RURAL CAREGIVERS RISK PERCEPTIONS OF ENVIRONMENTAL HAZARDS

by

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ABSTRACT

The mounting scientific evidence linking environmental exposures to human health hazards has increased the need for effective environmental risk communication efforts to the public. One key component of providing effective environmental risk communication is risk perception: understanding how individuals and communities perceive environmental health risks. Risk perception research has shown that environmental risk perceptions are affected by social, cultural, and economic factors as well as other concepts such as power, trust, and mass media. Nested in the larger Environmental Risk Reduction through Nursing Intervention Evaluation project (ERRNIE), the purpose of this study was to describe how rural caregivers perceive the severity of environmental health exposures and to determine which environmental exposures were most concerning to rural caregivers. The study was guided by two aspects of the health belief model, perceived susceptibility and perceived severity. Findings indicated that uncontrollable exposures such as exotic infectious disease, water quality concerns, and radon were perceived as most concerning while common controllable exposures were least concerning. These findings were discussed as it applies to current risk perception theory and to risk communication efforts of nurses and nurse practitioners.

CHAPTER 1

INTRODUCTION TO THE STUDY

Our contemporary world is filled with hazards many of which have only come into existence within the last half century. Approximately 75,000 chemicals are used and produced by industries and businesses to make clothing, automobiles, electronics, pharmaceuticals, and pesticides (United States Environmental Protection Agency [U.S. EPA], 2009). Some of these chemicals being produced are toxic and can cause hazardous effects to the environment and humans. A growing body of evidence has found that environmental exposure to pesticides, chemicals, and toxic substances in the air, soil, food, and water are detrimental to human health. A 2008 EPA report on air pollution revealed that 127 million people (over a third of the U.S. population) live in counties that exceed national air standards (U.S. EPA, 2010). Samet et al. (2000) found that in 90 cities air pollution has been associated with mortality and increased hospitalization of the elderly. Over 1 billion tons of pesticides are sprayed on soils and foods each year in the U.S. (U.S. EPA, 2007). Pesticides in general have been found to cause endocrine, reproductive, and neurological problems in adults and children. America's water supply is regulated by the EPA, although 35 million individuals rely upon self-supplied well water not subject to federal regulations. Many household wells have been found to contain toxic levels of arsenic and nitrates which often exceed EPA drinking standards (Focazio, 2006).

Healthy People 2020 has placed environmental health as one of its priorities. The documented national health plan describes environmental health as "preventing or

controlling disease, injury, disability related to the interactions between people and their environments" (U.S Department of Health and Human Services, 2010). Six themes have emerged in the Healthy People 2020 environmental health component of the document including: outdoor air quality, surface and groundwater quality, toxic substances and hazardous wastes, home and communities, infrastructure and surveillance, and global environmental health.

There is a known relationship between environmental exposures and health effects. Individuals are exposed to environmental risks in the air, water, soil, and food. Because of the significant correlation between environmental exposures and health risks, it is crucial that individuals, groups, and populations take actions to mitigate these hazards. The concern is that many individuals are not aware of the extent of the environmental exposures in and around their home, nor do they understand the relationship between particular exposures and their corresponding health effects (J. Burger & Gochfeld, 2009; Hill, Butterfield, & Larsson, 2006; Rao, Quandt, Doran, Snively, & Arcury, 2007). In addition, decades of research has shown that there is a difference between the environmental risk perceptions of a scientific expert and that of a layperson (Beecher et al., 2005; Miller & Solomon, 2003; Sandman, 1987; Slovic, 1987).

The differences in environmental risk perception between experts and laypeople had at one time been attributed to the ignorance and irrationality of the layperson; however, cultural and social science research has shown that environmental risk perception is far more complicated and multidimensional in nature (Bickerstaff, 2004). Individual thoughts, attitudes, beliefs, and values all contribute to an individual's perception of environmental risks. Different groups of people such as scientists,

professionals, the general public, urban dwellers, politicians and rural dwellers all have different meaning of risks. Environmental risk perceptions are affected by social, cultural, and economic factors as well as other concepts such as power, trust, and mass media (Morrone, 2011; World Health Organization [WHO], 2002).

Over the last 40 years, general risk perception data and health promotion theories utilizing the risk perception concept have been widely studied. Much environmental health research on air and water pollution, and environmental risk perception has been performed in urban areas (Hendryx, 2011). However, specific environmental risk perceptions especially amongst rural dwellers are less understood. According to the US Census Bureau's 2010 data, about a fifth of America's population live in rural areas. Rural areas are not immune from environmental exposures. In fact, these areas may be more vulnerable due to less environmental data collected in rural areas, socioeconomic pressures in rural areas, and more self-reliable resources such as well water usage (Hendryx, 2011). In fact a recent study found high levels of toxic chemicals released into the water and air to be associated with higher population mortality rates especially in rural areas when compared to urban areas (Hendryx & Fedorko, 2011). Therefore, it is crucial that environmental risk perception research is performed in rural areas to help health educators, politicians, and local leaders understand rural environmental risk perceptions and to provide education and policy interventions in mitigating environmental exposures.

Purpose of the Study

The purpose of this study was to examine environmental risk perceptions of rural caregivers. Two questions will be additionally answered by this study

1. How do rural caregivers perceive the severity of these environmental health risks?
2. What environmental exposures do rural caregivers perceive as the most important environmental health risks?

CHAPTER 2

REVIEW OF LITERATURE

Introduction

In order to provide background information on environmental health risks and risk perception, a thorough literature review was conducted to examine human health effects of environmental exposures, risk perception theory and its relationship to behavioral change, and risk perception specific to rural populations. Medline, The Cumulative Index of Nursing and Allied Health Literature, and Google were the primary data bases that were used during this literature search. The following key words were used in these computer searches: environmental health, environmental hazards, attitudes, rural, risk perception, risk perception theory, and nursing. In addition, several government agency websites such as the Environmental Protection Agency, Centers for Disease Control (CDC), and World Health Organization were important data sources for this literature review. Included in this literature review are peer reviewed articles or official government documents from 2000-2013 with the exception of sentinel papers on risk perception theories and the health belief model theory.

Health Consequences of Environmental Hazards

A growing body of evidence has found that environmental exposure to pesticides, chemicals, infectious agents, and toxic substances in the water, air, soil, and food are detrimental to human health. Some of these exposures such as lead and mercury have

been known to cause health effects for over a century. Other chemicals are known as persistent bioaccumulative toxicants (PBTs) which include methylmercury, dioxins, and pesticides. These PBT are especially dangerous as they bioaccumulate in the human body and the environment. Other exposures may be unknowingly causing harm as their health effects have either been understudied or not studied. Over 84,000 chemicals have been and in many cases continue to be released into the United States (U.S. EPA, 2013). However, the EPA only follows a tiny fraction (650 chemicals) of these chemicals being released into our air, water, and soil (U.S. EPA, 2011). In 2011 alone, 22.77 billion pounds of production-related chemicals were released from facilities into our environment (U.S. EPA, 2011).

The CDC has identified 250 chemicals in human blood and urine. Of these, 49 chemicals have been newly identified since 2009 (CDC, 2013b). The Environmental Working Group (EWG) in a research study on ten randomly selected newborns found 287 chemicals in newborn cord blood samples. Of these chemicals, 180 are known to cause cancer, 217 are toxic to the brain, and 208 carry the risk of causing birth defects (Ballard, 2010; EWG, 2005). These alarming statistics reveal that very little is understood of chemicals that humans come into contact with on a daily basis. It is clear that we do not fully understand how toxic these chemicals affect humans- especially vulnerable populations such as the fetus in utero and children.

Globally, the WHO has estimated that 24% of the disease burden (healthy life years lost) and an estimated 23% of all premature deaths have been attributed to modifiable environmental factors. In America these levels are lower, but still significant at 14% and 15%, respectively (Pruss-Ustun & Corvalan, 2007). Three compounds

(methylmercury, pesticides, and lead) used in manufactured products will be discussed to provide a background for the magnitude of environmental health effects caused by preventable exposures.

Methylmercury is one common PBT that is emitted into the atmosphere through the mining and smelting of mineral ores, the combustion of fossil fuels, and the incineration of wastes (Levenson & Axelrad, 2006). Bioaccumulation of methylmercury occurs in large fish at the top of the food chain which are in turn consumed by humans (Levenson & Axelrad, 2006). Human consumption of large predatory fish such as shark, swordfish, king mackerel should be avoided in pregnant women and women of childbearing age because of the health effects in fetuses and infants. In fetuses, infants, and children, methylmercury has been found to impair neurological development, cognitive thinking, language, memory, attention, and fine motor skills. In adults, methylmercury poisoning causes decreased peripheral vision, disturbances in sensation, lack of coordination, impaired speech, impaired hearing, and muscle weakness (Levenson & Axelrad, 2006; Sattler & Davis, 2008). Careful handling and appropriate disposal of mercury containing equipment such as mercury thermometers or thermostats as well as adhering to local and state fish advisories have been suggested to limit mercury exposure (Dunn, Burns, & Sattler, 2003; Levenson & Axelrad, 2006; Sattler & Davis, 2008).

Pesticides are used to kill or repel pests or insects in over 90% of household in the U.S. Like methylmercury, many pesticides persist in the environment. Dichloro-diphenyl-trichloroethane (DDT) perhaps the best known pesticide for its devastating effects on the bald eagle population and human health, has been found in detectable amounts in the majority of the population U.S. despite being banned in 1978 (CDC,

2005; Gilden, Huffling, & Sattler, 2010). Detectable levels of about 50 pesticides have been found in blood and urine samples across the country (CDC, 2005). Many pesticides have been found to have significant effects on the reproductive and endocrine systems as endocrine disrupting chemicals have been implicated in disrupting hormone function in the body (Gilden et al., 2010). Pesticides are also implicated in altered thyroid function, decreased hormone levels and infertility. Research has found that pesticides cause neurodevelopmental alterations such as social behavioral problems, neurodevelopmental delays, and impaired motor skills (Gilden et al., 2010). Finally, numerous types of cancers have been associated with pesticide use such as lymphoma, brain, kidney, breast, prostate, pancreas, liver, lung, and skin cancers (Gilden et al., 2010; Turner, Wigle, & Krewski, 2011). Risk reduction efforts to decrease exposure to pesticides include utilizing alternative non-pesticide management techniques, sealing cracks and holes to keep pests from entering buildings, wearing personal protective while working with pesticides, and eating organic foods (Dunn et al., 2003; Gilden et al., 2010).

The health effects of lead have been studied better than any other chemical or substance (Sattler & Davis, 2008). Lead was formerly used in plumbing, paints, and gasoline until the late 1970s. Common sources of childhood lead exposure include: air, bare soil, home remedies, drinking water, and toys. Lead exposure has most often occurred through deteriorated lead paint that is ingested by children through the hand to mouth behavior (Gaitens et al., 2009). High levels of lead exposure in children have been associated with intellectual and neurobehavioral deficits, slowed growth, hearing problems and headaches (Lanphear et al., 2005; Lidsky & Schneider, 2003; Sattler & Davis, 2008). In adults, lead causes difficulties during pregnancy, digestive problems,

nerve disorders, muscle and joint pain, concentration problems, high blood pressure, and reproductive problems (Sattler & Davis, 2008). In the last 30 years, there has been an 80% reduction in human exposure to lead due largely to the removal of lead from gasoline, residential paint, children's toys, and drinking water systems (Grosse, Matte, Schwartz, & Jackson, 2002). Success did not come without improving human risk perceptions towards lead and implementing risk communication strategies and policy changes. Policy makers' and the general public's perception that lead causes dangerous health effects gradually led to federal bans on lead and a decrease in lead-based paints, toys, and gasoline in the markets (Grosse et al., 2002).

Although there are over 84,000 chemicals utilized and manufactured in the U.S. that could cause significant health problems, there are also other naturally occurring environmental hazards that are equally as dangerous such as radon, mold, and infectious agents. Although these natural hazards may be difficult to avoid, numerous risk reductions methods can be implemented to significantly decrease exposure.

Radon is a naturally occurring colorless, odorless radioactive gas that silently affects human health. Seeping through cracks in the walls, foundations, and floors, radon concentrates inside buildings exposing both adults and children. Radon has been found to be a carcinogen and the second leading cause of lung cancer behind cigarette smoking (Darby et al., 2006; Pavia, Bianco, Pileggi, & Angelillo, 2003). Prevention strategies include testing basements and first floor of homes for radon, implementing radon mitigation for homes with levels above 4 pCi/L, sealing cracks in the foundation of homes, and ceasing indoor tobacco smoking (Dunn et al., 2003).

Numerous types of mold can be found in humid areas of homes especially on walls and the ceiling of bathrooms. Molds have been found to affect the respiratory, skin, and central nervous system causing symptoms such as shortness of breath, wheezing, cough, itchy and watery eyes, headaches, aches and pains, memory loss, and mood changes (Dunn et al., 2003). Disinfecting with bleach and maintaining a dry clean environment can often mitigate mold in the home (Dunn et al., 2003).

Finally, infectious agents transmitted in food, water, insects, or animals such as *E. coli*, West Nile virus, and Hanta virus have the potential to cause significant health issues. For example, West Nile virus transmitted by a mosquito can cause flu-like symptoms and rare cases of encephalopathy. However, this virus can be prevented by using N,N-Diethyl-meta-toluamide (DEET), avoiding skin exposure to mosquitoes, and decreasing mosquito breeding grounds (CDC, 2013d).

Child Specific Risk

One population that is uniquely vulnerable to all these environmental hazards is children. Pound for pound children take in more water, eat more food, and breathe more air; thus, increasing exposing to toxic chemicals (Landrigan et al., 2006; Sattler & Davis, 2008). Additionally, children's organs and body systems are still under development throughout adolescence. Infants' metabolic pathways are immature and thus are less likely to excrete and detoxify chemicals through the kidney and liver than adults (Landrigan et al., 2006; Sattler & Davis, 2008). Developing tissues and organs are much more vulnerable to toxic chemicals. In addition, infants and children have an immature immune system, decreasing the body's ability to defend against dangerous substances

(Sattler & Davis, 2008). Children also have behavioral patterns such as hand to mouth exploration and exploring close to the ground that create high risk of exposure to toxic chemicals found in dust and soil in and around the home (Sattler & Davis, 2008). Parents contribute to children's exposure if they bring toxic chemicals from work or recreation into the home. Finally, children also have more remaining life years than adults; therefore, they have more time to develop diseases with long latency periods that may be triggered by early environmental exposures.

Risk Perception Theory

In the Royal Societies landmark paper, risk perception is defined as "people's beliefs, attitudes, judgments, and feelings as well as the wider cultural and social dispositions they adopt toward hazards and their benefits" (Pidgeon, Hood, D., Turner, & Gibson, 1992). In the late 20th century, the field of risk perception began to emerge as researchers sought to understand the individual and societal concepts of risk (Beecher et al., 2005; WHO, 2002). Scientists had come to recognize that there existed a discrepancy between risk perceptions of scientific experts and the layperson (Slovic, 1987). It also became evident to researchers that different groups of people had different attitudes and beliefs about risk (Beecher et al., 2005; Bickerstaff, 2004; Miller & Solomon, 2003; Slovic, 1987; WHO, 2002). Risk perception is unique to each individual as it is influenced by values, psychological factors, education, experience, and personal stake in a particular outcome (Miller & Solomon, 2003; Morrone, 2011). In response, researchers from the fields of psychology, social scientists, nursing, and medicine started to investigate this idea of risk perception.

Numerous factors have been studied on how risks are perceived. One social scientist researcher Sandman (1987) called these factors outrage factors. In his work, Sandman defined risk as the sum of the hazard and outrage (risk = hazard + outrage) with the hazard referring to the probability of dangerous event and outrage to be an individual's emotional response (Sandman, 1987). Beecher et al. (2005) used Sandman's concept of outrage factors to define perceived risk as the sum of hazard and outrage. In his research, Beecher recognized that every individual is influenced by outrage factors to some degree and some more than others. For example, "experts" focus more on the actual risk or hazard than the outrage factors. On the other hand, the public gives less weight to the actual risk of the hazard and more weight to the outrage factors. Some outrage factors of environmental risks include being: involuntary, artificial, exotic, memorable by odor or sight, dreaded, catastrophic, not reversible, unknown or uncertain, affecting children and pregnant mothers, unfair, and affecting future generations (Beecher et al., 2005). Similarly, environmental psychologists use the term "heuristics" to describe the "outrage factors." Heuristics reveals the feelings, experiences and intuitions that individuals have toward a hazard (Miller & Solomon, 2003; Morrone, 2011).

In a similar way, Miller and Solomon (2003) suggested that there are three major factors that influence risk perception: the nature of the hazard, the demographics of the individual perceiving the risk, and the social context in which the exposure is being perceived. The nature of the hazard includes perceived characteristics of a particular hazard that may increase or decrease risk perception. Research has found that those risks that are unfamiliar, potentially catastrophic, synthetic, affect children, and involuntary provoke outrage and dread; thus, they are perceived as more serious risks. On the other

hand, risks that are familiar, not catastrophic, natural, affect adults, have non dreaded outcomes, and voluntary have decreased perceived risks (Miller & Solomon, 2003). For example, driving a car is perceived as less risky than flying in a jet because driving is both voluntary and familiar. Although, the actual risk of driving a car may be more hazardous than flying. A nuclear power plant in research has been notoriously perceived as higher risk because of its unfamiliar, potentially catastrophic, synthetic and dreaded characteristics, although common day to day activities like biking or operating equipment or automobiles are categorized as greater risks by scientific experts (Bickerstaff, 2004). In addition to the perceived characteristics of the hazards listed above, sensory awareness, specifically the powers of vision and smell plays an influential role in risk perception (Bickerstaff, 2004). Researchers often refer to this property as the organoleptic property. Visible images of soot, dust, and flumes and the olfactory evidence of sour, rotting, burning odors that permeate the air increase an individual's perception of heightened risk. The sensory system provides a lasting memory that influences human perception of certain environmental risks (Bickerstaff, 2004). The billowing smoke from industrial companies has become a symbol of environmental risk even if that perceived smoke is harmless steam. In addition, the organoleptic properties of drinking water, specifically the taste and color have consistently been the primary factor influencing individuals' perception of water quality and safety (Doria, 2010; Doria, Pidgeon, & Hunter, 2009; Jakus, 2009). As organoleptic properties are often directly experienced by an individual, it is frequently one of the most powerful influences in a person's perception of risk (Doria, 2010; Pachur, Hertwig, & Steinmann).

Not only does the nature of the hazard influence risk perception, but also the demographics of the individual perceiving the risk. Research has found that gender, race/ethnicity, and socioeconomic differences influence risk perception (Bickerstaff, 2004; Miller & Solomon, 2003). Among Caucasians, women tend to perceive risks higher than men. White males have the lowest perceived risk of any race and gender combination. Black men, black women, and white women all perceived risks at about the same level (Bickerstaff, 2004; Miller & Solomon, 2003). Social scientists have suggested that the risk perception differences may be attributed to power differentials. White females and other ethnic groups may feel they are in a position of less control and power and thus view the world and the risks around them as more hazardous (Bickerstaff, 2004). From an economic standpoint, those individuals who had higher education and better incomes tended to underestimate risks while those who are unemployed with lower incomes tended to overestimate risk (Bickerstaff, 2004). The perception of risk among minority and powerless groups is consistent with true inequalities of environmental risks (Bickerstaff, 2004).

Finally, social context is also vital to risk perception. If the organization, company, or individual creating the risk is deemed trustworthy, the perceived risk is dampened (Miller & Solomon, 2003). For example, if a company has produced a trustworthy product or supplied good jobs to a community for a long time, then the risk of the environmental exposure will be deemed less harmful. In addition, the concepts of justice, human rights, informed consent, and integrity also affect an individual's perception of risk. Those risks that have been perceived as being distributed unfairly or unequally have historically higher risk perceptions than those risks that are equally

distributed (Miller & Solomon, 2003). Finally, studies have found that if a group or town has received an unequal burden of the environmental exposure, community members will have an overall increased risk perception.

Risk perception is a multidimensional psychological construct in nature and it is influenced by a complex interaction of social, political, cultural, and scientific factors. It was once believed that the difference of risk perception between the public and the expert scientist was due simply to public ignorance and irrationality. However, social science research studies revealed that there are other issues such as power, value, ethics, and trust that influence the risk perception of the public. Understanding how risk is perceived by individuals, groups, and the general public is crucial as health professionals, government officials, and scientists provide risk communication to encourage awareness and behaviors that will mitigate environmental exposures.

Theoretical Framework

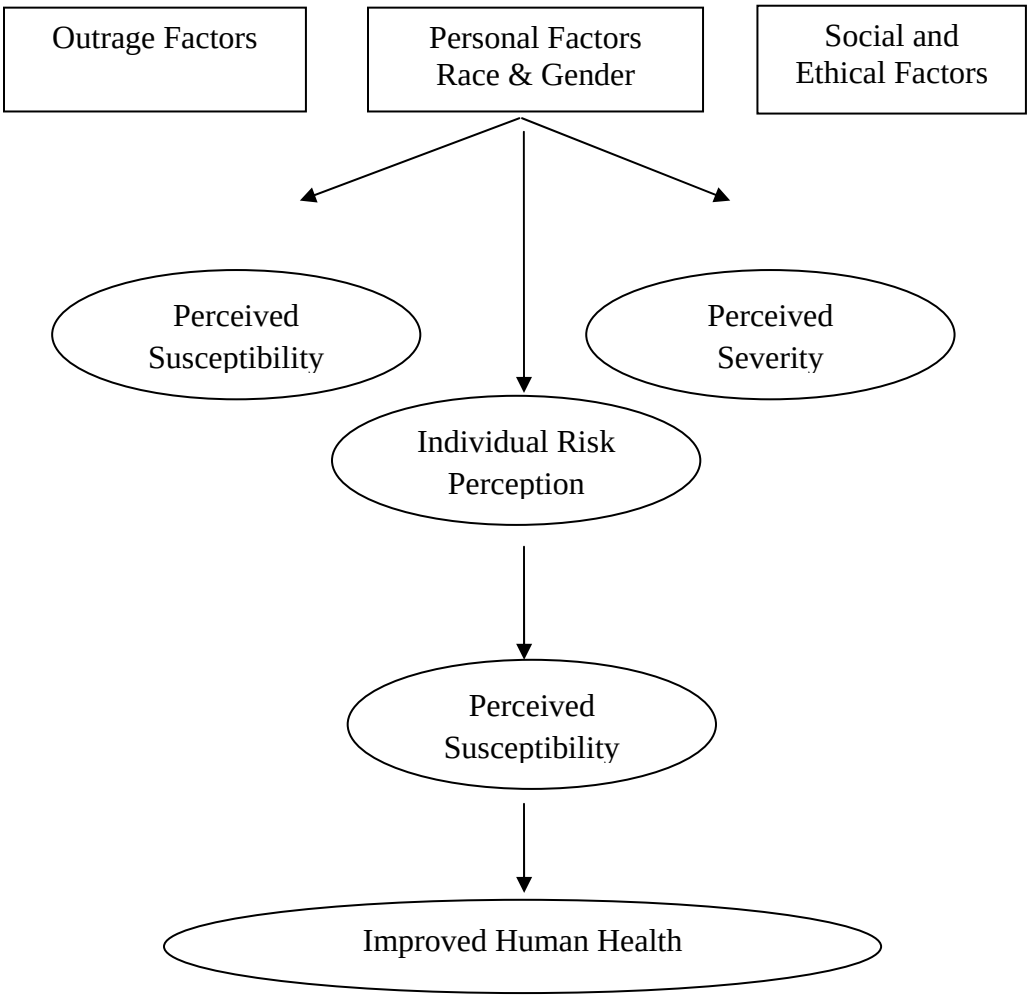
Risk perception is central to many health behavior theories including the health belief model, protective motivation theory, extended parallel process model, and the theory of reasoned action (Brewer, Chapman, Gibbons, Gerrard, & McCaul, 2007; Weinstein, 1993). Most theories of individual health behaviors focus on two determinants of risk perception: the perceived risk and the perceived severity (Weinstein, 2000). The term perceived risk which is also known as perceived likelihood, perceived susceptibility and perceived vulnerability, is the chance of getting a condition. Perceived severity also referred to as perceived seriousness is a subjective attitude about the

severity of the condition (Weinstein, 2000). Each theory uses different terminology to define these two determinants but the underlying meaning is the same.

For the last 40 years, the health belief model (HBM) has been one of the most widely used models in health behavior. Initially developed in 1950s by the U.S. Public Health Service, Becker extended the model to explain behaviors in response to illness (Becker, 1974; Strecher & Rosenstock, 1997). The health belief model guides this research study on care giver risk perceptions. The health belief model has several key concepts that are relevant to this study: perceived susceptibility, perceived severity, behavioral change, perceived benefits and perceived barriers. Perceived susceptibility is an individual's assessment of the chance of getting a condition or disease while perceived severity is one's view about the seriousness of the risk including medical and social consequences. Both perceived susceptibility and perceived severity are directly influenced by outrage factors, personal factors, social and ethical factors as described in the theories of risk perception. Most theorists agree that an increased perceived risk of harm should motivate a behavioral change to reduce risk. For example, if an individual perceives methylmercury as a serious environmental health risk, then the individual will take precautions to avoid eating fish known to have high methylmercury levels. The relationship between these concepts is shown in Figure 1. Brewer et al. (2007) suggested that the association between risk perception and behavior change is stronger for specific health threats versus general threats, for those behaviors that are individually initiated, and for those behavioral changes that are easy to carry out. Numerous metaanalyses and reviews of studies utilizing the health belief model have found positive relationships between risk perception and behavioral change (Brewer et al., 2007). One study found

that there is strong evidence that perceived likelihood, susceptibility, and severity of influenza are reliably associated with vaccinations and that the relationship is moderately strong (Brewer et al., 2007). The construct of risk perception in the health belief model is valuable as it influences an individual's or community's actions thereby improving human health (Figure 1)

Figure 1: Relationship between risk perception factors and perceived susceptibility, perceived severity, and behavioral change. Adapted from the health belief model from Stetcher & Rosenstock,(1997) and Miller & Solomon (2003).



Environmental Risk Perception of Environmental Hazards

Although much of the research has been done on risk perception of specific individual environmental hazards, only a few recent studies have been conducted on environmental risk perceptions of general environmental hazards (Bianco, Nobile, Gnisci, & Pavia, 2008; Joanna Burger, Fleischer, Jeitner, & Gochfeld, 2003; European Opinion Research Group [EORG], 2002) Authors of these broader investigations included a variety of man-made and natural hazards such as pollution, nuclear power, and noise pollution in their risk perception studies. Although the studies did not include exactly the same environmental hazard lists, certain hazards consistently ranked as top concerns. In these studies, if nuclear power was amongst the choices, it ranked as the top concern with the highest outrage factor (Joanna Burger et al., 2003). Other environmental factors which were most concerning included industrial or natural accidents, pollution of air and water, water quality, and infectious disease (Bianco et al., 2008; Joanna Burger et al., 2003; EORG, 2002).

Most of the environmental risk perception studies have been studied on a broad scale in urban areas. Few studies have been done addressing these environmental health hazards in rural communities, and those that have been done have addressed specific environmental health risks. These studies on rural environmental hazards reveal that many individuals have a general awareness of a specific environmental hazard but tend to underestimate the concern or do not see the hazards as an immediate health threat (Duckworth, Frank-Stromborg, Oleckno, Duffy, & Burns, 2002; Hill et al., 2006; Jones et al., 2006; Shaw, Walker, & Benson, 2005; Swistock, 2009). For example in a study on

perceptions of radon, more than a third of the participants underestimated the seriousness of the health concern and over half the participants were unaware that radon could cause health hazards (Hill et al., 2006). Similarly, Duckworth et al., (2002) found most participants were familiar with radon, but they did not perceive it as an immediate health hazard and tended to underestimate the long term radon exposures. In another study on perception and water quality of well water in rural Pennsylvania, the researchers found that although most people were very satisfied with their private water well and 84% wouldn't pay for access to municipal drinking water, 41% of the samples from the private wells tested failed at least one drinking water standing parameter (Swistock, 2009). Interestingly 64% of these individuals were very or somewhat concerned about their water quality in their well, yet 75% of the homeowners had either only tested the water quality once or not at all (Swistock, 2009). Finally, another study investigated well water in Nevada where the region was known to be an arsenic hot spot (Shaw et al., 2005). The researchers found that the reported health risk perception about arsenic was low for many respondents despite elevated arsenic levels in the ground water. In addition, the study confirmed that risk perceptions influenced drinking water behavior (Shaw et al., 2005). These studies revealed that environmental health concerns are present in rural areas and many residents may be underestimating the risks and thus not making the appropriate behavioral change.

Understanding risk perceptions of specific populations is crucial when designing and implementing environmental health interventions to impact behavioral change. Rural residents are one unique group in which risk perception information is needed. Rural populations often live closer to the environment and thus have closer contact to

environmental hazards. A specific focus on rural populations is needed to address health disparity outcomes as rural families often suffer from limited financial resources and access to healthcare services (Hendryx, 2011). Robson and Schneider (2001) conducted a study directed toward rural health care providers (RHCP) from across the country and their perceptions of environmental health issues facing their constituents. Over half of the 384 RHCP respondents indicated that they believed that environmental problems were the cause of health problems in their community (Robson & Schneider, 2001). The survey revealed ground water pollution, surface water pollution, and pesticide misuse to be among the top three concerns. In addition, water-related concerns were among the highest concerns followed by soil and air related concerns respectively (Robson & Schneider, 2001). This study was conducted toward RHCPs but not toward rural residents. How would rural residents rank the environmental health risks? What do rural residents perceive as environmental hazards? With this gap in the literature, health care providers are unaware of the perceptions of environmental hazards in rural areas and thus cannot adequately address knowledge deficits or incorrect perceptions of environmental health risks. Continued research is necessary to fully understand how individuals perceive risks and to develop interventions to decrease environmental health effects.

CHAPTER 3

METHODS

Introduction

This study is descriptive in nature using a secondary data set collected in the preliminary stages of the development of the ERRNIE study (Butterfield, Hill, Postma, Butterfield, & Odom-Maryon, 2011). The study used cross-sectional data to describe the perceived risk/concerns of numerous environmental health exposures amongst rural low-income families. This study is nested in the larger ERRNIE study which was a collaborative 5 year project designed to assess environmental health risk and to evaluate educational interventions to reduce environmental health risks. The goals of the ERNNIE project were to 1) Determine the prevalence of environmental exposures among rural children 2) Identify priority environmental exposures and test the effectiveness of risk reduction educational materials and strategies 3) Deliver risk reduction education to rural families through the vehicle of a public health nurse 4) Evaluate the ability and the need of the public health nurse to integrate environmental health into their everyday practice (Hill et al., 2006).

Definitions

Since the study addresses environmental health perceptions of rural residents, it is crucial the word rural is clearly defined. This study will use the U.S. Department of Agriculture's (USDA) definition of rural defined as areas less than 50,000 or more people

and their adjacent and contiguous urbanized areas (USDA, 2003). Based upon the census data that was current during the conduction of the study, Gallatin County was classified as a rural county with a rural urban continuum code of 5 (USDA, 2003). In addition, to ensure the rural status of the participant, the participant had to be on well water indicating the participants did not live in the city limits of Bozeman.

Sample Description

A total of 31 rural households including 71 adults and 60 children were referred from the Gallatin City and County Health Department (GCCHD) to the ERRNIE project. The study is a convenience sample rather than a random sample. The referral system took advantage of the infrastructure which exists between Woman Infants and Children Program (WIC), the immunization clinics, and Head Start programs to target low income families (Hill, Butterfield, Larsson, 2006.) Those families referred to the ERRNIE project had to meet the eligibility criteria which included: 1) residence in Gallatin County 2) minimum of one child under the age of six 3) use of a private or community well 4) utilizes the GCCHD 5) speaks and reads English (Hill, Butterfield, Larsson, 2006). The study utilized the largest possible number of households that met the study criteria. Each household designated one primary caregiver in the family to gather the data for the questionnaires. The designated primary caregivers in the sample consisted of all female caregivers who were predominately Caucasian (97%) women, between the ages of 20 and 40 (94%), and married (68%). A majority of these 31 households were deemed low-income with 68% of the families making a household income less than

$35,000 and 58% of the households using Medicaid services or having no health insurance.

Data Collection

Once the households were referred from the GCCHD and deemed eligible, the referred family member signed an official informed consent to share personal contact information with the ERRNIE team. The ERRNIE staff members then contacted the willing families to explain the project, confirm eligibility, and schedule the first home visit. An environmental risk and perception survey was mailed to each family prior to the first home visit by the ERRNIE staff. There was a 100% return rate for the questionnaire (Hill, Butterfield, Larsson, 2006). Embedded in this 24-page questionnaire of demographic and risk perception questions included set of questions on the risk perception/severity of general environmental health hazards. A total of 30 risk perception questions (Table 1) were analyzed for the research study using the Statistical Package for Social Sciences (SRSS) version 21. Participants were asked to rate a specific environmental hazards on a 1-7 point scale ranging from 1 strongly disagree to a 7 strongly agree to statement such as “I am concerned about radon levels in our home.”

Table 1: General Risk Perceptions of Environmental Health Hazards using the statement: I am concerned about…

1	Carbon monoxide from our furnace or stove
2	Radon levels in our home
3	Wood stoves polluting the air outside our home
4	Pesticide spraying inside our home
5	Burning garbage polluting the air outside our home
6	Local factories polluting the air
7	Cigarette smoking inside our home
8	Our septic system polluting our well
9	Our well being contaminated by our neighbor's septic system
10	Our septic system contaminating the Gallatin Valley
11	Arsenic in my drinking water
12	Bacteria and germs in my drinking water
13	Lead in my drinking water
14	Pesticide spraying on farms or gardens near our home
15	Fluoridation of drinking water in the U.S.
16	Asbestos inside our home
17	Chronic wasting disease in the game we hunt
18	Mold growth in our home
19	Mercury in the fish we catch
20	Animal waste around our yard or land
21	Hantavirus from mice droppings
22	West Nile virus from mosquitoes
23	Lead pain in our home
24	Pesticide dust in our food
25	Wood stoves polluting the air inside our home
26	Pesticides on our lawn or garden
27	Nitrates in my drinking water
28	Asbestos from Libby in our insulation
29	Chlorination of drinking water in the U.S.
30	Other? Please list.

CHAPTER 4

RESULTS

Introduction

Demographic data and environmental risk perception data were analyzed to address two questions: How do rural caregivers perceive the severity of environmental health risks and what environmental health risks do rural caregivers perceive as most concerning?

Sample Demographic Data

The sociodemographic data is shown in Table 2. The sample of 31 respondents was all female and primarily Caucasian with only one Native American. A majority of the respondents (64.5%) were under 30 and married (67.7%) or living with their partners (16.1%). Of the respondents, 39% had only a high school education and 61% had at least one year of college or more. Nearly all the respondents (87%) earned less than $46,000/year with 29% making less than $20,000/year. Half of the respondents had health insurance with a 32% having private insurance and 19% utilizing Medicaid. Nearly 40% did not have any health insurance coverage and 10% utilized other options.

Table 2. Demographic and Socioeconomic Description of Household Respondents (n=31).

	Participants	Sample %
Gender		
Male	31	100
Female	0	0
Age (years)		
21-30	20	64.5
31-40	9	29.0
41-50	0	0
50+	2	6.5
Ethnicity		
Caucasian	30	96.8
Hispanic or Latino	0	0
Black/African American	0	0
American Indian or Alaskan Native	1	3.2
Other	0	0
Marital Status		
Married	21	67.7
Divorced/separated	2	6.5
Widowed	0	0
Never married	3	9.7
Living with partner	5	16.1
Education (# of years of school completed)		
12 or less	12	38.7
13-15	11	35.5
16-18	8	25.8
19 or greater	0	0
Income		
<$10,000	5	16.1
$10,000-19,999	4	12.9
$20,000-24,999	3	9.7
$25,000-34,000	9	29.0
$35,000-45,999	6	19.4
$46,000-54,000	0	0
$55,000 or greater	4	12.9
Health insurance		
None	12	38.7
Medicaid	6	19.4
Private health insurance	10	32.3
“Other”	3	9.7

Perceived Susceptibility and Severity

Respondents addressed 29 environmental health risks on a Likert scale with possible responses ranging from 1-strongly disagree to 7-strongly agree. A mean score and standard deviation were calculated for each environmental health risk and ranked from highest perceived risk to lowest perceived risk (Table 3). Three of the environmental health hazards had mean scores greater than 5: "West Nile virus from mosquitoes," (5.29) "Bacteria & germs in drinking water" (5.16) and "Lead in drinking water" (5.06). This average score indicated that the majority of the respondents "slightly agreed" that these hazards were concerns. Another five of the environmental health hazards had mean scores between 4.5 and 5. These included "mold growth in home" (4.94), "Hantavirus from mice dropping" (4.90), "Septic system polluting well" (4.74); "home radon levels" (4.55), and "nitrates in drinking water (4.52). This average score indicated that a majority of the respondents inclined towards "slightly agreeing" that that these health hazards were concerns. Respondents were indifferent (neither agreed or disagreed) with over half of the environmental health hazards. The respondents were neutral as to whether these environmental health hazards were concerns. These environmental health hazards included pesticides dust in food, indoor cigarette smoking, fluorination and chlorination of drinking water, carbon monoxide from stove, well contamination from neighbors system, pesticides on farms/gardens near home, local factory pollution, arsenic in drinking water, asbestos, chronic wasting disease in game, pesticides on our lawn/garden, septic system contaminating Gallatin Valley, animal waste around yard or land, pesticides inside home, and outdoor wood stove pollution. Four of

the environmental health hazards had means between 3.0 and 3.5 indicating that respondents “slightly disagreed” that these environmental hazards were concerns to them. “Wood stoves polluting the air” and “lead paint in the home” ranked the lowest in perceived environmental concerns with a mean of 3.06 and 3.10 respectively while both “asbestos inside the home” and “mercury in fish” both had mean scores of 3.42. The standard deviation for all of the environmental health concerns ranged from 1.63-2.46.

Table 3. Risk Perceptions of Environmental Health Hazards Ranked by Perceived Severity (n=31)

Concerns	Mean	Std. Deviation
West Nile virus from mosquitoes	5.29	1.64
Bacteria & germs in drinking water	5.16	1.95
Lead in drinking water	5.06	2.02
Mold growth in home	4.94	1.98
Hantavirus from mice droppings	4.90	1.92
Septic system polluting well	4.74	2.02
Home radon levels	4.55	1.65
Nitrates in drinking water	4.52	1.81
Fluorination of drinking water in the U.S.	4.45	1.73
Pesticide dust in food	4.39	1.94
Indoor cigarette smoking	4.39	2.46
Chlorination	4.26	1.81
Carbon monoxide from stove	4.23	1.77
Well contamination from neighbors system	4.16	2.04
Pesticides on farms/gardens near home	4.13	1.80
Local factory pollution	3.94	2.02
Arsenic in drinking water	3.90	2.01
Asbestos	3.77	1.75
Chronic wasting disease in game	3.77	1.84
Pesticides on our lawn/garden	3.71	1.58
Septic system contaminating Gallatin Valley	3.65	1.89
Animal waste around yard or land	3.61	1.78
Pesticides inside home	3.58	2.09
Outdoor wood stove pollution	3.55	1.65
Asbestos inside home	3.42	1.63
Mercury in fish	3.42	1.58
Lead paint in home	3.10	1.83
Wood stoves polluting air inside	3.06	1.86

CHAPTER 5

DISCUSSION

The data collected from this research is consistent with many aspects of the risk perception theory. Risk perception research has shown that individuals do not just judge risks merely based on morbidity and mortality rates like many experts but are influenced by complex interactions consisting of social, political, cultural, and scientific factors. This data has shown that in general those environmental hazards that have high outrage factors (exotic, uncontrollable, involuntary, catastrophic, and fatal) were the most concerning to rural caregivers while those environmental hazards found in the home with low outrage factors (common, controllable, voluntary, not immediately harmful) were the least concerning hazards.

Perceptions of Environmental Health Hazards

Respondents perceived infectious agents as one of the top environmental hazards. West Nile virus and hantavirus ranked as two of the top five concerns amongst the list of environmental health hazards. West Nile virus is a potentially serious disease transmitted by mosquitoes that can cause neurological symptoms, fever, but rarely causes death (CDC, 2013d). Hantavirus is transmitted by rodents that can cause potentially fatal hantavirus pulmonary syndrome (CDC, 2013a). There have only been 616 cases of hantavirus with a 36% mortality rate and 37,088 cases of West Nile with 4% mortality in the entire United States over the past 20 years. Although the prevalence of these two diseases are low compared to exposure to radon or second hand smoke, these hazards

were perceived as one of the most concerning environmental hazards. Infectious diseases have the characteristics of being uncontrollable, involuntary, catastrophic, and fatal, while often provoke the dread/outrage factor (Slovic, 1987). This study finding is consistent with another research study which found new mothers most concerned about infectious disease as an immediate threat to their child's health (Crighton, 2013). New infectious diseases such as SARS, anthrax, and hantavirus often elicit a greater risk perception that the more common health hazards such as AIDS, smoking, and influenza, thus receiving more media coverage (Bomlitz & Brezis, 2008). As the American public has witnessed, media coverage can increase outrage factors as seen in the anthrax bioterrorism event (Swain, 2007). Finally, during the data collection process for this risk perception study in 2003, a significant outbreak of West Nile virus occurred throughout the country including Montana. There were 222 cases of West Nile virus in Montana in 2003 compared to six in 2004 (CDC, 2013c). Therefore, individuals could have had an interpersonal experience with the virus or the media may have been a contributing factor for escalating the risk during this study.

Drinking water perception ranked as another top concern in this study. In fact, four of the top eight environmental concerns addressed drinking water or well water pollution. Participants were concerned about bacteria, germs, lead, and nitrates in the drinking water. Over the past couple of decades there has been an overwhelming public concern over the general safety and quality of drinking water especially in North America (Doria, 2010; Doria et al., 2009; Jakus, 2009; Jones et al., 2006). Studies have shown that when placed against a list of other serious hazards, pollution of drinking water is often perceived as one of the higher risks (Doria, 2010). Given the general overall

concern of drinking water, it is not surprising that respondents listed water quality as a top concern. Risk perception research on drinking water has revealed that the perceived risk of the water is highly associated with the organoleptics (flavor and odor) likely due to the fact that organoleptics can be directly experienced personally by individuals (Doria, 2010; Doria et al., 2009). However, other risk perception factors include trust in institution, familiarity, perceived control, memorability and interpersonal impersonal information (Doria, 2010; Doria et al., 2009).

Another potential reason for drinking water concern ranking high may be due to the fact that the participants were all on private well water. Private wells are not subject to the Federal Safe Drinking Water Act or managed by local treatment systems. In these cases, well water quality and safety must be monitored and regulated by individual well owners in conjunction with local or state authorities. In addition, often individuals of low socioeconomic status rent and thus lack control over well water testing. Consistent with these study results, other studies have found that although well water users are satisfied with the quality of their drinking water, they are concerned about water safety (Jones et al., 2006; Swistock, 2009). A Canadian study found that 80% of the respondents had concerns about safety with their number one concern being microbiological pathogens or chemicals. Although respondents voiced safety concerns in this Canadian study, only 8% of the respondents actually tested their private well at a frequency that meets recommended guidelines and 21% of the households had never tested their drinking water (Jones et al., 2006). Two additional research studies have shown that well water quality should indeed be a concern for residents as 30-41% of the wells tested in these

studies failed to meet at least one of the health based drinking water standards (Butterfield et al., 2011; Swistock, 2009).

Radon served as another environmental hazard of concern to the respondents in this study. Although radon did rank below infectious diseases and water quality risks, respondents still listed radon amongst the top concerns. Approximately 88% of the counties in Montana (including Gallatin County) are ranked as high risk for radon and have a high percentage of homes over the EPA mitigation limit (U.S. EPA, 2012) According to the EPA, it is estimated that 21,000 people die from radon annually (U.S. EPA, 2003). This estimated mortality rate for radon is 200 and 20 times the mortality rates of hantavirus and West Nile virus, respectively. If individuals based their perceptions of risk on mortality alone, the perceived risk from radon in Montana would top the chart. However, risk perception research reveals that layperson risk perceptions do not merely base their risk perception on objective data, but other factors such as the characteristic of the hazard, demographics, and social content. Many of the research studies on radon risk perception have shown that although many people are aware of radon, many individuals did not consider it to be a significant health threat and often underestimate the risk of radon (Duckworth et al., 2002; Hill et al., 2006). In fact, Hill et al. (2006) found that more than a third of the rural households underestimated the seriousness of health effects and over half of the respondents were unsure whether radon could affect human health. Additional studies have also shown that residents living in counties with high radon levels were more knowledgeable about radon and more likely to be concerned about the health risks than those living in lower radon areas (Poortinga, Bronstering, & Lannon, 2011; Poortinga, Cox, & Pidgeon, 2008; Wang, Ju, Stark, &

Teresi, 2000). Similar to these research studies, this study did list radon as a significant concern, perhaps due to the state and counties high radon risk. However, the perceived radon risk in Gallatin County was underestimated when compared to other environmental health risks.

Environmental hazards that ranked the lowest in this risk perception study consisted of those hazards found inside the home. Four of the six lowest ranking environmental health hazards were "pesticides inside home," "asbestos inside home," "lead paint in home," and "wood stove polluting air inside out home" With these environmental health risks, the respondents may have perceived that they have control over these risks. This finding is consistent with a qualitative study of new mothers in Canada which found that respondents perceived many indoor risks as controllable and therefore of little concern when compared to those that originated from outside the home (Crighton, 2013).

Implications for Advance Practice Nursing

Although nurses have numerous qualities that make them ideal environmental risk communicators, "for the most part, nurses remain an under-recognized and under-utilized source of expertise in environmental health efforts (Butterfield, 2002, p. 33)." Nurse practitioners are in a unique position in the primary care setting to communicate environmental health risk information to individuals and communities, especially in rural settings. In rural areas, there are significant provider shortages, thus nurses and nurse practitioners are often utilized as trustworthy medical expert in educating rural residents about their health (Lemley & Marks, 2009). In addition to being a resource in rural

communities, nurses are overall the most trusted profession. Nurses have ranked as the number one trusted profession on the Gallup honesty and ethics survey for the past 12 years with the exception of 2001 when firefighters slipped above nursing after the events of the September 11th world trade center tragedy (Newport, 2012). Trust is essential when communicating risk to a community. Vincent Covello stated that,

> "only when trust has been established can other goals, such as education and consensus building, be achieved. Trust can only be built over time and is the result of ongoing actions, listening, and communication skill." (Covello, Peters, Wojtecki, & Hyde, 2001, p.386).

Given that building and maintaining trust is at the heart of effective risk communication, the nursing professional is in an ideal field to distribute environmental health risk information (Aakko, 2004). In addition, nurses often exude the characteristics of an effective risk communicator by being caring, empathetic, dedicated, committed, competent, experienced, honest, and open (Aakko, 2004).

In clinical practice, nurse practitioners can be advocates for educating patients and families about harmful environmental hazards. For example, during well child visits or adult annual visits, the nurse practitioner can ask patients/families screening questions regarding radon and bacteria in well water such as: "Are you aware that Montana has high levels of radon? Have you tested your house for radon? Do you use well water as your primary drinking source? Have you had your well tested this year for bacteria or other contaminates?" These standard screening questions become a great vehicle to educate families on resources available to help mitigate exposure to these hazards. In addition, the nurse practitioner can utilize risk perception theory during the conversation with the families to decrease concern on those perceived hazards that have been

overestimated while increasing concern and awareness for those underestimated concerns. One example of this intervention may entail emphasizing to patients that West Nile virus and is extremely a rare virus and exposure can be further reduced by simple protection measures such as the use of mosquito repellents contaminating DEET, eliminating standing pools of water around the house, or wearing long sleeves or pants during periods of high exposure to mosquitoes.

Given that nurse practitioners are ideal environmental risk communicators in the primary care setting, nurse practitioners need to be educated on environmental health hazards, risk perception theory, and how risk perception affects risk communication efforts (Aakko, 2004). Effective risk communication addresses a community's outrage, fear, and uncertainty as well as educating on a particular environmental hazard (Aakko, 2004). Studies have shown that many primary care providers do not feel adequately trained to address environmental health concerns with their clients (Beitz & de Castro, 2010). However slowly environmental risk assessment, prevention, and management material is starting to be integrated into some nurse practitioner programs with positive results, yet more emphasis on environmental health hazards and risk communication efforts is necessary (Beitz & de Castro, 2010). In order to effectively protect patients from the array of environmental health hazards, nurse practitioners need to be knowledgeable on environmental health risks and have an awareness of the environmental risk perceptions of the communities they serve.

Limitations

Although this study has provided valuable risk perception data that is consistent with risk perception theory research, there are numerous limitations of the study. The study utilized is a small sample size and thus the reader should be cautious about making broad generalizations on the findings. In addition, the sample also suffers self-selection bias as all the participants agreed to participate and were referred by the local health department. This sample does not fully capture all the low-income rural families as it selected for only those willing to participate and those that sought public resources. Also, this study did not include all the potential environmental health risks that low income families may face. Finally, the self-selection resulted in only women respondents and mainly Caucasian; thus this data should not be generalized to men and other races.

Future Research

Risk perception research has shown demographics including race and gender to be a significant factor influencing an individual's risk perception (Bickerstaff, 2004; Miller & Solomon, 2003). Future studies may include utilizing a large randomly selected sample addressing environmental risk perceptions that could be more easily generalized to other genders, races, and regions. In addition, there is an opportunity to research risk perception data and its use in designing risk communication strategies and materials.

Conclusion

Environmental health exposures are increasing and science is linking disease burden to environmental causes. Rural residents are not immune from these environmental exposures but may actually have increased exposures risks. Disease prevention efforts are necessary to maintain a healthy community. Trusted leaders, especially nurse practitioners, have a unique opportunity to help in this effort to educate about and prevent environmental health hazards especially in rural areas. Understanding environmental risk perceptions are vital to risk communication efforts to encourage behavioral change interventions in order to mitigate environmental health exposures. Rural health professionals, politicians, and local leaders should have a vested interest in understanding risk perceptions of the rural populations they serve.

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