompson & Dean, 1996).

In addition to these differences among experts, individuals, and society in general, risk perceptions can also be influenced by other characteristics and cognitions. Studies have found that familiarity, knowledge, dread, catastrophic potential, exposure, voluntariness, and unnaturalness also influence risk perceptions (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic, 2000, 2010). Familiarity and knowledge associated with a hazard, for example, can be related to risk perceptions (Fischhoff et al., 1978; Gupta, Fischer, & Frewer, 2012; Siegrist & Cvetkovich, 2000). Media attention and information availability can give rise to a

higher degree of perceived risk, especially for low probability and high consequence risks (e.g., airplane crashes) that tend to be overestimated and receive substantial attention when they occur (Boyd & Jardine, 2011). Conversely, larger risks (e.g., health effects from smoking or improper diet) can be underestimated despite widespread attention and available information (Breakwell, 2014; Roeser et al., 2012; Sjöberg, 1998, 2000a). Demographic characteristics can also influence risk perceptions (Sjöberg, 2006). Men, for example, are often less concerned about hazards than are women (Slovic, 2000). Research has also found associations between lower education levels and higher risk perceptions (Hanisch-Kirkbride, Riley, & Gore, 2013; Sjöberg, 2000a, 2004).

Perceptions of risk have been studied in many contexts such as healthcare (Shiloh, Wade, Roberts, Alford, & Biesecker, 2013), tourism and recreation (Morgan & Stevens, 2008), natural disasters (Armas & Avram, 2008), driving (Roche-Cerasi, Rundmo, Sigurdson, & Moe, 2013), and smoking (Oncken, McKee, Krishnan-Sarin, O'Malley, & Mazure, 2005). Much of the literature, however, has focused on risks of technologies such as nuclear energy and genetic engineering (Frewer, Miles, & Marsh, 2002; Gupta et al., 2012; Roeser et al., 2012; Sjöberg, 2004; Sjöberg & Drottz-Sjoberg, 2009; Slovic, 2010). Nature itself is also a source of risk and the concept of risk perception can be applied to natural resource issues such as wildlife diseases (Hanisch-Kirkbride et al., 2013). Wildlife diseases pose risks to humans and threaten domestic and wild animal populations (Gore et al., 2009; Vaske, Shelby, & Needham, 2009).

One wildlife disease that has received attention in the risk perception literature is CWD (see Vaske, 2010; Vaske et al., 2009 for reviews). Studies on perceptions of risk from CWD can be grouped into two general categories. First, research has examined hunter perceptions of future risks in response to hypothetical scenarios depicting potential CWD prevalence levels (e.g., 1%, 5%, 30%, 50% animals infected), geographic dispersal, severity of consequences (e.g., potential for human death), and other issues such as availability of CWD testing (Gigliotti, 2004; Lyon & Vaske, 2010; Needham, Vaske, Donnelly, & Manfredo, 2007; Needham et al., 2004, 2006; Vaske & Lyon, 2011; Vaske, Needham, Newman, Manfredo, & Petchenik, 2006a; Zimmer, Boxall, & Adamowicz, 2012). These studies showed that at low levels of prevalence and other impacts, most hunters perceived minimal risks and would not alter their location or frequency of hunting participation. As prevalence and other negative impacts (e.g., greater geographic dispersal, potential consequences to humans) increased, however, risk perceptions also increased and changes in participation were more probable, especially among new or novice hunters.

Second, studies have also examined perceptions of current risks from CWD, with results consistently showing that people are actually concerned and worried about this disease. In Illinois, for example, many hunters expressed concerns about effects of CWD on wildlife, perceived personal health risks associated with this disease, and believed that CWD could infect humans (Harper, Miller, & Vaske, 2015; Miller, 2003, 2004). Only 20% of Illinois hunters, for example, perceived no risk of becoming ill from CWD (Miller & Shelby, 2009). The majority of hunters and the general public in New York were also concerned about potential effects of CWD on hunting and both human and animal health (Brown et al., 2006; Garruto et al., 2008; Schuler, Wetterau, Bunting, & Mohammed, 2016). Across eight other states, hunters were concerned about their health because of CWD and perceived themselves to be at risk of becoming ill from this disease (Needham & Vaske, 2008). In addition, 50–74% of these hunters agreed that CWD may pose a risk to humans, 36–63% believed that CWD may cause disease in humans, and 41–73% were concerned about eating deer or elk because of CWD (Needham & Vaske, 2006). Similarly, two thirds of South Dakota hunters were worried

about CWD (Gigliotti, 2004). The majority of Wisconsin hunters who did not hunt the year after CWD was found in this state were influenced by perceived risks associated with CWD, 34% were concerned about eating deer meat, and 40% were concerned about becoming ill from this disease (Vaske et al., 2004). Similar results were found in another study of Wisconsin hunters and nonhunters (Stafford et al., 2007).

Some research, however, has suggested that slightly fewer people perceive risks from CWD and some of these risks may even be dissipating over time. Studies in some Canadian provinces, for example, showed that only 32% of hunters believed that CWD posed a threat to humans and 26% of the general public was worried that wild animals could have this disease (Lemyre et al., 2009; Zimmer, Boxall, & Adamowicz, 2011). In Wisconsin, Cooney and Holsman (2010) and Holsman, Petchenik, and Cooney (2010) found that although people were still slightly concerned about getting sick from eating deer infected with CWD, their perceived risks had diminished since the onset of the disease in this state and they were less concerned about CWD now, suggesting that time and experience with this disease may have tempered some of the initial concerns identified in earlier studies (Needham & Vaske, 2006, 2008; Needham et al., 2004, 2006; Stafford et al., 2007; Vaske et al., 2004). Although almost all of these studies of perceived risks from CWD have involved hunters or members of the general public (i.e., nonhunters), a few other studies have examined assessments of CWD risks by experts and other stakeholders (Amick, Clark, & Brook, 2015; Oraby et al., 2016; Schuler et al., 2016; Tyshenko et al., 2016).

Risk sensitivity and CWD

This body of research has demonstrated that hunters, nonhunters, and other stakeholders perceive personal health risks and other risks from CWD. It is possible, however, that some of these risks are a reflection of wider sensitivities to many risks in general. Some people tend to regard most or all risks in life as large, whereas others can do the opposite (Sjöberg, 2004; Warr, 1987). This suggests there exists a common underlying factor measured by most risk ratings, no matter what type of hazard is being investigated. There are two explanations that could account for this phenomenon (Sjöberg, 2000a, 2000b). First, risk sensitivity could truly exist with some people concerned about almost all hazards and other individuals completely indifferent or risk insensitive. Second, some people could implement scale use habits where they automatically respond on the high end of risk scales and others always use the low end, no matter what hazard is being considered. This satisficing behavior (e.g., straight-lining) can happen due to survey length or complexity (Kaminska, McCutcheon, & Billiet, 2010). Research has shown, however, that correlations between risk ratings and evaluations for different concepts have been small, suggesting that scale use habits are unlikely to explain the phenomenon (Sjöberg, 2000a, 2000b).

Risk sensitivity has been defined differently in other fields such as zoology and ethology (e.g., foraging behavior to minimize uncertainty and maximize rewards; Lim, Wittek, & Parkinson, 2015), and economics and finance (e.g., sensitivity of businesses to factors such as liquidity and exchange rates; Vallascas & Hagendorff, 2013). In psychology in general and the field of risk perception in particular, however, this concept evolved partially in response to the inability of other common risk theories and approaches (e.g., cultural theory of risk [Douglas & Wildavsky, 1982], social amplification of risk [Heberlein & Stedman, 2009; Kasperson et al., 1988], psychometric paradigm [Fischhoff et al., 1978]) to explain substantial amounts of variance in perceptions of risks among individuals (Sjöberg, 1996, 2000a, 2004; Warr, 1987). Risk sensitivity has proven to be important for understanding perceptions of

risks such as nuclear power and waste (Sjöberg, 1996, 2000a, 2000b, 2004), transportation (Lund, Nordfjærn, & Rundmo, 2012; Nordfjærn, Jørgensen, & Rundmo, 2011), food (Hohl & Gaskell, 2008), and crime (Chadee, Austen, & Ditton, 2007) where evaluations of other seemingly unrelated hazards (e.g., smoking, drowning, lightning, pollution, war, terrorism, natural disasters) have often correlated positively and strongly with these risks.

The concept of risk sensitivity has also been examined in the context of CWD. Miller and Shelby (2009) measured risk perceptions among Illinois hunters for CWD, insect-borne diseases (e.g., Lyme disease, West Nile virus), and food-borne illnesses (e.g., Salmonella, E. coli). Cluster analysis of these risks revealed no (24%), slight (57%), and moderate (19%) risk groups. The moderate risk group was either less likely to hunt in the most recent season or more likely to hunt in areas without CWD and monitor how deer were behaving before harvesting. This group was also more likely to believe that CWD could infect humans and less likely to think the threat of this disease had been exaggerated. Correlations among risk perceptions for the different diseases and illnesses suggested risk sensitivity among these hunters. What remains unknown, however, are characteristics of groups who perceive risks from CWD (e.g., demographics, knowledge) and whether these risks are related to perceptions of other hunting, wildlife, and health risks. In addition, Vaske (2010) proposed: (a) "risks that hunters may perceive for family members, other hunters, or society in general have received less attention"; (b) "existing research has generally not examined other risks associated with CWD"; (c) "more research on other diseases would broaden our understanding of risk sensitivity"; and (d) "continuing to draw on the risk literature to examine risk perceptions and other CWD risks may facilitate a better understanding" (p. 175).

This article addressed these propositions and built on Miller and Shelby (2009) by examining three research questions in the context of hunters in Colorado. First, to what extent do hunters perceive that CWD currently poses a personal health risk? Second, are these health risks related to demographic characteristics, information sources, and knowledge about CWD? Third, to what extent are these health risks related to perceived risks of CWD to other humans, CWD to wildlife, hunting to personal health, other diseases to personal health, and the future of hunting?

Methods

Data were obtained from a mail survey of Colorado hunters. Colorado Parks and Wildlife provided random samples of resident and nonresident hunters 18 years of age or older who purchased licenses to hunt deer or elk with a firearm. Overlap among these strata was minimized by deleting the few duplicate cases across samples before administration (e.g., deer hunters who also hunted elk). Three mailings were used for administering questionnaires (Dillman, Smyth, & Christian, 2014; Vaske, 2008). Hunters were sent a questionnaire, postage paid return envelope, and letter explaining the study. Reminder postcards were sent to nonrespondents two weeks later, and a second full mailing (e.g., questionnaire, letter) was sent three weeks after this postcard.

In total, 2,725 questionnaires were completed and 131 were undeliverable (e.g., moved, incorrect address), yielding a 63% overall response rate. Limited funding prohibited a nonresponse bias check. The sample sizes across strata were 672 resident deer hunters, 679 nonresident deer hunters, 643 resident elk hunters, and 731 nonresident elk hunters. Ancillary analyses showed small or minimal differences in responses among these four

strata, so the data were aggregated and weighted to reflect the actual population proportions of hunters in the state.[1]

Perceived personal health risks associated with CWD were measured with four variables. Hunters reported how much risk they perceived was associated with two incidents happening to them: (a) "contracting a disease caused by CWD" and (b) "becoming ill as a result of contracting a disease caused by CWD." Responses were on a 9-point scale of 1 "no risk" to 9 "extreme risk." Hunters were also asked "because of CWD, how concerned are you about your own personal health" on a 9-point scale of 1 "not at all concerned" to 9 "extremely concerned." In addition, hunters were asked to respond to the statement "because of CWD, I have concerns about eating deer or elk meat" on a 7-point scale of 1 "strongly disagree" to 7 "strongly agree." These four variables are consistent with those used in previous CWD research (Harper et al., 2015; Lyon & Vaske, 2010; Needham & Vaske, 2006, 2008; Stafford et al., 2007; Vaske & Lyon, 2011).

Additional variables in this article included five demographic questions (Table 1), 10 questions measuring factual knowledge about CWD (true, false, unsure; Table 2), 12 questions measuring perceived information about CWD (Table 3), and 16 questions measuring sources of receiving information about CWD (Table 4). In addition, 33 questions measured perceived risks associated with: (a) CWD to other humans (two questions, Table 5), (b) CWD to wild animal populations (six questions, Table 6), (c) hunting to personal health (five questions, Table 7), (d) other diseases to personal health (four questions, Table 8), and (e) the future of hunting (16 questions, Table 9).[2] Variables and response scales measuring these concepts are provided in the tables and are similar to those used in other studies of demographics, knowledge, information, and risks (Hanisch-Kirkbride et al., 2013; Hohl & Gaskell, 2008; Miller & Shelby, 2009; Sjöberg, 1996, 2000b; Stafford et al., 2007; Vaske, Needham, Stafford, Green, & Petchenik, 2006b). Given this substantial number of variables and the large

Table 1. Relationships between risk of CWD to personal health and demographic characteristics.

	Risk of CWD to personal health clusters[1]						
Demographic characteristics	No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	χ^2 or F value	p value	Effect size (V or η)
Sex					10.67	<.001	.07
Male	96	97	93	96			
Female	4	3	7	4			
Marital status					3.49	.175	.04
Married or living with partner	82	85	83	84			
Not married or living with partner (divorced, separated, single, widowed)	18	15	17	16			
Highest level of education					0.98	.614	.02
Postsecondary education (more than high school diploma or GED)	61	60	63	61			
Secondary education or less (high school diploma, GED, or less)	39	40	37	39			
Current residence or community					3.03	.220	.04
Towns or rural areas with fewer than 25,000 people	55	53	50	54			
Cities with 25,000 or more people	45	47	50	46			
Mean age (in years)	48	49	48	48	1.14	.320	.03

Note. [1]Cell entries are percentages (%), unless specified as means.

Table 2. Relationships between risk of CWD to personal health and factual knowledge about CWD

Factual knowledge true/false variables (correct answer in brackets)	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	χ^2 or *F* value	*p* value	Effect size (*V* or η)
CWD is a disease found in deer and elk (true)	95	96	94	95	3.10	.212	.04
Weight loss is one symptom of CWD in animals (true)	82	82	74	81	13.63	<.001	.08
An animal that has CWD can still look healthy (true)	78	80	75	78	3.67	.160	.04
CWD is believed to spread by animal-to-animal contacts (true)	72	73	69	72	3.21	.201	.04
CWD is believed to be caused by an abnormal brain protein called a prion (true)	66	65	62	65	1.54	.646	.03
Research suggests there is no known relationship between CWD and human health problems (true)	60	47	35	51	82.79	<.001	.18
CWD has been found in wildlife in all states west of the Mississippi River (false)	44	41	39	42	3.86	.145	.04
Animals infected with CWD always die (true)	42	41	44	42	0.71	.701	.02
CWD has been found in less than 200 animals in Colorado (false)	30	30	35	30	4.15	.126	.04
In Colorado, CWD was first identified in wildlife populations in 1998 (false)	21	18	17	19	4.40	.111	.04
Mean total number of questions answered correctly (out of 10)	5.90^{a}	5.73^{ab}	5.46^{b}	5.77	6.80	<.001	.07

Note. [1]Cell entries are percentages (%) who answered correctly, unless specified as means. Means with different letter superscripts across the row for total number of questions answered correctly differed significantly using Scheffe post-hoc tests for equal variances.

Table 3. Relationships between risk of CWD to personal health and information about CWD.

Prior to receiving this survey, I feel I had enough information about:	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
Precautions that hunters should take because of CWD	5.24^{a}	4.92^{b}	4.47^{c}	5.00	29.65	< .001	.15
Where deer /elk with CWD have been found in Colorado	4.90^{a}	4.64^{b}	4.40^{b}	4.72	13.97	< .001	.10
The symptoms of CWD in wildlife	4.87^{a}	4.61^{b}	4.19^{c}	4.66	22.79	< .001	.13
What type(s) of wildlife species can have CWD	4.75^{a}	4.48^{b}	4.10^{c}	4.55	19.74	< .001	.13
What the Colorado Division of Wildlife is doing about CWD in Colorado	4.67^{a}	4.37^{b}	3.81^{c}	4.42	32.24	< .001	.16
Possible human safety risks associated with CWD	4.47^{a}	4.03^{b}	3.51^{c}	4.15	43.14	< .001	.18
What states have deer /elk with CWD	4.24^{a}	4.05^{b}	3.87^{b}	4.11	7.80	< .001	.08
When CWD was first identified in deer /elk in Colorado	4.15^{a}	3.98^{a}	3.64^{b}	4.00	12.00	< .001	.10
What causes CWD in wildlife	4.09^{a}	3.99^{a}	3.50^{b}	3.96	15.47	< .001	.11
Possible livestock health risks associated with CWD	4.05^{a}	3.93^{a}	3.56^{b}	3.93	12.03	< .001	.10
How many deer /elk with CWD have been found in Colorado	3.98^{a}	3.83^{a}	3.52^{b}	3.85	10.37	< .001	.09
How CWD first got to Colorado	3.77^{a}	3.63^{a}	3.27^{b}	3.64	12.52	< .001	.10
Mean total scores for combined index[2]	4.44^{a}	4.20^{b}	3.82^{c}	4.25	31.88	< .001	.16

Note.[1] Cell entries are means on 7-point scale: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree. Means with different letter superscripts across each row differed significantly using Tamhane's T2 post-hoc tests for unequal variances or Scheffe post-hoc tests for equal variances.

[2]Cronbach alpha reliability coefficient = .94 (item-total correlations = .69–.96, alphas if item deleted = .92–.93).

Table 4. Relationships between risk of CWD to personal health and information sources about CWD

How often have you:	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
Read about CWD in Colorado Division of Wildlife hunting regulations brochure	2.16	2.15	2.12	2.15	0.31	.732	.02
Discussed CWD with friends and /or family members	1.92	1.99	2.03	1.96	2.11	.122	.04
Read newspaper articles about CWD	1.76	1.67	1.63	1.70	3.78	.023	.05
Read about CWD in magazines and /or books	1.43	1.44	1.43	1.43	0.01	.988	.01
Read about CWD in other Colorado Division of Wildlife publications	1.43	1.43	1.35	1.42	0.94	.392	.03
Read about CWD on Colorado Division of Wildlife internet website	1.25	1.18	1.19	1.22	1.19	.304	.03
Watched television news reports about CWD	1.16	1.16	1.19	1.17	0.10	.903	.01
Watched other television programs about CWD	0.82	0.87	0.93	0.86	2.38	.096	.04
Read about CWD in hunting /sportsmen's club newsletters	0.80	0.80	0.79	0.80	0.01	.989	.01
Listened to radio news /radio programs about CWD	0.79	0.75	0.79	0.77	0.78	.459	.03
Discussed CWD with Colorado Division of Wildlife employees	0.69	0.62	0.66	0.66	1.77	.170	.04
Discussed CWD at hunting /sportsmen's club meetings	0.59	0.61	0.76	0.62	5.08	.007	.06
Read about CWD on other internet websites	0.51	0.55	0.62	0.54	2.29	.102	.04
Learned about CWD from conservation groups	0.41	0.37	0.43	0.40	0.88	.415	.03
Watched videos /DVDs about CWD	0.23	0.27	0.29	0.26	1.63	.196	.04
Attended and /or listened to a live presentation about CWD	0.23	0.23	0.29	0.24	1.80	.165	.04
Mean total scores for combined index[2]	1.01	1.00	1.04	1.01	0.55	.576	.02

Note. [1]Cell entries are means on 4-point scale: 0 = never, 1 = 1 or 2 times, 2 = 3 or 4 times, 3 = 5 or more times.
[2]Cronbach alpha reliability coefficient = .86 (item-total correlations = .39–.56, alphas if item deleted = .84–.85).

Table 5. Relationships between risk of CWD to personal health and risks of CWD to other humans.

Risks of CWD to other humans	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
CWD may cause disease in other humans if they eat meat from animals infected with CWD	3.52[a]	4.74[b]	5.12[c]	4.25	253.07	<.001	.41
Because of CWD, members of my family (e.g., spouse, children) have concerns about eating deer /elk meat	2.78[a]	5.20[b]	5.56[c]	4.18	832.99	<.001	.63
Mean total scores for combined index[2]	3.15[a]	4.97[b]	5.33[c]	4.22	847.10	<.001	.63

Note. [1]Cell entries are means on 7-point scale: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree. Means with different letter superscripts across each row differed significantly using Tamhane's T2 post-hoc tests for unequal variances.
[2]Cronbach alpha reliability coefficient = .60 (item-total correlations = .39).

sample size, a significance level of $p < .001$ was adopted based on the Bonferroni correction procedure to reduce the possibility of false discoveries and multiple test bias (i.e., multiple comparison problem, family-wise error).

Results

The first research question focused on the extent that hunters perceived CWD as a personal health risk. Given that the four variables measuring this concept were on different scales,

Table 6. Relationships between risk of CWD to personal health and risks of CWD to wild animal populations

Risks of CWD to wild animal populations	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
The health of the deer /elk population in Colorado due to CWD	5.75[a]	6.49[b]	7.41[c]	6.29	100.97	<.001	.27
The threat CWD poses to the future of deer /elk hunting in Colorado	5.69[a]	6.39[b]	7.34[c]	6.21	93.57	<.001	.26
CWD spreading throughout the entire deer /elk population in Colorado	5.29[a]	6.29[b]	7.42[c]	6.00	135.66	<.001	.31
The potential for CWD to dramatically reduce the deer /elk population in Colorado	5.30[a]	6.23[b]	7.37[c]	5.98	125.99	<.001	.30
Not having enough healthy deer /elk to hunt in Colorado due to CWD	5.17[a]	6.04[b]	7.13[c]	5.81	108.07	<.001	.28
The potential for CWD to kill the entire deer /elk population in Colorado	3.87[a]	4.92[b]	6.34[c]	4.65	131.34	<.001	.30
Mean total scores for combined index[2]	5.18[a]	6.06[b]	7.17[c]	5.82	150.58	<.001	.32

Note. [1]Cell entries are means on 9-point scale: 1–2 = not concerned, 3–4 = slightly concerned, 5–7 = moderately concerned, 8–9 = extremely concerned. Means with different letter superscripts across each row differed significantly using Tamhane's T2 post-hoc tests for unequal variances or Scheffe post-hoc tests for equal variances.
[2]Cronbach alpha reliability coefficient = .95 (item-total correlations = .75–.91, alphas if item deleted = .93–.95).

Table 7. Relationships between risk of CWD to personal health and risks of hunting to personal health.

Risks of hunting to personal health	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
Being in a car accident traveling to /from the hunting site	4.06[a]	4.11[a]	4.60[b]	4.16	15.94	<.001	.11
Getting shot by another hunter	3.47[a]	3.66[b]	4.79[c]	3.73	87.12	<.001	.25
Getting lost while hunting	2.98[a]	3.35[b]	3.92[c]	3.27	46.72	<.001	.19
Having a heart attack while hunting	3.03[a]	3.29[b]	3.95[c]	3.27	38.64	<.001	.17
Accidentally shooting yourself	1.89[a]	2.18[b]	2.49[c]	2.09	42.57	<.001	.18
Mean total scores for combined index[2]	3.09[a]	3.32[b]	3.95[c]	3.31	99.40	<.001	.27

Note. [1]Cell entries are means on 9-point scale: 1–2 = no risk, 3–4 = slight risk, 5–7 = moderate risk, 8–9 = extreme risk. Means with different letter superscripts across each row differed significantly using Tamhane's T2 post-hoc tests for unequal variances.
[2]Cronbach alpha reliability coefficient = .68 (item-total correlations = .40–.48, alphas if item deleted = .61–.63).

Table 8. Relationships between risk of CWD to personal health and risks of other diseases to personal health.

Risks of other diseases to personal health	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
Contracting West Nile virus	2.46[a]	2.95[b]	3.83[c]	2.86	99.35	<.001	.27
Contracting Lyme disease	2.52[a]	2.79[b]	3.61[c]	2.79	68.76	<.001	.23
Contracting Rabies	1.76[a]	2.02[b]	2.68[c]	2.00	102.17	<.001	.27
Contracting BSE (Mad Cow disease)	1.52[a]	2.00[b]	2.98[c]	1.93	240.52	<.001	.40
Mean total scores for combined index[2]	2.07[a]	2.44[b]	3.28[c]	2.39	195.95	<.001	.36

Note. [1]Cell entries are means on 9-point scale: 1–2 = no risk, 3–4 = slight risk, 5–7 = moderate risk, 8–9 = extreme risk. Means with different letter superscripts across each row differed significantly using Tamhane's T2 post-hoc tests for unequal variances.
[2]Cronbach alpha reliability coefficient = .78 (item-total correlations = .51–.64, alphas if item deleted = .69–.76).

Table 9. Relationships between risk of CWD to personal health and risks to the future of deer/elk hunting.

Risks to the future of deer /elk hunting	Risk of CWD to personal health clusters[1] No risk (42%)	Slight risk (44%)	Moderate risk (14%)	Total	*F* value	*p* value	Effect size (η)
Lack of land and access							
Difficult to get access to privately owned land	6.36[a]	6.56[a]	7.26[b]	6.57	22.28	<.001	.13
Decreasing amount of available public land for hunting	6.35[a]	6.38[a]	7.12[b]	6.47	17.93	<.001	.12
Too much privately owned land	5.99[a]	6.15[a]	6.94[b]	6.19	22.40	<.001	.13
Mean total scores for combined index[2]	6.24[a]	6.36[a]	7.11[b]	6.41	24.70	<.001	.14
Weather							
Threats from severe drought weather (not enough rain)	4.45[a]	4.71[b]	5.34[c]	4.69	26.79	<.001	.14
Threats from severe winter weather	4.38[a]	4.66[b]	5.14[c]	4.60	21.20	<.001	.13
Mean total scores for combined index[3]	4.41[a]	4.68[b]	5.24[c]	4.64	28.35	<.001	.15
Regulatory constraints							
Difficult to get a deer /elk hunting tag /license	4.60[a]	4.92[b]	5.54[c]	4.87	24.70	<.001	.14
Cost of deer /elk hunting licenses	4.44[a]	4.80[b]	5.31[c]	4.71	15.65	<.001	.11
Too many hunting regulations	3.60[a]	3.92[b]	4.46[c]	3.85	20.63	<.001	.13
Complicated /difficult to understand hunting regulations	3.55[a]	3.91[b]	4.53[c]	3.84	23.93	<.001	.14
Mean total scores for combined index[4]	4.05[a]	4.39[b]	4.96[c]	4.32	36.57	<.001	.17
Wildlife health and disease							
CWD in deer /elk	4.25[a]	5.44[b]	6.91[c]	5.12	288.60	<.001	.43
Not enough healthy deer /elk left to hunt	3.74[a]	4.51[b]	5.77[c]	4.35	134.85	<.001	.31
Lyme disease in deer /elk	3.02[a]	3.67[b]	4.81[c]	3.54	162.93	<.001	.34
Tuberculosis in deer /elk	3.07[a]	3.63[b]	4.69[c]	3.53	123.01	<.001	.30
Mean total scores for combined index[5]	3.53[a]	4.32[b]	5.55[c]	4.14	271.96	<.001	.42
Attrition in hunting participation							
Not enough new or young people taking up deer /elk hunting	4.26[a]	4.37[a]	4.78[b]	4.38	7.34	<.001	.08
Too many people quitting deer /elk hunting	3.54[a]	3.92[b]	4.51[c]	3.83	33.94	<.001	.16
Too many other activities competing with deer /elk hunting	3.41[a]	3.60[a]	3.95[b]	3.57	9.99	<.001	.09
Mean total scores for combined index[6]	3.74[a]	3.96[b]	4.41[c]	3.92	19.98	<.001	.12

Note. [1]Cell entries are means on 9-point scale: 1–2 = no threat, 3–4 = slight threat, 5–7 = moderate threat, 8–9 = extreme threat. Means with different letter superscripts across each row differed significantly using Tamhane's T2 post-hoc tests for unequal variances or Scheffe post-hoc tests for equal variances.
[2]Cronbach alpha reliability coefficient = .89 (item-total correlations = .73–.84, alphas if item deleted = .79–.89).
[3]Cronbach alpha reliability coefficient = .83 (item-total correlations = .71).
[4]Cronbach alpha reliability coefficient = .76 (item-total correlations = .43–.68, alphas if item deleted = .64–.76).
[5]Cronbach alpha reliability coefficient = .85 (item-total correlations = .56–.75, alphas if item deleted = .77–.85).
[6]Cronbach alpha reliability coefficient = .83 (item-total correlations = .59–.76, alphas if item deleted = .67–.83).

responses were converted to standardized *z*-scores and K-means cluster analyses were performed on these variables. A series of two to six group cluster analyses showed that the three group solution provided the best fit with the groups labeled as no risk, slight risk, and moderate risk. These groups were compared in terms of their responses to the original variables. The no risk group had the lowest scores on all four variables with means corresponding to moderately disagree, no risk, and not concerned on the scales. The moderate risk group had the highest scores on all four variables with means corresponding to moderate agreement, risk, and concern. The slight risk group fell between these two groups with responses of slight agreement, risk, and concern. The largest proportion of hunters was in this slight risk group (44%), the second largest group expressed no risk (42%),

and the fewest hunters were in the moderate risk group (14%). This cluster analysis did not identify any discernable group perceiving high personal health risks.

Two analyses validated and confirmed the stability of this cluster solution. First, the data were randomly sorted and cluster analyses were conducted after each of five random sorts. These analyses supported the solution identifying the three groups of hunters based on personal health risks associated with CWD. Second, discriminant function analysis was conducted to determine how well the four original variables predicted these three cluster groups. All four variables significantly predicted the clusters, Wilks' lambda $U = .358–.653$, $F = 683.37–2310.50$, $p < .001$. The variables correctly classified 95% of hunters in the no risk group, 96% in the slight risk group, and 87% in the moderate risk group. In total, 94% of the hunters were correctly classified. Taken together, these results supported the validity and stability of this three cluster solution.

The second research question focused on the extent that these personal health risks were related to demographics, knowledge, and information about CWD. There were no differences among the three cluster groups in marital status, education, residence, and age, $\chi^2 = 0.98–3.49$, $F = 1.14$, $p = .175–.614$ (Table 1). The majority of hunters was married or living with a partner (84%), had a postsecondary education (61%), and lived in towns with fewer than 25,000 people (54%). Their average age was 48 years old. There were slightly more females in the moderate risk group (7%) compared to the no risk (4%) and slight risk (3%) groups, $\chi^2 = 10.67$, $p < .001$. The Cramer's V effect size, however, was only .07 and guidelines for interpreting effect sizes suggest the magnitude of this difference was "small" (Cohen, 1988) or "minimal" (Vaske, 2008).

The total factual knowledge score out of 10 questions showed low knowledge about CWD for all three groups, but it was highest for the no risk group ($M = 5.90$ correct/10), followed by the slight ($M = 5.73$/10) and moderate risk groups ($M = 5.46$/10), with the moderate risk group having significantly lower knowledge than the no risk group, $F = 6.80$, $p < .001$ (Table 2). The eta effect size ($\eta = .07$), however, was "small" (Cohen, 1988) or "minimal" (Vaske, 2008). The moderate risk group was also least likely to correctly answer eight of these 10 questions measuring knowledge. However, there were statistical differences among the cluster groups for only two of these questions (weight loss is one symptom of CWD in animals, research suggests no relationship between CWD and human health), $\chi^2 = 13.63–82.79$, $p < .001$, $V = .08–.18$.

Hunters in the moderate risk group were also least likely to believe that they had enough information about all 12 CWD topics, whereas those in the no risk group were most likely to have enough information, $F = 7.80–43.14$, $p < .001$ (Table 3). The eta effect sizes ($\eta = .08–.18$), however, were "small" (Cohen, 1988) or "minimal" (Vaske, 2008). Across all three groups combined, hunters had the most information about precautions they should take because of CWD ($M = 5.00$) and the least information about how CWD first got to Colorado ($M = 3.64$). Despite these findings, the three cluster groups did not differ significantly (at the $p < .001$ level) in their responses to any of the 16 questions measuring sources of information about CWD, $F = 0.01–5.08$, $p = .007–.989$, $\eta = .01–.06$ (Table 4). Across all three groups combined, hunters were most likely to have read about CWD in the state agency hunting regulations ($M = 2.15$) and least likely to have attended presentations about this disease ($M = 0.24$).

Discriminant function analysis was conducted to determine how well the demographic questions, total factual knowledge score, and combined indices measuring perceived

information (Cronbach alpha = .94) and sources of information (Cronbach alpha = .86) predicted the three cluster groups. Only sex (i.e., male, female), factual knowledge, and perceived information significantly predicted the groups, Wilks' lambda $U = .972—.993$, $F = 4.82–34.05$, $p < .001$. Other demographics and the sources of information about CWD were not significant. Only 64% of hunters in the no risk group, 43% in the slight risk group, and 21% in the moderate risk group (total = 48%) were correctly classified, suggesting that concepts other than just demographics, knowledge, and information explain perceived personal health risks associated with CWD.

The third research question, therefore, focused on the extent that these health risks were related to perceptions of other risks. Hunters who perceived the highest personal health risks from CWD (i.e., moderate risk group) also perceived the highest risks associated with CWD to other humans, CWD to wildlife, hunting to personal health, other diseases to personal health, and the future of hunting. Conversely, the no risk group perceived the lowest risks associated with these other hazards, and the slight risk group fell between these two groups. Hunters in the moderate health risk group, for example, were most likely to agree that CWD can cause disease in other humans ($M = 5.12$) and that members of their family were concerned about eating deer or elk because of CWD ($M = 5.56$; Table 5). In contrast, hunters in the no risk group disagreed that CWD presented these risks to other humans ($M = 2.78–3.52$), and responses from the slight risk group fell between these two groups ($M = 4.74–5.20$), $F = 253.07–832.99$, $p < .001$. The eta effect sizes ($\eta = .41–.63$) were "large" (Cohen, 1988) or "substantial" (Vaske, 2008).

This pattern among groups was consistent and statistically significant across the: (a) six variables measuring risks of CWD to wild animal populations such as it dramatically reducing or killing deer and elk herds (no risk: $M = 3.87–5.75$, slight risk: $M = 4.92–6.49$, moderate risk: $M = 6.34–7.42$; $F = 93.57–135.66$, $p < .001$, $\eta = .26–.31$; Table 6); (b) five items measuring risks of hunting to personal health such as getting lost or shot (no risk: $M = 1.89–4.06$, slight risk: $M = 2.18–4.11$, moderate risk: $M = 2.49–4.79$; $F = 15.94–87.12$, $p < .001$, $\eta = .11–.25$; Table 7); (c) four variables measuring personal health risks of other diseases such as West Nile virus, Rabies, and BSE (no risk: $M = 1.52–2.52$, slight risk: $M = 2.00–2.95$, moderate risk: $M = 2.68–3.83$; $F = 68.76–240.52$, $p < .001$, $\eta = .23–.40$; Table 8); and (d) 16 items measuring risks to the future of hunting such as lack of land and access, weather, regulatory constraints, wildlife diseases, and attrition in participation (no risk: $M = 3.02–6.36$, slight risk: $M = 3.60–6.56$, moderate risk: $M = 3.95–7.26$; $F = 7.34–288.60$, $p < .001$, $\eta = .08–.43$; Table 9).[3]

Across all three groups combined, hunters perceived slight risks of CWD to other humans ($M = 4.18–4.25$, Table 5), moderate risks of CWD to animals ($M = 4.65–6.29$, Table 6), slight risks of hunting to their own personal health ($M = 3.27–4.16$) except accidently shooting themselves ($M = 2.09$, Table 7), slight risks of contracting West Nile virus ($M = 2.86$) and Lyme disease ($M = 2.79$), and minimal risks of contracting BSE ($M = 1.93$) and Rabies ($M = 2.00$, Table 8). For risks to the future of hunting, respondents perceived slight risks from attrition in participation (e.g., not enough new or young people hunting, too many people quitting; $M = 3.57–4.38$), Lyme disease and Tuberculosis in deer or elk ($M = 3.53–3.54$), and the number and complexity of hunting regulations ($M = 3.84–3.85$; Table 9). Hunters perceived moderate risks from lack of land and access (e.g., decreased availability of public land for hunting, difficulty accessing private land;

M = 6.19–6.57), CWD (M = 5.12), costs and difficulty of obtaining hunting licenses (M = 4.71–4.87), and severe drought and winter weather (M = 4.60–4.69).

Discriminant function analysis was conducted to determine how well the combined indices measuring these risks associated with CWD to other humans (Cronbach alpha = .60), CWD to wildlife (Cronbach alpha = .95), hunting to personal health (Cronbach alpha = .68), other diseases to health (Cronbach alpha = .78), and the future of hunting (Cronbach alphas = .76–.89) predicted the three personal health risk cluster groups. All of these indices significantly predicted the groups, Wilks' lambda U = .601–.985, F = 19.96–847.99, $p < .001$. These indices correctly classified 80% of hunters in the no risk group, 77% in the slight risk group, and 63% in the moderate risk group. In total, 72% of the hunters were correctly classified. Taken together, these results illustrate the concept of risk sensitivity where perceived personal health risks from CWD were associated with perceptions of other hunting, wildlife, and health risks.

Discussion

These results have implications for both management and research. From a management perspective, the majority of the hunters (58%) perceived slight to moderate personal health risks from CWD, which contradicts most agency information and education efforts stating there is no evidence that CWD currently poses risks to human health. These messages, however, also advise hunters to take precautions such as to test animals for CWD and wear gloves when processing animals, implying that a risk may be present. These mixed messages may cause hunters to attend more to one part of the messages than the other, which may influence risk evaluations (Needham & Vaske, 2008). Hunters may also believe this ambiguity suggests that agencies are uncertain about CWD, resulting in heightened risk perceptions (Harper et al., 2015). Although agencies are likely to continue communicating these precautionary messages primarily out of concern for both liability and public safety, they should take these issues into consideration when developing CWD communication campaigns and planning their responses to this disease (Vaske, 2010).

Additional communication campaigns, however, may not be successful for educating risk sensitive hunters. In total, 14% of the hunters perceived higher personal health risks from CWD (i.e., moderate risk group), but these individuals also perceived the highest risks associated with CWD to other humans, CWD to wildlife, hunting to personal health, other diseases to personal health, and the future of hunting. This risk sensitivity or inherent predisposition to rate most risks as large makes it challenging for agencies to single out a specific hazard such as CWD and then reduce risk perceptions associated with this hazard (Sjöberg, 2000a, 2002). This moderate risk group, however, had the lowest knowledge about CWD, was least likely to know there is no current relationship between CWD and human health problems, and was least likely to believe they had enough information about various CWD topics. These results suggest that specific communications, especially about the lack of evidence showing connections between CWD and human health problems, should be reiterated, emphasized, and targeted to risk sensitive groups (Needham & Vaske, 2008). Differences between CWD and other hunting, wildlife, and health risks should also be clearly articulated in any information and education campaigns. Perceptions of risk from CWD and other hazards that are based on erroneous information and misconceptions may render management efforts ineffective, so it is important for agencies to measure public risk evaluations and then target groups who hold these perceptions (Miller & Shelby, 2009).

In the United States, wildlife oriented recreation participation declined from 109 million participants in 1991 to fewer than 87 million in more recent years, and data from hunting license sales show a similar trend with the number of hunters in the nation declining from almost 17 million in 1982 to fewer than 14 million in more recent years despite a national population increase of 92 million people during this timeframe (Duda, Jones, & Criscione, 2010). Results presented here showed that respondents considered CWD to be the second greatest risk to the future of hunting after issues associated with lack of land and access. In fact, studies have shown that some people have already stopped hunting because of concerns about CWD (Lyon & Vaske, 2010; Miller, 2004; Miller & Shelby, 2009; Needham et al., 2004, 2006; Stafford et al., 2007; Vaske & Lyon, 2011; Vaske et al., 2004). Hunting declines associated with CWD may further reduce revenue from license sales, impact wildlife management if funds get diverted to address CWD, limit an agency's ability to manage game species, and constrain cultural traditions and the economic stability of communities dependent on hunting (Needham et al., 2004).

From a research perspective, the cluster analysis of personal health risks associated with CWD revealed that the largest proportion of hunters was in the slight risk group (44%), the second largest group expressed no risk (42%), and the fewest hunters were in the moderate risk group (14%). These findings are consistent with Miller and Shelby (2009) who also found three clusters and labeled them as no, slight, and moderate risk groups. Miller and Shelby (2009), however, reported fewer hunters in the no risk group (24%) and more in both the slight (57%) and moderate (19%) risk groups, likely because their analyses were based on risks from more diseases and illnesses than just CWD (i.e., Lyme disease, West Nile virus, Salmonella, E. coli, CWD). Regardless, both the results in Miller and Shelby (2009) and those presented here showed that the largest groups of hunters perceived slight health risks, the smallest perceived moderate risks, and there were no discernable groups perceiving extremely high risks. This finding is also consistent with studies of several other risks (Breakwell, 2014; Sjöberg, 2000a; Slovic, 2010).

Despite these findings, most research has been oriented toward understanding people who perceive risks as large and why they do so, whereas little effort has been made to understand why large groups often perceive no risks or only slight risks (Sjöberg, 2006). People could perceive low personal health risks associated with CWD because they may: (a) trust agencies to manage these risks on their behalf (Needham & Vaske, 2008), (b) demonstrate risk denial by believing this hazard will never affect them personally (Bronfman & Cifuentes, 2003; Sjöberg, 2000a), or (c) know that the actual probability of CWD presenting a health hazard is extremely low. Results showed, for example, that 60% of hunters in the no risk group compared to only 35% in the moderate risk group knew there is no current relationship between CWD and human health. Research is needed to understand these and other potential drivers of risk perceptions associated with CWD and other wildlife diseases (Gore et al., 2009; Hanisch-Kirkbride et al., 2013).

Results also showed some relationships between personal health risks from CWD and demographic characteristics, information availability, and factual knowledge about this disease. Hunters in the moderate risk group were slightly more likely to be female, have less knowledge about CWD, and believe they did not have enough information about this disease. These findings are consistent with other research showing that familiarity, knowledge, information availability, and demographic characteristics can be related to risk perceptions (Gupta et al., 2012; Siegrist & Cvetkovich, 2000; Sjöberg, 2006; Slovic, 2000). Effect sizes in this study, however, showed that the strength of most of these relationships was small. This is somewhat predictable because, for example, factual knowledge about CWD is low across almost all hunters

as shown here and in other studies (Vaske et al., 2006b), and big game hunting tends to be dominated almost entirely by men as shown here (96%) and elsewhere (Duda et al., 2010). Related concepts not measured in this study's questionnaire, however, include years of hunting participation and length of time spent following CWD in the media. In Wisconsin, researchers found that risk perceptions associated with CWD have slightly diminished over time since the onset of the disease in this state (Cooney & Holsman, 2010; Holsman et al., 2010). In addition, a study in eight states by Needham et al. (2007) found that people who participated in hunting for many years of their life (i.e., "veteran" hunters) perceived the lowest risk from CWD and were least likely to change their hunting behavior in response to this disease. What remains unknown, however, is the actual influence of the passage of time on an individual's perceived personal health risks from CWD. Panel design studies are needed to address this issue. Regardless, knowledge, information availability, and demographic characteristics collectively only classified 48% of hunters in this study based on their perceptions of personal health risks associated with CWD, suggesting that additional concepts, such as risk sensitivity, explain these perceptions.

This study clearly demonstrated the phenomenon of risk sensitivity in the context of perceived health risks from CWD, as all 33 other hunting, wildlife, and health hazards were statistically related at the $p < .001$ level to these personal health risks from CWD. For all of these other hazards, hunters in the moderate personal health risk group perceived the greatest risks, those in the no risk group perceived the lowest risks, and responses from the slight risk group fell between these two groups. Risks associated with these other hazards classified 72% of hunters based on their perceptions of health risks associated with CWD. These results are consistent with Miller and Shelby (2009) who reported correlations among hunter perceptions of personal health risks from CWD and other diseases and illnesses. This study built on Miller and Shelby (2009) by demonstrating this pattern of findings across a much larger suite of hazards (e.g., risks of CWD to other humans, CWD to wildlife, hunting to personal health, future of hunting) and for other types of hunters (e.g., elk hunters, nonresident hunters) in a different state (i.e., Colorado).

This pattern of findings is also identical to studies of other risks (e.g., nuclear power, transportation, food, crime) where evaluations of unrelated hazards have correlated strongly with these risks (Chadee et al., 2007; Hohl & Gaskell, 2008; Lund et al., 2012; Nordfjærn et al., 2011; Sjöberg, 1996, 2000a, 2000b, 2004). Scale use habits (e.g., straightlining) could possibly explain this phenomenon, but results presented here and elsewhere (Sjöberg, 2000a, 2000b) showed minimal correlations between scales measuring risk perceptions and scales immediately preceding and following these risk scales in questionnaires. This suggests that risk sensitivity truly exists, but what remains largely unknown is what causes some people to be concerned about almost all hazards, whereas others remain indifferent or risk insensitive. Personality research from the field of clinical psychology may be most suitable for addressing this knowledge gap (Sjöberg, 2000a). Concepts from this field, however, have received little attention in human dimensions of natural resources in general and wildlife in particular. Perhaps this article can serve as a starting point for integrating more concepts from clinical psychology and investigating risk sensitivity in the context of other populations, geographical settings, and natural resource hazards.

Notes

1. Responses were examined for differences among these four strata. In total, 42% of the tests for differences among these strata for all of the questionnaire items examined in this article were not statistically significant and 58% were significant, but tests of significance are sensitive to the large sample sizes here (Vaske, 2008). There were also no clear patterns in any of these differences. In addition, Cramer's V and eta (η) effect size statistics ranged from only .01 to .21, averaged only .08, and were ≤.15 for 86% of these tests. Using guidelines from Cohen (1988) and Vaske (2008) for interpreting effect sizes, these values suggested the magnitude of almost all differences among the strata was "small" or "minimal," respectively. Weights were calculated as: Weight = Population %/Sample %, where Population % = hunters in stratum/hunters in state, and Sample % = respondents in stratum/respondents in state. The weight for resident deer hunters, for example, was 0.847 (46,559 deer hunters in stratum /222,862 hunters in state)/(672 respondents in stratum/2,725 respondents in state).
2. Sjöberg (2000a, 2000b) suggested that risk sensitivity could possibly be an artifact of people implementing satisficing scale use habits where they always respond either on the high or low ends of scales, no matter what is being considered (i.e., straight-lining). Correlations between these scales measuring risk perceptions and the other scales immediately preceding (r = .04–.18, average = .10) and following (r = .01–.22, average = .14) these risk scales in the questionnaires, however, showed only "small" (Cohen, 1988) or "minimal" (Vaske, 2008) relationships, suggesting that only scale use habits do not explain the findings in this article.
3. Principal components exploratory factor analyses (EFA) with both oblique and varimax rotations on all four CWD health risk variables and the 33 other risk items consistently produced separate factors reflecting the identical categories in this article (e.g., risks of CWD to health, CWD to other humans, CWD to wildlife, hunting to health, other diseases to health) and all loadings were ≥.40. In addition, a single EFA of all these risk variables without rotation and with the number of factors fixed to one showed that the factor explained only 25% of the variance. These approaches represent Harman single factor tests (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) and suggest that common method variance or bias was generally absent.

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